CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice (Core)

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

General comments

In general this paper was well answered by the majority of candidates.

Candidates did very well on **Question 12**.

Question 15 proved most difficult for the candidates.

Other questions causing difficulty were **Questions 16, 19, 28**, **29**, **30**, **34**, **38** and **40**.

Comments on specific questions

Question 3

In this question candidates confused the results of a test for starch with a test for reducing sugar.

Question 8

There was some evidence of guessing in this question involving insects and their use of oxygen. The question involved quite a lot of reading and a diagram. A large number of candidates believed that insects use carbon dioxide and release oxygen.

Question 12

Almost all candidates correctly answered this question on what living organisms get from their food.

Question 13

This question on deforestation was also very well answered.

Question 15

Candidates chose the incorrect **B** and **C** more often than the correct answer, **D**. They are expected to recognise the symbols of the elements, and to know that nitrogen gas is a diatomic element.

Question 16

Candidates chose the incorrect **A** more often than the correct answer, **C**. They should know that electrons surround the nucleus of an atom and are not present in the nucleus of an atom.

Question 18

Candidates chose the incorrect **C** more often than the correct answer, **A**. They are required to know that the electrolysis of dilute sulfuric acid using inert electrodes produces hydrogen at the negative electrode and oxygen at the positive electrode.

Question 19

There was evidence that many candidates had guessed at the answer. They should know that carbon monoxide is formed by the incomplete, rather than complete, combustion of carbon-containing fuels.

Question 20

There was evidence that many candidates had guessed at the answer. They are expected to be able to identify metals and non-metals and know that non-metal oxides are acidic.

Question 24

A significant proportion of more able candidates chose the incorrect **B** rather than the correct answer, **A**. They should know that aluminium is extracted from the ore bauxite by electrolysis. They should also know that copper is extracted from its ore by heating with carbon.

Question 25

Some candidates chose the incorrect **C** rather than the correct answer, **A**. They are expected to understand that nitrogen dioxide is a pollutant gas, and as such is not present in clean air.

Question 26

Candidates are required to know that petroleum is a mixture of saturated hydrocarbons, and that it contains limited amounts of alkenes.

Question 28

This question on speed–time graphs was not well answered, with more than half the candidates opting for the incorrect **D**. These candidates simply multiplied the final speed by the total time.

Question 29

A very common error here was to fail to subtract the mass of the empty measuring cylinder from the total mass, leading to a choice of option **D**.

Question 30

The topic of this question was moments. Both of the incorrect options **B** and **D** were more commonly chosen than the correct **C**. **D** is arrived at by failing to choose the correct unit, and **B** combines this mistake with dividing the weight by the distance to the pivot.

Question 31

Almost one in three candidates believed geothermal resources to be non-renewable, therefore choosing option **A**.

Question 32

It was common for candidates to think that water gives out heat as it evaporates.

Question 33

A significant number of candidates believed that convection could occur in a vacuum, leading them to opt for **B**.

Question 34

The topic here was refraction of light through a parallel-sided glass block. A large majority of candidates thought that the ray would either pass straight through undeviated (option **C**) or refract away from the normal on entering the block (option **D**).

Question 37

Popular misconceptions were that either current and p.d. (option **A**) or p.d. and resistance (option **D**) shared the same units.

Question 38

Fewer than a quarter of candidates could answer this question on resistance and current in a parallel circuit correctly. Most were unaware that the combined resistance would be less than 3.0 Ω, leading to them choosing either **C** or **D**. However of these, slightly more than half did know that the greater current would be in ammeter Q.

Question 40

Here both options **B** and, particularly, **D** were more commonly chosen than the correct **A**. The mistakes leading to these were either confusing mass number with the number of neutrons (**B**) or combining this error with mixing up which number is the mass number and which is the atomic number (**D**).

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

In general this paper was not well answered and there was evidence of quite a lot of guessing at the answers.

Question 2 proved to be particularly straightforward for the candidates.

Questions 16, **19**, **23**, **25** ,**31**, **35**, **40** and, particularly, **37** and **38** were difficult for the candidates.

Comments on specific questions

Question 2

Most candidates had no difficulty in working out the magnification of the beetle diagram.

Question 3

There was some evidence of guessing in this question involving food tests. In particular candidates appeared to confuse the tests for reducing sugar and starch.

Question 5

This question asked what factors increase the rate of transpiration. Although the majority of candidates correctly identified temperature, most of them thought a low wind speed increased transpiration rate.

Question 7

Many candidates may have guessed the answer to this question about water uptake and wilting. Almost all of them chose either the highest uptake and lowest loss, or the lowest uptake and highest loss, suggesting that they have failed to connect the ideas of uptake and loss, and simply assumed it was one of the extremes.

Question 10

In this question on fertilisation in a plant, a majority of candidates confused pollination and fertilisation.

Question 16

There was evidence that many candidates had guessed at the answer, with more able candidates choosing the incorrect **A** rather than the correct answer, **D**. They should know that oxygen molecules are diatomic.

Question 18

Candidates chose the incorrect **C** more often than the correct answer, **D**. They are required to understand reduction as the loss of oxygen from an oxide.

Question 19

There was evidence that many candidates had guessed at the answer. Most higher performing candidates chose the incorrect **A**, **C** and **D** rather than the correct answer, **B**. They are expected to know that acids react with carbonates to produce carbon dioxide, an acidic gas.

Question 20

Candidates chose the incorrect **B** more often than the correct answer, **A**. They are expected to be able to identify metals and non-metals, and know that metal oxides are basic.

Question 21

There was evidence that many candidates had guessed at the answer. Candidates should know that the halogens have seven outer-shell electrons, and that there is a trend in the colour of the halogens down the group.

Question 23

There was evidence that many candidates had guessed at the answer. Higher performing candidates chose the incorrect **B** rather than the correct answer, **A**. They are required to know that aluminium, a finite resource, is extracted from its ore by electrolysis.

Question 24

Many candidates chose the incorrect **B** rather than the correct answer, **D**. They should understand that although carbon dioxide is a greenhouse gas, it is not an air pollutant.

Question 25

There was evidence that many candidates had guessed at the answer. Candidates are expected to be able to describe the manufacture of lime from limestone in terms of the chemical reactions involved.

Question 28

A good majority of candidates knew that the unit for mass is the kilogram, but half of these failed to select the correct unit for gravitational field strength.

Question 29

To calculate density, as many multiplied the mass by the volume (option **B**) as performed the correct division (option **C**).

Question 31

The topic of this question was quantities needed to calculate the work done by a force. Both of the incorrect options **B** (force and mass) and **D** (force and weight) were more commonly chosen than the correct **A** (force and distance moved).

Question 32

Most candidates knew the relationship between gas pressure and the speed of molecules, but many of these believed that cooling the gas would increase its pressure (option **B**).

Question 35

Although it was widely known that electron transfer is involved in the charging process, it was commonly believed that in this case they moved from the cloth to the rod, possibly suggesting that candidates believed them to have a positive charge.

Question 36

Many candidates thought that the charge carriers in a metal wire are ions.

Question 37

By far the least popular option here was the correct one. Few candidates were aware that the lamp is brightest in circuit **D** because the circuit has the least combined resistance.

Question 38

There was a similar situation in this question on the magnetic field pattern around a wire. Only a small proportion of candidates recognised the correct pattern and direction of the field lines.

Question 40

In this question on half-life, the majority of candidates chose the incorrect option **C**. Candidates were required to determine that the question asked for the rate of emission **two** half-lives earlier, not one.

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Paper 0654/13
Multiple Choice (Core)

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

General comments

In general this paper was well answered although there was evidence of quite a lot of guessing at the answers.

Candidates did very well on **Questions 1**, **6**, **28** and **29**.

Questions causing the most difficulty were **Questions 14, 21, 24, 34**, **36**, **40** and, particularly, **39**.

Comments on specific questions

Question 1

Most candidates had no difficulty in attributing the characteristics of movement and sensitivity to the action of a dog fetching a ball.

Question 3

There was some evidence of guessing in this question involving food tests. Many candidates believed that the test for fat involves heating rather than the test for reducing sugars.

Question 5

Almost all candidates realised that protein and chlorophyll require different ions, however, a small majority believed that nitrate was needed for chlorophyll and magnesium for protein rather than vice versa.

Question 6

Candidates had no problem identifying citrus fruits as a good source of vitamin C.

Question 9

In this question candidates were asked to interpret data from graphs depicting heart rate and pupil diameter. Almost all of them correctly chose a point on the graphs that indicated increased heart rate after a shock, but a significant number believed that pupil diameter would decrease, suggesting that they were interpreting the graphs correctly, but believed adrenaline decreased pupil size.

Question 14

Candidates chose the incorrect **B** and **D** more often than the correct answer, **C**. They are required to describe methods of separation, including chromatography.

Question 20

Candidates chose the incorrect **A** more often than the correct answer, **C**. Candidates are required to know that the acidic gas chlorine bleaches litmus paper.

Question 21

Candidates chose the incorrect **B** and **D** more often than the correct answer, **C**. The incorrect **A** was also a popular distractor for high performing candidates. Candidates should know that metal oxides are basic and have high pH values.

Question 22

Candidates chose the incorrect **D** more often than the correct answer, **B**. They are expected to know the melting point and reactivity trends of the elements descending Group I of the Periodic Table.

Question 24

Candidates, including high performing candidates, chose the incorrect **D** more often than the correct answer, **B**. They should understand that carbon is more reactive than copper and so is used to extract it from its ore.

Question 25

Many more able candidates chose the incorrect **B** rather than the correct answer, **A**. Candidates are expected to know that nitrogen is relatively unreactive, and that oxygen and water are required for iron to rust.

Question 26

A significant proportion of the higher performing candidates chose the incorrect **D** rather than the correct answer, **B**. Candidates should know that methane is the main constituent of the fossil fuel natural gas.

Question 27

A significant proportion of higher performing candidates chose the incorrect **C** and **D** rather than the correct answer, **A**. Candidates are expected to describe the formation of poly(ethene) from ethene as an example of addition polymerisation.

Questions 28 and 29

Few candidates had difficulty with these two questions on equilibrium of forces and pressure.

Question 31

In this question on solidification, the incorrect option **D** was a more popular choice than the correct **A**. The candidates choosing **D** were aware that the substance was solidifying, but failed to notice that, at 18 minutes, its temperature was still dropping.

Question 34

Although the relationship between frequency and pitch of a sound was widely known, many candidates apparently believed that an increased amplitude causes a quieter sound.

Question 36

Fewer than one in four candidates could calculate resistance, with a large majority either multiplying the values of current and p.d. or dividing current by p.d.

Question 38

It was quite commonly believed that a fuse provides a constant current in a circuit.

Question 39

The topic here was the direction of the force on a current-carrying wire in a magnetic field. Few candidates could determine this, although it was widely known that it would still be at right angles to the field lines after the changes.

Question 40

All three incorrect options here were more popular than the correct one, suggesting widespread guessing of the effect of α-emission on a nucleus.

CO-ORDINATED SCIENCES

Paper 0654/21
Multiple Choice (Extended)

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

General comments

This paper was fairly well answered, but there was widespread evidence of guessing in some of the questions.

Question 13 was very straightforward for candidates.

Candidates found **Question 15**, **20** and **31** to be particularly difficult**. Questions 12, 20**, **25**, **28**, **34**, **37**, **38** were also difficult for candidates.

Comments on specific questions

Question 2

In this question a significant number of candidates confused the terms flaccid and plasmolysis.

Question 4

This question involved interpreting a graph and choosing correct statements about it. There was evidence of guessing, possibly suggesting that many candidates did not read both parts of each statement, since they should have realised that if an enzyme denatures it will not act faster.

Question 6

Some candidates may have guessed at which secretions of the pancreas are enzymes. Reiterating the nomenclature of enzymes to ensure that candidates are aware that almost all enzyme names end in 'ase' would have solved this.

Question 8

Many candidates believed that photosynthesis involves only two molecules of carbon dioxide and water for every six of oxygen. Using the blank space on the multiple choice exam paper for rough working is acceptable and could help some candidates.

Question 12

There was widespread guessing at the answer to this question about energy passed down to the next trophic level. All of the processes stated either use energy, or are a direct loss of energy (excretion), therefore the answer must be **A**.

Question 13

This question on deforestation was very well answered.

Question 14

Some of the more able candidates chose the incorrect **A** rather than the correct answer, **C**. They should be able to describe and explain separation of a coloured mixture by chromatography.

Question 15

Candidates chose the incorrect **B** and **C** more often than the correct answer, **D**. They are expected to recognise the symbols of the elements, and to know that nitrogen gas is a diatomic element.

Question 17

Candidates chose the incorrect **B** more often than the correct answer, **A**. They should be able to calculate stoichiometric reacting masses and volumes of gases, using relative formula mass, the mole and the molar gas volume, 24 dm^3.

Question 18

Candidates chose the incorrect **A** more often than the correct answer, **D**. They are required to identify endothermic and exothermic reactions, and understand that in exothermic reactions the reacting chemicals lose energy as thermal energy.

Question 20

Candidates chose the incorrect **B** and **C** more often than the correct answer, **A**. They should be able to identify oxidising agents as substances that cause the loss of electrons, oxidation, of another substance. They should also be able to identify reducing agents as substances that cause the gain of electrons, reduction.

Question 24

Lower performing candidates chose the incorrect **C** rather than the correct answer, **B**. Candidates are expected to describe the reaction of a more reactive metal with the aqueous ions of a less reactive metal.

Question 25

Candidates chose the incorrect **C** and **D** more often than the correct answer, **A**. They are required to know how a car exhaust system uses a hot catalyst to remove carbon monoxide and nitrogen monoxide.

Question 28

This question on speed–time graphs was not well answered, with slightly more than half the candidates opting for the incorrect **D**. These candidates simply multiplied the final speed by the total time.

Question 29

Most candidates could calculate the resultant force on the rocket, but a common error after this was to multiply the resultant force by the mass instead of dividing, leading to a choice of option **B**.

Question 31

This question on energy was particularly badly answered, with all three incorrect options being more popular than the correct **D**. Particularly common choices were **C** (found by multiplying the output energy by the efficiency instead of dividing) and **B** (found by failing to multiply by the gravitational field strength in the calculation for gravitational potential energy).

Question 32

Many less able candidates seemed unfamiliar with the term thermocouple and often opted for **A** (expansion) or **B** (pressure).

Question 34

A majority of candidates could not recall the direction of refraction of light entering a glass block.

Question 37

Slightly fewer than one in three candidates could recognise the current–voltage characteristics of an ohmic resistor and a filament lamp.

Question 38

Many candidates could not answer this question on resistance and current in a parallel circuit correctly. Most were unaware that the combined resistance would be less than $3.0\,\Omega$, leading to them choosing either **C** or **D**. However of these, most did know that the greater current would be in ammeter Q.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

This paper was generally well answered.

Candidates performed very well on **Question 1, Question 5, Question 13 and Question 14.**

Question 16 proved most difficult for the candidates. Also proving difficult were the physics **Questions 31** and **32**.

Comments on specific questions

Question 2

Almost all candidates knew that osmosis involved the movement of water, but they were divided on whether it moved from a concentrated solution to a dilute one, or vice versa.

Question 9

In this question candidates had to interpret a diagram of an eye and its muscles. There was some confusion over radial and circular muscles, and the involvement of ciliary muscles.

Question 11

Candidates were confident that variation does not occur due to environmental differences only, but were less certain about the effect of genetic differences.

Question 13

This question on increase in atmospheric carbon dioxide was very well answered.

Question 14

Candidates understood well how to separate a soluble solute and an insoluble impurity from water.

Question 15

Candidates knew well the similarities and differences in the composition of different isotopes of the same element.

Question 16

Candidates chose the incorrect **B** and **C** more often than the correct answer, **A**, with even a large proportion of more able candidates choosing the incorrect **C**. Candidates should be able to construct and use symbol equations, with state symbols, including ionic equations. They should understand that ionic equations do not include spectator ions.

Question 18

Candidates understood very well the effect of changing reaction conditions on the frequency of collisions between reactant particles.

Question 20

A significant number of more able candidates chose the incorrect **D** rather than the correct answer, **B**. Candidates are expected to know that acids react with carbonates to produce carbon dioxide, an acidic gas.

Question 22

Candidates understood very well that argon is used to fill lamps because it is unreactive.

Question 23

Candidates were easily able to deduce the order of reactivity of the metals from the statements about the reactions of the metals with other metal compounds.

Question 31

This question on energy was not well answered, with many candidates choosing the incorrect option **D**. This is arrived at by simply multiplying the two values given (height and gravitational field strength).

Question 32

This question on energy was particularly badly answered, with the incorrect options **A** (geothermal) and **B** (nuclear fission) being much more popular than the correct **D**.

Question 36

A common error here was to confuse the current–voltage characteristics of an ohmic resistor with that of a filament lamp, leading to a choice of option **A**.

Question 37

This question was on resistor combinations. Almost half the candidates opted for **C**, this being the option with the smallest number of resistors. They were unaware that adding a resistor in parallel would reduce the combined resistance.

Question 39

A majority of candidates recognised the shape of the magnetic field around a current-carrying wire, but several of them failed to choose the correct direction of the field lines.

CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice (Extended)

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

General comments

This paper was generally well answered with little evidence of guessing.

Candidates performed very well on **Question 1** and **Question 4**.

Questions 21 and **23** proved most difficult for the candidates. The physics questions were answered well, although candidates found **Question 28** the most difficult.

Comments on specific questions

Question 1

Almost all candidates realised that a dog fetching a ball is showing movement and sensitivity.

Question 4

Candidates interpreted this enzyme graph very well.

Question 9

While the majority of candidates realised that a cold environment produces vasoconstriction and a hot one vasodilation, many of them believed it was the capillaries rather than the arterioles that showed this change.

Questions 12 and 13

These questions on ecosystems and deforestation were very well answered.

Question 15

Candidates were able to identify the mixture of an element and a compound from the diagrammatic representations.

Question 21

Many candidates chose the incorrect **D** rather than the correct answer, **B**. Candidates are expected to know the melting point and reactivity trends of the elements descending Group I of the Periodic Table.

Question 23

Candidates chose the incorrect **B** more often than the correct answer, **A**. They should be able to relate the method of extraction of a metal from its ore to its position in the reactivity series. They are expected to know that calcium is a relatively reactive metal which requires electrolysis for its extraction because it is more reactive than carbon, whereas copper can be extracted from its ore by heating with carbon because it is less reactive than carbon.

Question 28

In this question on speed–time graphs, option **A** was almost as popular as the correct option **B**. Candidates making this mistake seemed to relate a speed of zero with an acceleration of zero.

Question 29

Although a sizeable majority of candidates was aware that the graph is a straight line, a significant number of these could not use the values shown to determine which of the two options was correct.

Question 30

Almost half chose the correct option here, but many chose option **B**, dividing the distance travelled by either the force or the time for which it acted.

Question 31

A common error in this question was to determine the efficiency by dividing the useful energy transferred by the wasted energy, so arriving at option **B**.

Question 34

A majority of candidates was aware that a lower-pitched sound is related to a decreased frequency, but quite a large proportion of these also thought that a quieter sound is caused by an increased amplitude.

Question 39

Although it was widely known that the magnetic field is at right angles to the directions of both the current and the force acting, one in three of these candidates opted for the wrong direction (from Q to P).

CO-ORDINATED SCIENCES

Paper 0654/31
Core Theory 31

Key messages

Candidates had 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 often done well with working shown.

General comments

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

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

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

A number of candidates continue to cross out a correct answer and replace it with an incorrect answer.

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

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

Comments on specific questions

Question 1

(a) This question was well answered. Many candidates gained 2 or 3 marks.

(b) The ovum was not well known as the female gamete. Ovary and ovule were frequently suggested.

(c) Some candidates labelled structures found in plant cells. A few candidates misunderstood the question and drew labelled diagrams of the male and female gametes.

(d) Some candidates confused embryo with zygote. The uterus was well known as the place where the embryo is implanted.

Question 2

(a) (i) Most candidates were able to identify sample **A** as clean air and give an explanation in terms of the proportion of oxygen and other gases being correct.

(ii) Carbon dioxide and hydrogen were sometimes identified as gas **X**.

(b) (i) Many candidates knew that sulfur dioxide causes respiratory problems.

(ii) Very few candidates knew a source of sulfur dioxide in the air. Many suggested acid rain.

(iii) Many different correct responses were given.

(iv) Most candidates suggested a suitable pH value for acid rain.

(v) Limestone and lime were not well known as chemical substances used by farmers to treat soil acidity. A common error was fertiliser.

(c) (i) Many candidates were able to draw the electronic structure of the sulfur atom.

(ii) This was well answered.

Question 3

(a) (i) Force **C** was identified as the weight by most candidates. Downward force was sometimes suggested.

(ii) This was not well answered. Few candidates answered the question by referring to the magnitudes of forces **A** and **B**. Most described the forces as opposite.

(b) (i) Most candidates were able to suggest a frequency above 20 000 Hz for the frequency of ultrasound.

(ii) Many candidates chose to divide the speed by the time rather than multiply speed by time. Other candidates divided their answer by two.

(iii) Very few candidates were able to calculate the distance between the sea floor and the submarine. This was most easily achieved by dividing the distance calculated in **(b)(ii)** by two.

(c) (i) The definition of isotope was not well known.

(ii) Few candidates were able to describe what happens to the nucleus of a uranium-235 atom during nuclear fission.

(iii) There were very few correct responses in terms of no carbon dioxide emissions or reliability.

Question 4

(a) (i) Many candidates misread the question and suggested resting rather than yoga.

(ii) This calculation was not well done. Many candidates misread the value for the pulse rate during rest and most candidates were unable to complete the percentage increase calculation.

(b) (i) Few candidates understood the question and consequently did not name either of the reactants in aerobic respiration. Carbon dioxide and water were often seen.

(ii) Few candidates referred to energy in their answers.

(c) (i) Adrenaline was well known as the hormone that causes the pupils in the eye to widen.

(ii) Plasma was not well known as the component of blood that transports hormones. Red blood cell was a common incorrect response.

Question 5

(a) (i) Ethene (**D**) was quite well known as an unsaturated hydrocarbon. Carbon monoxide (**A**), methane (**C**) and ethane (**E**) were all popular incorrect responses.

(ii) Very few candidates knew the aqueous bromine test for unsaturated hydrocarbons. Some candidates found it difficult to describe the colour changes (if any).

(b) (i) Carbon monoxide and carbon dioxide were not well known as the possible combustion products of ethane. Some candidates suggested substances such as water, hydrogen and carbon, which were not shown in Table 5.1.

(ii) Ethanol was not well known as the compound made when ethene (**D**) reacts with steam.

(iii) Few candidates were able state that poly(ethene) is the polymer made using ethene (**D**) as a monomer.

(iv) Many candidates were able to draw the structure of ethane (**E**). Some showed a double bond between the two carbon atoms rather than a single bond.

(c) Carbon dioxide and methane were frequently chosen as the two greenhouse gases from Table 5.1.

Question 6

(a) (i) Very few candidates were awarded all three marks. Most candidates knew the correct symbols for the ammeter and voltmeter. Many knew to connect the ammeter in series. Few candidates knew that the voltmeter needed to be connected in parallel with lamp A.

(ii) Some candidates knew that component X is a resistor, but few identified it as a variable resistor.

(b) (i) Some candidates were able to determine the potential difference across lamp A as 7.2 V.

(ii) The correct answer, 10 Ω, was often given.

(iii) Few candidates were able to explain why the combined resistance of the two resistors in parallel had to be 2.4 Ω. Candidates were not expected to calculate this value but to note that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

(c) Many candidates were awarded one mark but few were awarded two marks.

Question 7

(a) Most candidates were able explain that a herbivore only eats plants but few could link this idea to that of the animal getting its energy by eating plants.

(b) (i) Teeth X and Y were not well known. Front teeth and back teeth were frequent wrong answers.

(ii) Canines were quite well known as the other type of tooth.

(iii) Mechanical digestion was not well known. Chemical digestion and ingestion were frequently seen incorrect answers.

(c) Few candidates identified both of the statements that describe the process of absorption.

These were food molecules cross the wall of the small intestine and food molecules enter the blood.

(d) Most candidates gained at least one mark. Usually for knowing that iodine solution is used to test for the presence of starch.

Question 8

(a) Most candidates gained full marks here.

(b) (i) Ethanol or water were not well known as compounds, Carbon was often suggested.

(ii) Ethanol and water were often suggested as two solvents from the list.

(iii) Copper was sometimes identified as a transition element.

(iv) Chlorine was sometimes identified as a halogen. Oxygen was also frequently suggested.

(v) Chlorine and oxygen were sometimes identified as diatomic molecules. Water and ethanol were also frequently suggested.

Question 9

(a) (i) Few candidates referred to expansion during hot weather in their response. Many candidates suggested that it was designed to slow the trains down.

(ii) This calculation was well done by many candidates.

(b) (i) Candidates either gained two marks here or zero.

(ii) Many candidates attempted a calculation which was not necessary. Candidates needed to remember that work done equals energy transferred.

(c) (i) The harmful effects of ionising radiation were well known.

(ii) Few candidates were able to suggest a suitable method of storing the nuclear waste during the train journey.

(d) Few candidates were able identify the three missing radiations. Even fewer were able to place them in their correct positions.

Question 10

(a) Many candidates realised that the seeds in test-tube **B** did not have water.

Some candidates realised that seeds in test-tube **D** did not have a suitable temperature.

A few candidates realised that the seeds in test-tube **C** did not have oxygen.

(b) (i) Phototropism was sometimes confused with photosynthesis.

(ii) Candidates needed to explain that plants grow towards the light to maximise their exposure to light energy so that they are able to photosynthesise.

(c) Cuticle and palisade were not well known.

Question 11

(a) (i) Many candidates did not realise that they were expected to name the salt produced i.e. magnesium sulfate.

(ii) Some candidates did not describe observations that could have been made but named the products.

(iii) Some candidates were able draw the dot-and-cross diagram to show the bonding in a hydrogen molecule.

(b) (i) The number of different elements shown in the formula of sulfuric acid is 3. This was the most common answer seen.

(ii) The total number of atoms shown in the formula is 7. Many obviously incorrect numbers were suggested.

(c) (i) Many candidates were able to describe at least one physical property of metals.

(ii) Few candidates were able to determine that the alloy contained 96% magnesium and so there were 48 kg of magnesium contained in 50 kg of the alloy.

Question 12

(a) (i) Few candidates correctly determined the average time as 35.3 s.

(ii) Molecules moving faster was not suggested by many candidates.

(iii) Most candidates correctly identified gases and liquids from their descriptions.

(b) (i) Some candidates correctly drew the arrow going away from the cyclist or towards the car driver, but many other candidates drew the arrow in the opposite direction.

(ii) Few candidates were able to identify the angle of incidence.

(c) (i) Radiation was quite well known as the method of energy transfer between the Sun and the Earth.

(ii) Conduction was quite well known as the method of energy transfer through the frame of the bicycle.

(iii) Few candidates suggested using a magnet to test whether the frame of the bicycle was made from steel or aluminium.

CO-ORDINATED SCIENCES

Paper 0654/32
Core Theory

Key message

Candidates had 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 often done well with working shown.

General comments

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

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

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

A number of candidates continue to cross out a correct answer and replace it with an incorrect answer.

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

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

Comments on specific questions

Question 1

(a) This question was quite well answered. Many candidates gained 1 or 2 marks. Few candidates realised that krill is a herbivore.

(b) This question was well answered. Most candidates drew two arrows in the direction of the orca.

(c) Some candidates knew that the Sun is the principal source of energy for all food chains. Some candidates incorrectly suggested phytoplankton. Light or light energy was not accepted as an answer.

(d) (i) Few candidates were able to state the word equation for photosynthesis. Most candidates named the four substances but did not know whether they were reactants or products.

(ii) Chloroplast was the most popular response and the correct response.

Question 2

(a) This question was not well answered. Many candidates thought that the halogens form covalent molecules with metals.

(b) (i) Some candidates knew the number of protons and others knew the number of neutrons. Few candidates knew both. The number 37 was a popular suggestion for both the protons and neutrons.

(ii) Some candidates knew that the protons and neutrons are contained in the nucleus. Popular incorrect suggestions were electrons, inner shell and outer shell.

(c) (i) Cathode was more popular than the correct response anode. Graphite electrode was also a popular suggestion.

(ii) Few candidates identified hydrogen as the other gaseous product of the electrolysis. Many suggestions were solid substances.

(iii) This question was not well answered. There were a number of possible answers but good electrical conductor was the only correct response seen.

(iv) A few candidates were able to explain that in a chemical change new substances are made and that the change cannot be reversed.

(d) Many candidates knew why the drinking water for a town is treated with chlorine.

Question 3

(a) Force or weight was better known than area.

(b) (i) Few candidates suggested using a magnet to test whether car wheels are made from steel or aluminium.

(ii) Some candidates chose to divide the force by the distance rather than multiply force by distance.

(iii) Very few candidates were able to state that the turning effect of a d.c. motor could be increased by increasing the current or voltage.

(c) Friction was better known than electrons.

Question 4

(a) Some candidates correctly determined that the number of people with polydactyly was five. Less candidates identified four people with a heterozygous genotype.

(b) Most candidates correctly completed the genetic diagram although many were unable to correctly determine the percentage likelihood of the offspring not having polydactyly.

(c) (i) Very few candidates were able to define the term gene.

(ii) Few candidates knew that the sex chromosomes present in the body cells of a human male is XY. Popular incorrect responses were XX, X, Y and sperm.

(iii) The nucleus was quite well known as the structure in cells that contains the genetic material.

Question 5

(a) (i) The correct answer, experiment **D**, was the most popular answer. However, a number of candidates suggested experiment **B**, presumably due to confusion between large particle size and large surface area.

(ii) A stopwatch was known by most candidates.

(b) (i) Very few candidates explained that the student needed to check the colour against a pH chart to determine the pH.

(ii) Any value for pH below seven was accepted.

(c) (i) Many candidates were awarded one mark for showing a single shared pair of electrons.

(ii) Covalent bonding was well known.

(d) Few candidates were able to give clear descriptions of the differences in the structure between a liquid and a gas.

Question 6

(a) (i) Most candidates correctly determined that the energy transferred as sound was 5 J.

(ii) Most candidates were awarded at least one mark.

(iii) Many candidates correctly determined the mass as 12 kg.

(b) (i) Many candidates seemed to understand what the electrical hazard was but few could give a clear statement. There were some very vague answers.

(ii) The candidates' explanations of why the identified hazard was not safe were much clearer.

(c) (i) The normal was the correct and most popular response.

(ii) All four angles were equally popular.

(iii) Some candidates knew that angle of incidence = angle of reflection.

Question 7

(a) (i) Most candidates were awarded at least one mark. Some were awarded three marks. All answers were equally well known.

(ii) The liver (part **A**) and the pancreas (part **C**) were both well known.

(b) Many candidates showed a good understanding of the process of assimilation.

(c) (i) Most candidates were awarded at least one mark. Some were awarded three marks.

(ii) Few candidates knew all three elements and so failed to score.

(**iii)** Most candidates knew that calcium is important in the diet because it strengthens teeth and bones.

Question 8

(a) (i) A finite resource is a non-renewable resource that is no longer being made or is being made extremely slowly.

(ii) Few candidates knew that bauxite is the ore of aluminium from which aluminium is extracted.

(b) Few candidates were able to give two physical or chemical properties of aluminium that make it suitable for use as food containers. Possible answers here included aluminium being unreactive or having a low density.

(c) (i) This part was not well answered. An alloy is a mixture of metals. Some candidates referred to a compound.

(ii) Some candidates correctly determined that there was 83.8 g of aluminium in 100 g of the alloy.

(iii) Most candidates identified at least two transition elements.

Question 9

(a) (i) Candidates needed to identify the two animals and show that they knew the connection between pitch and frequency.

(ii) Some candidates were able to state the range of frequencies emitted by a bat that a human is able to hear.

(b) (i) Most candidates correctly determined the time taken by the bat to travel 200 m.

(ii) Reliability was the only correct response seen.

(iii) Water was not a sufficient response to this question.

(c) (i) The position of ultraviolet radiation in the electromagnetic spectrum was well known.

(ii) Many different correct responses were seen including skin cancer and sunburn.

Question 10

(a) Trachea and bronchus were quite well known. Alveoli were often confused with bronchioles.

(b) Few candidates were able to describe even one way in which the composition of expired air is different from inspired air.

(c) Some candidates knew that diffusion is due to the random movement of particles. Other candidates knew that diffusion occurs across a cell membrane. Few candidates knew both.

(d) (i) Stomata were well known as the parts of the leaf where water vapour exits.

(ii) Some candidates knew that transpiration is the evaporation and then diffusion of water out of a leaf.

(iii) Many candidates knew the factors that increase the rate of water loss from a leaf but did not state whether it was an increase or decrease in these factors. For example, an increase in temperature or a decrease in humidity.

Question 11

(a) (i) Few candidates knew that methane is the main constituent of natural gas.

(ii) Coal and petroleum were acceptable answers. Petrol, diesel and oil were not accepted.

(iii) Many candidates identified carbon dioxide as another greenhouse gas.

(b) Some candidates drew very clear structural formulae for methane.

(c) (i) Equations showing two molecules of oxygen and two molecules of water were frequently given,

(ii) Most candidates correctly described the observation made during an exothermic reaction.

(d) (i) Many candidates were able to identify diagram C as an alcohol.

(ii) Few candidates were able to describe the test to distinguish between a saturated and an unsaturated hydrocarbon.

Question 12

(a) (i) Some candidates drew the correct circuit diagram. Others seemed to forget about the lamp or did not attempt the question

(ii) Some candidates correctly identified component **X** as a fuse. Many suggested that it was a battery or cell.

(iii) Very few candidates knew the purpose of a fuse.

(b) Alpha, beta and X-rays were all common correct answers

(c) Many candidates were able to do the calculation but few managed the unit conversion from kilograms to grams.

(d) (i) Ethanol, methanol and mercury were all popular responses. Some candidates were able to identify all three liquids.

(ii) Few candidates were able to state the physical property of the liquid in the thermometer that varies with temperature.

CO-ORDINATED SCIENCES

Paper 0654/33
Core Theory 33

Key message

Candidates had 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 often done well with working shown.

General comments

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

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

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

A number of candidates continue to cross out a correct answer and replace it with an incorrect answer.

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

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

Comments on specific questions

Question 1

(a) This question was not well answered. Many candidates suggested species rather than organism.

(b) This question was well answered. Part **A** (prostate gland) was the link that was often incorrect.

(c) The nucleus was quite well known as the cell structure that contains the genetic material.

(d) Chloroplasts, cell walls and vacuole were all frequently suggested. Chlorophyll was not accepted.

Question 2

(a) (i) Most candidates were awarded at least one mark. This was usually for the chromatography links.

(ii) Water was rarely suggested as the solvent in aqueous copper sulfate. Copper or sulfur were common incorrect suggestions.

(iii) Very few candidates were able to suggest a use for bitumen such as road surfacing.

(b) Many vague answers were given. The purpose of filtration is to remove solid particles and the purpose of chlorination is to kill microbes, etc.

(c) Most candidates were awarded at least one mark. This was often the mark for recognising that the molten lead bromide is the electrolyte. Few candidates knew that the electrolyte contains free moving ions.

Question 3

(a) (i) Most candidates knew that ultraviolet radiation causes sunburn.

(ii) Fewer candidates were able to place ultraviolet in the correct position in the electromagnetic spectrum.

(b) Force or weight was better known than area.

(c) Few candidates managed to complete the calculation. Some candidates chose to multiply the weight by the mass rather than divide weight by mass.

(d) (i) This question was quite well answered.

(ii) This question was quite well answered.

(e) (i) Some clear and accurate diagrams were drawn by many candidates.

(ii) There were many correct calculations. However, some candidates chose to multiply the mass by the volume rather than divide mass by volume.

Question 4

(a) (i) Many candidates were able to work out the areas cleared in 2004 and 2007, but few could calculate the percentage change.

(ii) Few candidates referred to less photosynthesis.

(iii) Loss of habitat was the most popular correct answer. Few candidates were able to suggest more than one undesirable effect of forestation on the environment.

(b) Feeding, respiration and excretion were all commonly suggested ways that living animals transfer carbon in the carbon cycle.

Question 5

(a) Most candidates were awarded at least one mark. This was usually for the metal/non-metal column. The colour of chlorine gas was not known.

(b) Few candidates knew that the Group VII elements are known as the halogens.

(c) Most candidates were awarded at least one mark for correctly identifying two correct statements about iodine.

(d) This chemical test was not known. Many candidates did not attempt it.

(e) Some candidates knew something about diffusion but did not refer to diffusion in their responses.

Question 6

(a) (i) Whilst many candidates correctly calculated the current in hotplate A as 6 A, many others multiplied the two numbers together rather than dividing voltage by resistance.

(ii) Some candidates knew that the circuit arrangement was a parallel circuit.

(iii) Few candidates were able to explain why the combined resistance of the hotplates in parallel had to be 20 Ω. Candidates were not expected to calculate this value but to note that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

(b) (i) Conduction was not well known. Evaporation was a popular incorrect response.

(ii) There were very few correct responses that showed a convection current.

(iii) Surface and energy were well known as the two words that correctly completed the sentences about evaporation.

(iv) The boiling point of water was not that well known.

(v) More candidates thought that the temperature of water increases while it is boiling than thought that it stayed the same.

Question 7

(a) Most candidates were awarded at least one mark for correctly identifying enzyme activity.

(b) Temperature was well known as a factor that affects enzyme activity.

(c) Few candidates suggested that nitrogen is a chemical element found in all enzymes**.**

(d) Few candidates were able to answer this question correctly. The only smaller molecule correctly identified was amino acids from which proteins are made.

(e) Many candidates identified one of the correct statements about absorption.

Some candidates ticked more than two statements.

Question 8

(a) (i) Few candidates correctly identified both the reactants and the products in the reaction. A number of candidates suggested water as either a reactant or a product.

(ii) Many candidates knew the factors that increase the rate of a reaction but did not state whether it was an increase or decrease in these factors. For example, an increase in temperature or a decrease in particle size.

(**iii)** Few candidates were able to explain what exothermic means.

(iv) This question was well answered.

(b) (i) Some candidates correctly determined that the percentage of magnesium in the alloy is 89%.

(ii) Some candidates correctly determined that there was 1.8 kg of aluminium in 20 kg of the alloy.

(iii) Many vague answers were given. Few candidates mentioned the fact that the alloy would be stronger.

Question 9

(a) Many candidates gained full marks on this question.

(b) Nuclear fission was not known as the process by which a nuclear fuel produces heat.

(c) Many candidates correctly determined that there are 145 neutrons in one atom of plutonium-239.

(d) (i) Very few candidates were able to write the word equation for the decay process.

(ii) Very few candidates were able to describe an alpha particle as a helium nucleus.

(e) Few candidates were able to place the three radioactive emissions in order of their ionising ability.

Question 10

(a) (i) Few candidates were able to identify either the upper epidermis or the spongy mesophyll.

(ii) Few candidates were able to draw an arrow to show the pathway of water vapour during transpiration. Many candidates drew the arrow in the opposite direction.

(b) Some candidates correctly labelled the axes of the graph, but were unable to sketch the correct graph.

(c) A few candidates correctly identified the root hair cell as the type of plant cell that absorbs water from the soil. Many candidates suggested root cell.

(d) Xylem was quite well known.

(e) A few candidates were able to suggest a reason why not all the water absorbed is lost through transpiration.

(f) (i) A few candidates gave very clear responses to describe the function of white blood cells.

(ii) A few candidates identified one component of blood. Many others described the functions of blood and the materials transported in the blood.

Question 11

(a) Few candidates were able to state that non-metals form acidic oxides and metals form basic oxides.

(b) Many candidates gave clear descriptions of the differences between a solid and a gas.

(c) Most candidates knew one of the words used to describe the structure and bonding in diamond – giant and covalent. Ionic and polymer were popular incorrect suggestions.

(d) (i) Many candidates successfully balanced the equation for the reaction.

(ii) Few candidates determined the electronic structure of a sodium atom as 2, 8, 1 and of a chlorine atom as 2, 8, 7. A number of candidates gave the structures of a sodium ion and a chloride ion.

(iii) Many candidates found it difficult to describe the reaction of lithium with water and to describe the trend in the reactivity of Group I elements.

Question 12

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

(ii) Most candidates correctly determined the speed of the cyclist.

(iii) Many candidates were able to explain that the graph showed the cyclist moved at constant speed because the line had a constant gradient.

(b) (i) Most candidates were awarded one mark for showing that kinetic energy increases as speed increases. Fewer candidates knew that it was chemical energy in the cyclist's body that decreases in this energy transfer.

(ii) Many candidates correctly described the change in motion of the air molecules as moving faster.

(c) Many candidates were awarded one mark for explaining that spanner **X** had a longer handle. Few candidates could connect the longer handle to producing a greater moment.

CO-ORDINATED SCIENCES

Paper 0654/41
Extended Theory 41

Key messages

Candidates should read the stimulus material carefully and follow the guidance given. Questions with command words that require candidates, for example, to use information in a diagram, state, explain, describe, use the correct notation, show, identify, calculate, suggest, list and use ideas all require different types of responses. Marks were often missed because the candidate has not answered all aspects of the question using the required terminology. This was evident in **Question 1(a)(iii)** where many candidates did not use the letter 'a' for recessive alleles and the letter 'A' for dominant alleles, in **Question 2(c)(iii)** where the equation given was not balanced and in **Question 8(d)** where general differences between diamond and graphite were listed rather than why graphite is used as an electrical conductor but diamond is not.

Candidates should try to match their answers with the number of marks available for that part of the question. A question worth 3 marks will require 3 separate marking points. For example, **Question 6(c)** where the candidate was required to suggest how the positive charge is produced on the bee as it flies through the air. For this question candidates need to mention electrons, the direction in which electrons move and the cause of the movement of these electrons for the 3 marks. Candidates should attempt all questions even if they only know one part of the answer, for example, **Question 4(b)** which required three ways aerobic respiration is different from anaerobic respiration in humans. Some candidates did not attempt this question rather than try to think of at least one difference.

When completing calculations candidates need to state the expressions or formulae required before attempting the calculation, to show all their working, to express their answer to an appropriate number of significant figures and to include the unit as required. Candidates also need to read the question carefully to ensure all the values given are in the appropriate units, for example, in **Question 4(a)(ii)** the unit of 2 hours needed to be converted to 120 minutes and in **Question 6(a)(ii)** where the unit of 0.20 g needed to be converted to 0.00020 kg.

Candidates should use correct scientific terminology and scientific language when describing phenomenon and have a good understanding of the definitions and specific scientific terms used in the syllabus. This was particular important in **Question 1(a)(ii)** where homozygous recessive was required to describe 'aa', in **Question 1(b)(i)** where goblet cells were required as the answer, in **Question 2(a)** where a full description of a hydrocarbon was needed, in **Question 5(b)** where definitions of an acid and base were required in terms of being a proton donor and proton acceptor respectively, in **Question 6(d)** where candidates needed to know about Brownian motion as evidence for the molecular model of matter and in **Question 9(d)** where a description of thermal energy transfer was required in terms of molecular vibrations and transfer of electrons.

General comments

A high standard of vocabulary, legibility and scientific knowledge were displayed by the majority of candidates. The use of scientific knowledge and scientific terminology was generally good with just a few candidates giving vague responses which prevented them from accessing all the available marks for a question. Candidates appeared to have sufficient time to complete the question paper.

Most candidates completed the required calculations throughout the question paper and these calculations were attempted in a logical manner with clear steps including the use of expressions, formulae and units when required. Some candidates had difficulty rearranging equations and balancing chemical equations.

Comments on specific questions

Question 1

(a) (i) Most candidates gained the first mark for identifying the number of people with the genotype aa. The number of people with the sex chromosomes XY was more challenging, with many candidates giving the answer 1, 3 or 5.

(ii) The majority of candidates only wrote homozygous or only wrote recessive but homozygous recessive is required to fully answer this question.

(iii) Candidates who followed the instructions and used 'a' for recessive alleles and 'A' for dominant alleles usually gave the correct parent gametes, offspring genotypes and the percentage likelihood of the child having cystic fibrosis. A few candidates gave the parent P gametes and the parent Q gametes as AA rather than Aa but were still awarded marks as an error carried forward. Other candidates gave aA and aA as the parent P gametes and the parent Q gametes and were unable to complete the genetic diagram. Many candidates did not follow the instructions and used letters P and Q or X and Y to represent the parent gametes.

(b) (i) Some candidates gave goblet cells as the answer. Many other candidates gave answers such as ciliated cells, cilia, blood cells and villi.

(ii) Many candidates linked the idea that the thick and sticky mucus produced by the cells lining the airways to the idea that this mucus traps bacteria. Fewer candidates then explained that the cilia were unable to remove the mucus containing the trapped bacteria.

(c) The majority of candidates gave smoking as a major cause of lung cancer.

Question 2

(a) Many candidates were able to describe a hydrocarbon as containing hydrogen and carbon. However, a significant number of candidates did not state that a hydrocarbon only contains the elements hydrogen and carbon. Marks were not awarded when a hydrocarbon was described as an element, a mixture or an atom.

(b) (i) Many candidates identified the type of bond in an alkane as being a single bond.

(ii) Many candidates identified C_3H_8 as the molecule that is a saturated hydrocarbon.

(c) (i) The other type of hydrocarbon was usually identified as an alkene. Common incorrect answers included named hydrocarbons such as methane, ethane and propane.

(ii) Candidates found this question challenging with many vague answers such as heat, hot, temperature and pressure. Some candidates also confused a catalyst with a catalytic converter. The best answers about the conditions needed for cracking were a high temperature or a stated high temperature and the need for a catalyst or the need for a high pressure.

(iii) Many candidates did not balance the equation for the cracking of $C_{24}H_{50}$ correctly. These candidates tried to add a hydrocarbon such as C_2H_4 in the space before the C_6H_{12} rather than the number 2.

(d) The majority of candidates linked sulfur dioxide to acid rain but usually linked carbon monoxide to global warming rather than poisoning of living organisms.

Question 3

(a) Candidates found this question about the advantage of generating electricity from nuclear fission challenging. Many candidates gave vague answers such as nuclear fission being renewable, sustainable, environmentally friendly, cheap or not harmful.

(b) (i) Many candidates gained one mark for giving the correct nuclide notation for beta but often gave the answer for the atomic number of lanthanum as 55 rather than 57. A significant number of candidates did not attempt this question.

(ii) The majority of candidates attempted to calculate the time taken for the mass of barium-141 to decrease by 10 g. These candidates showed clear steps in their calculations, but some gave their final answer as the mass left rather than the time taken. A few candidates tried unsuccessfully to calculate the time taken by using proportion rather than halving the mass four times from 160 g to 10 g.

(c) (i) Many candidates gave the correct expression, pressure = force / surface area, but failed to rearrange this equation and substitute the given values of pressure and surface area to show that the force is 2.2×10^6 N.

(ii) Many candidates gained one mark for giving the equation for calculating the moment of the force but fewer were able to rearrange the equation to give the distance *d*.

(iii) Candidates found this question about explaining why the velocity of blade A changes challenging. These candidates gave incomplete answers such as velocity is a vector, velocity can change, speed changes and blade A is spinning rather than realising that the velocity changes because the direction of blade A is changing.

Question 4

(a) (i) The majority of candidates identified sugar C as the sugar with the largest volume of gas produced.

(ii) Most candidates were able to calculate the rate of respiration for sugar A in cm^3 / min. Some candidates did not convert the value from the table of volume of gas produced in 2 hours into volume of gas produced in 120 minutes.

(iii) The majority of candidates gave carbon dioxide as the name of the gas produced during anaerobic respiration in yeast. Incorrect answers included oxygen and ethanol.

(iv) The majority of candidates gave bread making or fermentation as their answer to the practical use for the anaerobic respiration of yeast.

(b) Most candidates realised that one difference between aerobic respiration and anaerobic respiration is that only aerobic respiration requires oxygen. Some candidates wrote about aerobic respiration releasing more energy or not having lactic acid as one of the products. Other differences were not as well known. A few candidates thought that anaerobic respiration in humans has ethanol as one of the products or that aerobic respiration is faster.

(c) This question about the characteristics of living organisms was very well answered.

Question 5

(a) The majority of candidates identified pH 1 as the pH value of a strong acid.

(b) Candidates that gained marks for this question usually identified that dilute hydrochloric acid is a donor and aqueous sodium hydroxide is an acceptor but were unable to identify that they were a proton donor and a proton acceptor respectively.

(c) (i) The majority of candidates were able to write a symbol equation using the information given in the question, but a few found it more challenging to balance the symbol equation. A few candidates missed the arrow between the reactants and products.

(ii) The test for carbon dioxide using lime water and giving a positive result of a white precipitate was well known by candidates.

(d) Candidates found this question about calculating the number of moles of sulfuric acid and the number of moles of copper oxide to determine the limiting reactant in the reaction challenging. Many candidates only calculated the relative formula mass of sulphuric acid and copper oxide and then compared these answers giving copper oxide being the limiting reactant as it had a smaller value. Other candidates only calculated the number of moles of sulfuric acid and the number of moles of copper oxide and then just gave the numerical value of 0.02 or the difference between 0.025 and 0.02 on the answer line.

Question 6

(a) (i) Many candidates stated the expression speed = distance / time and then rearranged this expression to correctly calculate the maximum distance a bee can travel in 60 seconds. A few candidates did not rearrange the expression correctly and attempted to calculate the distance by dividing the speed by the time.

(ii) Many candidates stated the expression kinetic energy = $\frac{1}{2} \times \text{mass} \times \text{velocity}^2$ to calculate the kinetic energy of the bee. The mass of the bee was given as 0.20 g in the question and many candidates did not convert this mass into 0.00020 kg before substituting the numerical values into the expression.

(b) The majority of candidates gained a mark for stating that a difference between visible light and ultraviolet light was the wavelength or the frequency. A few candidates incorrectly gave the wavelength of visible light as being less than the wavelength of ultraviolet light. The similarity between visible light and ultraviolet light was more challenging. A few candidates gave the answer that they are both transverse waves or both travel at the same speed, but many candidates thought that both visible light and ultraviolet light are visible to humans.

(c) This question about how the bee becomes positively charged as it travels through the air was challenging to many candidates. Incorrect ideas included the bee collecting positively charged pollen which makes it positively charged, the bee leaving the negative charge on the flower, the bee having more energy and so more charge, positive electrons moving onto the bee from the flower and protons moving from the air to the bee. Candidates that mentioned electrons moving from the bee to the air also usually mentioned that this was due to friction between the bee and the air as the bee was moving through the air.

(d) Many candidates did not attempt this question. Some candidates did not describe how Brownian motion provides evidence for the kinetic molecular model of matter but just described what happens to pollen when suspended in water. Many answers given by candidates were just simple descriptions about pollen moving on the surface of water. Other candidates confused Brownian motion with diffusion or wrote about the increase in the movement and kinetic energy of particles when temperature increases or an increase in the frequency of successful collisions between particles.

Question 7

(a) The majority of candidates identified the optimum temperature as 25 °C, amylase particles gain kinetic energy and at temperatures above 75 °C all the amylase has become denatured. Fewer candidates identified the substrate as starch, the product as simpler sugars and the active site having changed in shape.

(b) The majority of candidates gave the answer of the pancreas for one part of the alimentary canal that secretes amylase. Another part of the alimentary canal that secretes amylase was not well known with vague answers such as the mouth, the stomach and oesophagus seen.

(c) (i) Most candidates identified carbon, hydrogen and oxygen as the chemical elements present in all proteins but often missed out nitrogen. Amino acid was a common incorrect response.

(ii) Candidates usually gave the name of the test as Biuret but there were a few candidates who gave the answer burette or Benedict's test.

Question 8

(a) Most candidates gave the answer D and often put a ring around the boiling point being –183 °C, showing that they had understood that oxygen is a gas at room temperature.

(b) (i) Many candidates gave clear ordered steps in the calculation of the volume occupied by 224 g of oxygen gas. Some candidates gave the relative molecular mass, M_r, for oxygen as O = 16 rather than O_2 = 32 in the calculation and then calculating the moles of O_2 as 14 rather than 7. The final answer of 336 gaining these candidates just 2 marks rather than 3 marks.

(ii) The majority of candidates described the property of iron when chromium is added as not rusting or being more resistant to rusting. A few candidates incorrectly described various changes in melting points and boiling points because of the change in bonding between the iron and chromium.

(c) Most candidates gained one mark for drawing one dot and one cross in one of the overlapping circles between the H and the N. The completion of the whole diagram was more challenging with many candidates adding extra dots and crosses or forgetting to complete the electronic structure with eight electrons in total.

(d) This question required candidates to explain why graphite is used as an electrical conductor, but diamond is not. Many candidates only described general differences between the structure of graphite and diamond such as graphite is soft, metallic and can be used as a lubricant, and diamond as hard, transparent and used to make tools and jewellery rather than answer the questions about graphite being used as an electrical conductor. Most candidates gained just one mark for stating that graphite has electrons that can move and diamond does not have electrons that can move.

Question 9

(a) (i) Candidates found this question about explaining why the peak at X was different to the peak at Y very challenging. Few candidates explained that as the magnet is falling it is increasing in speed and that the peaks were caused by the South pole and then the North pole of the magnet passing through the coil of wire.

(ii) Most candidates sketched the data to show that both peaks would be smaller but very few candidates realised that the shape of the graph would be the same and that the line would cross the *x*-axis at the same point.

(b) Candidates usually ticked that potential difference is equal to work done per unit charge and relates to the energy transferred by a circuit component. Fewer candidates ticked that electromotive force is equal to work done per unit charge and relates to the energy supplied by the source.

(c) The majority of candidates gained one mark for understanding that the forces between atoms are strong, that this allows the atoms to vibrate but keeps the atoms in a fixed position. Fewer candidates appreciated that in solids the arrangement of atom is regular or ordered or in a lattice. Many candidates gave answers such as the arrangement being small, arranged or random.

(d) Many candidates gave answers that included atoms vibrating and that these vibrations are passed onto the next atom. Fewer candidates gave answers that included the transfer of free electrons.

Question 10

(a) (i) In this question candidates were expected to compare photograph A taken in 1985 with photograph B taken in 2000 to conclude that there was a decrease in areas of forest in photograph B. Then candidates needed to explain why this decrease affected the concentration of carbon dioxide in the atmosphere. Most candidates gained one mark for stating that there would be an increase in the carbon dioxide in the atmosphere. However, only a few candidates linked this increase in carbon dioxide to a reduction in photosynthesis.

(ii) The majority of candidates were able to give several effects of a decrease in the areas of forest on animal species in the area. These usually included migration, the habitat being destroyed and lack of suitable food sources.

(b) Many candidates did not give a complete definition of an ecosystem as a unit containing all of the organisms and their environment interacting together in a given area. These candidates did not include the idea of the environment or of the organisms interacting together.

(c) Many candidates stated that the Sun is the principal source of energy in the ecosystem, but some candidates only mentioned that light is involved. Other candidates thought that the principal source of energy are the green plants or producers.

(d) The majority of candidates were able to state one advantage of asexual reproduction and this was usually that asexual reproduction is faster than sexual reproduction or that asexual reproduction is still possible if the plant is isolated. Fewer candidates were able to give a second advantage of asexual reproduction. The idea that favourable traits are kept was not well understood.

Question 11

(a) (i) Most candidates gave the answer of bromine, but a significant number of candidates gave the answers of bromide, oxygen or lead.

(ii) Many candidates gave answers in terms of electron transfer rather than the idea that ions are able to move.

(b) Many candidates did not attempt to construct the ionic half-equation for the formation of copper. Candidates that attempted to construct the ionic half-equation usually did not give the correct notation for the two electrons as $2e^-$ or tried to include $CuSO_4$ or C in their answer.

(c) (i) Many candidates did not suggest the change in mass of the cathode after the electrolysis. Those candidates that did suggest a value usually gave the answers of 0.0 or –0.62.

(ii) Candidates found this question about explaining why the anode loses mass very challenging. Many candidates wrote about the anode oxidising, copper reacting with sulfate and the anode losing oxygen. Few candidates understood that copper atoms become copper ions and that these copper ions move into solution.

Question 12

(a) The majority of candidates gave the relationship of $n = \sin i / \sin r$ but many candidates then did not use this relationship correctly to calculate the refractive index of the glass block. These candidates just divided 53 by 31 to give the answer of 1.71°.

(b) (i) Many candidates gave the answer as 4.8 and did not include the 10^{-7} from the label on the graph as part of their answer.

(ii) The majority of candidates were able to describe how Fig. 12.2 shows that red light travels through glass faster than violet light.

(c) The majority of candidates first calculated the volume of the glass block using the measurements given in Fig. 12.3 and then used this volume together with the density of glass to calculate the mass.

CO-ORDINATED SCIENCES

Paper 0654/42
Extended Theory 42

Key messages

Candidates should read the stimulus material carefully and follow the guidance given. Questions with command words that require candidates, for example, identify the letter, complete the diagram, to use information in a diagram, state, explain, describe, sketch on a graph, show, identify, calculate, suggest, list and predict all require different types of responses. Marks are often missed because the candidate has not answered all aspects of the question using the required terminology. This was evident in **Question 1(b)** where many candidates saw the word 'zygote' and did not see that the cell division was between the zygote and the embryo rather than in the production of the gametes needed to form the zygote, in **Question 5(c)(i)** where the equation given was not balanced and in **Question 12(b)(i)** where the question asked the candidate to explain why the pressure in the radon gas increases rather than just the force exerted on the walls of the container increases when the temperature increases.

Candidates should try to match their answers with the number of marks available for that part of the question. A question worth 3 marks will require 3 separate marking points. For example, **Question 1(c)(ii)** where the candidate was required to describe the function of the placenta and the umbilical cord. For this question candidates need to name the substances involved and the direction of movement of these substances through the umbilical cord as well as a separate description for the placenta being a barrier to toxins for the 3 marks. Also, for **Question 8(b)** which required candidates to explain, using ideas about collisions between particles, why the reaction is faster. Here many candidates only wrote about there being more collisions, gaining just one mark, rather than more frequent collisions because the particles were closer together.

When completing calculations candidates need to state the expressions or formulae used before attempting the calculation, to show all their working, to express their answer to an appropriate number of significant figures and to include the unit as required. Candidates also need to read the question carefully to ensure all the values given are in the appropriate units, for example, in **Question 6(b)(ii)** where three 1.5 V cells are used and not just one 1.5 V cell and in **Question 9(a)(i)** where the distance needs to be converted from cm to m.

Candidates should use correct scientific terminology and scientific language when describing phenomenon and have a good understanding of the definitions and specific scientific terms used in the syllabus. This was particular important in **Question 2(a)(iii)** where the question is about different isotopes of carbon having the same **chemical** properties, in **Question 3(b)** where a description of thermal energy transfer was required in terms of molecular vibrations and transfer of electrons, in **Question 6(a)(ii)** where candidates needed to make sure the angle of incidence is equal to the angle of reflection when completing the ray diagram to show TIR inside the optical fibre, in **Question 6(a)(iii)** when stating clearly what is meant by the term critical angle, in **Question 8(c)** where the labelling of the activation energy and the energy change were not always accurate and in **Question 12(a)(ii)** where candidates were asked to draw lines to match an alpha particle to its correct characteristics and many connected to can penetrate paper when alpha particles cannot penetrate paper.

General comments

A high standard of vocabulary, legibility and scientific knowledge were displayed by the majority of candidates. The use of scientific knowledge and scientific terminology was generally good with just a few candidates giving vague responses which prevented them from accessing all the available marks for a question. Candidates appeared to have sufficient time to complete the question paper.

Most candidates completed the required calculations throughout the question paper and these calculations were attempted in a logical manner with clear steps including the use of expressions, formulae and units when required. Some candidates had difficulty rearranging equations and balancing chemical equations.

Comments on specific questions

Question 1

(a) Most candidates gained the first two marks for identifying B as the part where eggs are released and A as the part where fertilisation occurs. The part where implantation occurs and the part where meiosis occurs were more challenging, with many candidates giving D for implantation and F for meiosis.

(b) Candidates found this question challenging with many candidates thinking that the type of cell division that occurs when a zygote divides to form an embryo is meiosis rather than mitosis. Some candidates confused haploid number with diploid number and other candidates gave vague answers in terms of the cells being the same or the cells being similar rather than the cells being genetically identical.

(c) (i) The majority of candidates stated a function of the amniotic fluid as protection from mechanical damage or protection from external damage such as knocks and bumps.

(ii) The majority of candidates were able to describe functions of the umbilical cord as transferring oxygen from the mother to the fetus and as transferring excretory products from the fetus to the mother. Some candidates only mentioned that oxygen, carbon dioxide, nutrients and waste products are transferred without mentioning the direction in which these different substances were transferred. The placenta providing a barrier to toxins and the exchange of materials being by the process of diffusion were not as well known.

Question 2

(a) (i) The majority of candidates completed the labels to identify the electrons, the protons and the neutrons on the diagram of an atom of one isotope, carbon-14.

(ii) Most candidates completed Fig. 2.2 to show the particles in the nucleus of one of the other two isotopes of carbon by clearly labelling the protons and the neutrons.

(iii) This question about explaining why the different isotopes of carbon have the same chemical properties was challenging. Many candidates gave the answer in terms of the same proton number or same neutron number or same electron number rather than the same number of electrons in the outer shell.

(b) The test for carbon dioxide using lime water and giving a positive result of a white precipitate was well known by candidates.

(c) The majority of candidates identified the carbon and hydrogen compounds with only single covalent bonds as hydrocarbons. However, a significant number of candidates confused saturated with unsaturated.

Question 3

(a) (i) The majority of candidates used the correct symbol for a voltmeter in series with the wire and the correct symbol for an ammeter in the position across the wire.

(ii) Most candidates gave the unit for resistance as the ohm or the symbol Ω. Some candidates multiplied the ammeter reading by the voltmeter reading rather than dividing the voltmeter reading by the ammeter reading.

(iii) The majority of candidates recognised that as the resistance of the wire increases as the length of the wire increases. However, some candidates thought that the resistance of the wire only increases initially and then decreases or remained unchanged as the length of the wire increases. A significant number of candidates did not attempt this question.

(b) Many candidates gave answers that included atoms vibrating and that these vibrations are passed onto the next atom. Fewer candidates gave answers that included the transfer of free electrons.

Question 4

(a) (i) The majority of candidates gave the answer of 10.5 (mm / min) with many candidates using the space below the question to show their calculation.

(ii) The majority of candidates gained one mark for giving the distance moved by the air bubble in 2 minutes decreased by 16 (mm), the process as transpiration and that less water vapour diffuses through the stomata. Fewer candidates appreciated that there is a decrease in the concentration gradient between the inside and outside of the leaf. Many candidates gave answers such as a decrease in the concentration of just water vapour, oxygen or carbon dioxide.

(iii) Most candidates suggested that some of the water is used in photosynthesis. Incorrect suggestions included the water being stored in the xylem, being used in respiration or being used to transport minerals.

(iv) The factors that affect the rate of transpiration were well known with the majority of candidates giving temperature or wind speed as their answer.

(b) (i) Candidates found this question about how transpiration pull causes the movement of water molecules challenging. Few candidates explained that transpiration pull creates a difference in water potential gradient between the top of the xylem and the bottom of the xylem. Many candidates just wrote in general terms about cohesion, adhesion, suction pressure or osmosis.

(ii) The term cohesion was usually given as the term used to describe how water molecules are held together in the column of water.

(iii) This question about one other substance transported in the xylem was not answered well. The majority of candidates gave answers about the substance being oxygen, carbon dioxide or glucose rather than mineral ions.

Question 5

(a) (i) The majority of candidates gave a prediction of the boiling point of chlorine within the acceptable range.

(ii) The majority of candidates gave a prediction of the state at room temperature of bromine as a liquid.

(b) Most candidates ticked the box to show that the reason why bromine has a lower boiling point than iodine being because the forces between bromine molecules are weaker. A few candidates thought that the reason was because bromine is more reactive than iodine.

(c) (i) The majority of candidates were able to write a symbol equation using the information given in the question, but a few found it more challenging to balance the symbol equation. A few candidates missed the arrow between the reactants and products.

(ii) The majority of candidates were able to draw a dot and cross diagram to show the ions formed when sodium bonds with chlorine. These candidates usually included the charges on the ions.

(iii) Most candidates ticked the box to show that the reason why concentrated sodium chloride conducts electricity is because concentrated sodium chloride contains ions that can move. A few candidates thought that concentrated sodium chloride contains electrons that can move.

(iv) Most candidates gave the answer of chlorine, but a significant number of candidates gave the answers of chloride, hydrogen or water.

Question 6

(a) (i) The majority of candidates gave the relationship of $n = \sin i / \sin r$ or $\sin r = \sin 45 / 1.55$ but many candidates then did not use this relationship correctly to calculate the angle of refraction. These candidates just divided 45 by 1.55 to give the answer of 29°. Some candidates stated that the angle of incidence = the angle of refraction and then gave the answer as 45°.

(ii) Most candidates gained one mark for completing the diagram to show how an optical fibre can transmit a ray of light along the fibre by showing the ray of light internally reflecting inside the fibre. However, these candidates usually showed five or more reflections with the angle of incidence very different to the angle of reflection.

(iii) Candidates found it challenging to state what is meant by the term critical angle. Most candidates did not mention the angle of incidence in their answer but just wrote about the angle of refraction being 90°.

(b) (i) The majority of candidates calculated the power input provided by the laser's batteries correctly. A few candidates tried to use the incorrect expression efficiency = (power input / power output) × 100 or the equation $P = IV$ to calculate the power input.

(ii) This question requiring candidates to calculate how long the battery will power the laser for was challenging to many candidates. Most candidates were able to calculate the current using $I = P / V$ but then did not use the equation $t = Q / I$ to calculate the time. Some candidates used just the value of 1.5 V for one cell rather than the value of 4.5 V for the three cells that made up the battery.

Question 7

(a) (i) Most candidates stated the name of the part labelled Y on the diagram of a villus as a capillary. A few candidates only named this part of the villus as a blood vessel or tried to describe the function of this part of the villus in terms of absorption of amino acids and glucose into the blood.

(ii) Most candidates correctly described part X as having the function to absorbed digested fats. A few candidates thought that part X was involved in the digestion of fats rather than the absorption of fats.

(iii) The majority of candidates stated that villi are found in the small intestine.

(b) Most candidates gained a mark for explaining that less nutrients are absorbed so this may cause weight loss in people with coeliac disease. Fewer candidates linked the flattened villi to a reduction in the surface area available for absorption.

(c) Most candidates completed the table for the enzyme protease having the substrate as protein and the products as amino acids. Very few candidates knew that the enzyme amylase has the substrate starch and that the products are simple sugars. These candidates usually wrote carbohydrates or glucose or saliva for the substrate rather than starch.

(d) The majority of candidates gave the answer of the stomach or pancreas for one part of the alimentary canal that secretes protease. Another part of the alimentary canal that secretes protease was not as well-known with answers such as the liver and large intestine seen.

Question 8

(a) (i) The time at which the reaction stops was usually given correctly as 240 (s).

(ii) The majority of candidates started the line at the origin with a steeper gradient and made the line level off at 80 cm^3. Some candidates either did not level the line off or levelled the line off above 80 cm^3.

(b) Most candidates linked the idea that a more concentrated hydrochloric acid has more crowded particles or has more particles per unit volume. These candidates then explained that this causes more collisions or more successful collisions, but a significant number of candidates did not mention that this causes more frequent collisions or more collisions per second.

(c) The majority of candidates attempted to draw an energy level diagram for the reaction between marble chips and dilute hydrochloric acid as an exothermic reaction. These candidates usually placed the products below the reactants and had an activation energy shape curve linking the reactants and the products. However, the labelling of the activation energy and the energy change were not always correct with the activation energy arrow going from the products to the top of the curve and the energy change just being a general downward arrow not specifically from the reactants to the products.

(d) Most candidates were able to calculate the volume occupied by 2.2 g of carbon dioxide gas. Some candidates were able to calculate the relative molecular mass, M_r, of CO_2 as 44 and the number of moles of CO_2 as 0.05 but then multiplied these by 1000 when calculating the volume of CO_2.

Question 9

(a) (i) There was an error in question 9(a)(i). The distance given in the text was different by a power of ten to the distance given in the diagram. This has been corrected in the published version of the paper.
Due to the issue with this question, careful consideration was given to its treatment in marking in order to ensure that no candidates were disadvantaged. A distance of 35 cm converted to 0.35 m from the diagram, or a distance of 3.5 cm converted to 0.035 m from the question text were both acceptable as the distance in the expression moment = force × distance. A significant number of candidates correctly used the expression to calculate the moment but did not convert the distance value from cm to m.

(ii) Most candidates realised that the magnitude of the force would increase when the number of turns on the coil is doubled and the current is doubled. Some candidates were more specific and stated that the magnitude of the force would quadruple as both the number of coils is doubled and the current is doubled.

(b) The majority of candidates stated the expression kinetic energy = $\frac{1}{2} \times \text{mass} \times \text{velocity}^2$ to calculate the maximum kinetic energy of the toy boat. The unit of kinetic energy was usually given as J or joules although some candidates gave the unit as N, W or kg / m^2.

(c) (i) The majority of candidates only stated that the speed was increasing between 0 minutes and 1.5 minutes rather than stating that there was constant acceleration during this time. Most candidates recognised that the speed was a constant value of 3 m / s after 1.5 minutes.

(ii) This question asking candidates to suggest why the shape of the graph is not a realistic description of the toy boat at 1.5 minutes was challenging. Many candidates thought that a toy boat would not be able to reach a speed of 3 m / s, there were other forces acting on the boat or that the toy boat is unable to maintain a constant speed.

Question 10

(a) (i) Nearly all candidates were able to calculate the percentage increase in blood glucose concentration after an injection of adrenalin.

(ii) The liver was usually the answer given for the name of the target organ of adrenaline that causes the changes given in Table 10.1. However, a significant number of candidates gave the names of other organs, for example, heart, pancreas and brain.

(iii) The increase in pulse rate or heart rate was well known as one other effect of adrenaline on the body. However, the effect of adrenaline to dilate pupils or widen pupils was not as well known.

Many candidates gave vague answers such as increasing strength, increasing energy and triggering responses.

(iv) The majority of candidates gave the answer plasma with just some candidates giving answers such as platelets, white blood cells and haemoglobin.

(b) (i) Phototropism was the most common correct answer with hormones, photosynthesis and just tropism being common incorrect answers.

(ii) Auxin as the name of the chemical that controls growth in plant shoots was well known.

(iii) In this question candidates were asked to complete the sentence to define the term growth. This was challenging for nearly all candidates. Some candidates identified that growth was an increase in the cell size or increase in the number of cells but very few candidates recognised growth as a permanent increase in size and dry mass.

Question 11

(a) Most candidates identified B and C as the dyes that are in food colouring X. Many of these candidates confirmed this by drawing horizontal lines on the chromatograph in Fig. 11.1.

(b) In this question candidates were required to 'show your working' and the majority of candidates did show their working. A few candidates did not measure the distance travelled by substance B accurately or may have measured the distance travelled by a substance other than substance B as answers of 5.0, 5.7 and 3.0 were seen. A few candidates divided the distance travelled by the substance B by the distance travelled by substance B rather than the distance travelled by the solvent, giving them an answer of 1.0.

(c) This question required candidates to rearrange the equation given in **(b)** to calculate the distance travelled by substance A. Candidates that were able to rearrange the equation usually gained both marks.

(d) Many candidates gave clear ordered steps in the calculation of the concentration of the solution made in mol / dm^3. Some candidates just gave the number of moles as 0.005 and then did not convert 200 cm^3 into 0.2 dm^3 so giving them an answer of 0.000025 rather than 0.025 and so were just awarded 2 marks rather than the 3 marks available.

Question 12

(a) (i) Many candidates gained one mark for giving the correct nuclide notation for alpha but a few candidates gave alpha with the number 2 above the number 4. A few candidates gave the answer for the atomic number of polonium as 224 or 226 rather than 218.

(ii) This question asking candidates to draw lines to match an alpha particle to its correct characteristics was challenging. Many candidates connected the alpha particle correctly to have a mass of 4 and to have a high ionizing activity but also connected to can penetrate paper.

(iii) Many candidates completed the path of an alpha particle as it travels through the electric field between two charged plates correctly by showing a path curving towards the negative plate. A significant number of candidates did not curve the path.

(b) (i) Most candidates were able to relate the increase in temperature of a fixed volume of radon gas to an increase in the kinetic energy of the atoms of radon. Fewer candidates then linked this to an increased frequency of collision of the atoms of radon with the walls of the container. Very few candidates then explained that this would cause a larger force per unit area and so cause an increase in pressure.

(ii) The majority of candidates first calculated the mass of the radon gas in the container by using the rearranged expression density = mass / volume before using this to calculate the weight of the radon gas in the container.

CO-ORDINATED SCIENCES

Paper 0654/43
Extended Theory 43

Key messages

Successful candidates were well prepared for the examination.

- Candidates are reminded to use the number of marks available as a guide to the level of detail required and time spent on the question. A good guideline is approximately one minute for each mark available.
- Some candidates did not appreciate the difference between 'describe' and 'explain', especially applicable to **Question 10(a)(ii)**. An understanding of 'command' words would be of great value in the examination.
- Learning definitions of keywords in the specification is always very useful, especially applicable to **Questions 10(c)** and **11(a)(ii)**

General comments

Care should be taken to ensure all question are attempted. When annotation of a diagram is required in general there is no answer line provided, so these can easily be missed.

In calculation questions always quote the formula being used and show all steps in working. Numerical answers should be to an appropriate number of significant figures and include units where required. Most of the physics calculation questions were answered correctly.

Candidates are advised to read each question very carefully and to follow any directions given. Sometimes candidates 'fixate' on one two words and miss the point of the question.

Comments on specific questions

Question 1

(a) (i) Most candidates scored this mark with the word 'blockage' or something with the same meaning, such as 'block' or 'cloggage' (sic).

(ii) Many scored both marks but some did not follow the instruction given, as in 'Use Fig. 1.1' and gave factors not included in the data given. Vague answers also missed out, such as 'do exercise' as this does not mention doing more or more frequent.

(iii) Almost all candidates scored this mark.

(b) (i) The necessity of a thick wall to withstand high pressure was well understood by most candidates. However, many candidates did not score further marks as they did not mention muscular/elastic walls to maintain the pressure.

(ii) Almost all candidates scored this mark.

Question 2

(a) The majority of candidates chose the correct response. A small number thought the answer should be 'good thermal conductor'. Perhaps not relating the idea of low density to use in aircraft.

(b) Many suggested aluminium was unreactive and so did not corrode. Others mentioned the formation of an oxide layer but did not indicate this layer adhered to the metal protecting it from further corrosion, even so there were many fully correct responses.

(c) Most were able to access at least part of this question though there was some confusion over malleability. A few thought the alloy would be more malleable than pure aluminium which would make it suitable for aircraft.

(d) Many fully correct responses but some thought a layer of zinc was a barrier to prevent contact of the steel with air and water, missing the point about differences in reactivity.

(e) Unfortunately most candidates scored zero here. The main problem was misinterpretation of the given data, the most common response for M1 was copper. Most appeared to read the table the wrong way round, possibly thinking reactivity increased downwards. Those who did score M1 did not often score any further marks, missing the point about carbon being less reactive.

Question 3

(a) (i) Most candidates had no problem with this question though a small number did do an 'upside down' calculation.

(ii) Generally well answered with most candidates scoring all three marks.

(b) The vast majority of candidates scored both marks.

(c) (i) A few problems here as many candidates stated 'longitudinal waves', correct but does not answer the question, a description was asked for not the wave type. A good case for reading the question carefully and understanding 'command words'.

(ii) Almost all candidates scored this mark.

Question 4

(a) Many fully correct responses. Another example of where learning definitions is very helpful. A fairly common error was to state just 'respiration' rather than aerobic respiration.

(b) (i) Another definition, though most candidates did score this mark.

(ii) The key phrase here for one of the marks was 'genetically identical'. 'Genetically' was often omitted. Most understood the idea of just one 'parent'. Some responses referred to the time or energy requirements of asexual reproduction which was not credited.

(iii) Almost all scored this mark.

Question 5

(a) Almost all candidates achieved full marks on this definition question.

(b) (i) Most candidates understood that ammonia molecules moved faster than hydrogen chloride molecules but very few related this to their molecular masses. Some suggested ammonia molecules had more kinetic energy.

(ii) Many fully correct responses, almost all scored the mark for M_r of ammonia = 17. A few calculated an incorrect M_r but went on to use their value correctly so scoring two marks. Some of those with a correct M_r did an upside down calculation.

Question 6

(a) (i) Most candidates gave the correct response. A small number suggested convection or radiation.

(ii) Some candidates gave a potentially good explanation but did not include any reference to density, which was specifically asked for in the question. A case of 'read the question carefully'. A few thought the density of cold air decreases/hot air increases.

(b) Mostly fully correct. However there was some confusion evident about the effects of temperature and pressure on a fixed mass of gas.

(c) Many fully correct but there were a few vague responses such as 'reduce the speed of the coil' and 'use smaller magnets', perhaps not realising that smaller does not necessarily mean weaker.

Question 7

(a) (i) Mostly correct, with almost all candidates scoring at least one mark.

(ii) Most candidates appreciated the idea of large air spaces but very few mentioned diffusion.

(iii) A goodly number of correct responses. The most common errors were: arrow and labelling of stomata (perhaps not realising the stomata is just a gap, not a cell), arrow to the stomata with 'guard cell' (scored one mark) and arrow to a guard cell but giving a different name to the cell (scored one mark).

(b) This question did cause a few problems. Many candidates correctly stated the use of carbohydrates but did not give the name of a carbohydrate fulfilling the function described. It was also fairly common to see non-carbohydrates such as amino acids and lipids.

Question 8

(a) A large majority of the candidates scored all the available marks on this question. The most common error was to have 'gain' and 'lose' the wrong way round.

(b) Only a few incorrect responses with the following being the most common: copper(II), sulfur, sulfate and Cu^{2+}.

(c) Many completely correct answers, only a relatively small number of candidates did not score on this question. An uncommon error, though one to be aware of, was to assign three negative charges to a single electron. A small number of candidates also included an ionic equation for the production of oxygen, impressive but did not receive any credit. Perhaps another case of read the question carefully.

Question 9

(a) (i) Many fully correct answers though some lacked detail, stating 'increase' or 'decrease' without any numbers. A few candidates gave unexpected, but correct answers such as 'decreases to 50' for the first part.

(ii) A significant number of candidates had no idea how to tackle this question. Even so there were quite a few fully correct and many others scored one or two of the available marks. The main stumbling block was working out the number of half-lives.

(b) (i) Almost all scored both marks and those who did not usually scored one. It was fairly common to see vague suggestions such as 'good for the environment'.

(ii) Many candidates referred to absorption or attraction of heat. Of those who realised radiation/light was the important factor the response often included 'attracts' radiation/light, without mention of black being a better absorber.

(iii) Relatively few fully correct responses. Most candidates favoured the second method and usually scored the first point but then stopped, perhaps missing the information about the area of cells being $0.75\,m^2$.

Question 10

(a) (i) Most candidates scored both marks here, a few did an incorrect percentage calculation.

(ii) Most candidates did a perfectly good description of the changes shown in the graph but did not explain the changes. This question emphasises the importance of understanding the difference between 'describe' and 'explain'. Those who did 'explain' usually scored all three marks.

(b) Very few incorrect responses.

(c) Many fully correct, another question which shows the importance of learning and understanding definitions.

(**d) (i)** Almost all correct with a few 'micro-villi'.

(ii) Many fully correct responses though some did miss the second mark with vague responses such as 'absorb nutrients' or just incorrect: absorb carbohydrates/amino acids/glucose.

Question 11

(a) (i) Well answered with only a very few incorrect responses.

(ii) Only a relatively small number of correct responses. Many were vague (such as 'loses protons') or just repeated the question. Another case of learn the definitions.

(b) (i) Generally well answered but a few gave symbol equations, yet another case of read the question carefully.

(ii) Generally well answered, very few incorrect responses.

(iii) Almost all started correctly with a steeper line but some then flattened the line higher than the original. Even so there were a good number of fully correct lines shown.

(iv) Most understood the idea of increased kinetic energy of the particles. Some otherwise fully correct responses were spoilt by not mentioning the frequency of collisions, just stating 'more collisions'.

(c) This question proved problematic for many candidates though it was common to score the first two marks. Very few candidates were able to show why magnesium was the limiting reactant.

Question 12

(a) (i) The calculation presented few problems but sometimes, even where the calculation was correct, the wrong units were stated. The most common incorrect units were joules, watts and ohms.

(ii) There seemed to a lot of confusion here with many thinking the reading decreased. Of those who scored the first mark only a small number scored for the explanation. A common misconception was that more light made the current travel faster.

(iii) Many fully correct responses. Almost all candidates scored at least one mark quoting the speed of light or a correct equation (without further calculation). The question asked for the minimum frequency, some calculated the maximum frequency, which scored two marks. Another case of read the question carefully or perhaps not understanding the relationship between frequency and wavelength

(b) Mostly well answered with only a few incorrect responses.

(c) Some fully correct responses but the majority scored just one mark. Many candidates did the following calculation (a good start), but then went no further: (360/10.5) × 4.2 and gave the final answer as 144.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

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

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

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

CO-ORDINATED SCIENCES

Paper 0654/53
Practical Test 53

Key messages

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

Answers to the planning question were often detailed and logical.

Candidates found interpreting and evaluating experiments difficult.

It is advisable for candidates to read the questions carefully to ensure they have answered all of what is being asked, this will help ensure that numerical answers are given to an appropriate number of significant figures and that written responses cover all aspects of the question.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques and were quite careful in their experimenting.

The standard of graph drawing was generally quite high although candidates need to remember that axes need to be labelled with quantity and unit and a curve of best fit needs to be a single line.

Candidates had sufficient time to complete the paper.

Comments on specific questions

Question 1

Enzyme controlled reactions.

(a) (i) Almost all candidates recorded the time correctly. A small number did not record to the nearest second.

(ii) Almost all candidates recorded four times. Some did not have the values for the two trials within 10 per cent of ach other. Almost all had the time for the apples much higher than the beans.

(iii) Almost all candidates calculated the average correctly.

(b) The vast majority of candidates appreciated that beans contained more enzymes. The most common incorrect response was the enzyme in beans reacting more quickly.

(c) Candidates found this very difficult with most discussing the enzyme being able to react with the hydrogen peroxide rather than the enzyme being able to reach or mix with the hydrogen peroxide. The other common responses were to increase the surface area and increase the rate of the reaction.

(d) Candidates found this difficult. The most common non-creditworthy response was the beans are at the bottom of the test-tube without saying what the stirring would do to the mixture.

(e) Candidates found this very challenging. Some stated contamination without saying what the contamination would be or that it would be from the apple.

(f) (i) Many candidates drew a fully correct diagram usually collecting the gas in a syringe and some in an upturned measuring cylinder over water, some used a non-volumetric collecting vessel such as a test-tube. Some drew a delivery tube from the test-tube but either omitted the stopper or had the delivery tube under the level of the liquid. Some delivered the gas by downward delivery into a test-tube, beaker or conical flask and often put a stopper into the receiving vessel. The name of the delivery tube was not well known.

(ii) Candidates found this very difficult. The majority repeated the stem of the question or thought that timing does not measure volume or that human reaction time would cause the most inaccuracies.

Question 2

Planning question.

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

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

Many named a thermometer for measuring the temperature but had no means of changing the temperature. Few used a spotting tile.

Many candidates placed all three reagents in a test-tube and waited for the colour to change rather than using a sampling technique at timed intervals. Many also thought the colour would change to blue-black rather than returning to brown as the starch is broken down. Some discussed noting the time when the starch was broken down with no observation which would tell them when this occurred, when both starch was included in the reagents and also when it was not. Whilst many could name a safety precaution few could explain why it was needed.

Many measured the time for the reaction to go blue-black rather than brown. Few repeated at the same temperature so that anomalies could be identified or did the experiment at 5 different temperatures so that a graph could be drawn.

The control variables were quite well known. Keeping the volumes of the solutions the same is insufficient, the reagents of the experiment should be named.

Candidates continue to find processing results and drawing conclusions challenging. Where repeats have been undertaken, averaging is insufficient – the reason for averaging needs to be explained. Citing a conclusion from previous knowledge, stating a hypothesis or simply looking for a pattern in the results is insufficient. The use of the results to formulate a conclusion for the details of their investigation is required, for example does the time increase, decrease or stay the same when the temperature is raised or does the graph show a linear or proportional relationship between the variables.

Question 3

Percentage purity.

(a) The majority of candidates recorded three masses with the order of magnitude correct.

(b) (i) Almost all candidates described the appearance correctly. Turquoise and grey were common incorrect responses. A small number only gave the colour.

(ii) Almost all candidates described the appearance correctly. A small number only gave the colour.

(iii) Many candidates named a safety precaution, but few could explain why it was necessary.

(c) (i) Many candidates tested the gas with limewater and identified carbon dioxide. Incorrect responses included oxygen, ammonia and chlorine.

(ii) Candidates found identifying the carbonate ion difficult. Incorrect responses included oxygen, carbon, nitrate, chloride and copper.

(d) (i) More successful candidates gave a correct colour. Green was the most popular response.

(ii) More successful candidates performed the test carefully and so recorded their observations for a few drops and for an excess of aqueous ammonia. Many recorded the colours without reference to precipitate or the amount of aqueous ammonia added, milky was also common.

(iii) The vast majority of candidates identified the ion correctly. Copper carbonate was a common response.

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

(ii) Almost all candidates calculated the mass correctly.

(iii) Most candidates calculated their value of percentage purity correctly however a significant number did not give the answer to three significant figures.

(iv) Candidates found evaluating the method very difficult. Common non-creditworthy responses included repeat (with no explanation), use a stopwatch to measure 3 minutes, measure the time, measure the amount added and measure the mass outside the test-tube rather than in the test-tube.

(f) Candidates found this difficult. Sulfate rather than the acid was the most common response. Chloride and hydrochloric acid were also quite common.

Question 4

Oscillations of a pendulum.

(a) (i) The vast majority of candidates measured the length of the pendulum correctly. A small number did not follow the pattern in the table and give their answer to one decimal place.

(ii) Candidates found this difficult with few describing how to avoid parallax errors. The most common responses were to use a meter ruler or use a piece of string and then measure that.

(b) (i) Almost all candidates recorded the time.

(ii) Almost all candidates recorded a time smaller than that in **(b)(i)**.

(iii) Almost all candidates recorded all times and they decreased. A very small number only timed one or two of the lengths.

(c) Whilst many calculated the values correctly, many did not record these to one decimal place.

(d) (i) The standard of graph drawing was generally quite good. Some candidates reversed the axes and many omitted the label for the quantity and/or the unit on the axes. Some scales did not start at (0,0) or were non-linear. Plotting of the points was generally good except where scales were awkward and required the use of a calculator when points were usually plotted incorrectly. A small number omitted the question.

(ii) Drawing the best-fit curve proved difficult. Many candidates drew dot-to-dot lines which included point(s) which did not fit on the best-fit curve or drew a straight line. Curves were often feathery or had multiple lines. A small number omitted the question.

(e) (i) More successful candidates read the correct value from their graph. Many gave values which were not read from their graph. A small number omitted the question.

(ii) Many candidates gave a correct relationship. A small number omitted the question.

(f) Candidates found this very difficult, and some omitted the question. Most thought the relationship to be proportional due to one variable increasing as the other variable increased. However, a graph

of proportional variables would be a straight line passing through the origin. Also the ratio of length to time (or time to length) must be constant.

Question 5

Cooling of hot water.

(a) (i) The majority of candidates recorded the temperature. A small number did not record to the nearest 0.5 °C.

(ii) The majority of candidates recorded a smaller temperature. A small number reversed the temperatures.

(b) Almost all candidates recorded the temperatures correctly. A small number did not have the temperature drop smaller than that seen in beaker P.

(c) The majority of candidates used their results correctly to choose the method which gave the lower temperature decrease. The most popular incorrect response compared the final temperature in the two beakers at 180 seconds.

(d) The majority of candidates discussed thicker insulation. Adding a lid or cooling the room temperature were common incorrect responses.

(e) The majority of candidates named a control variable. Room temperature with no indication of higher or lower, same water temperature without specifying when and using a lid on both were common responses.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical 61

Key messages

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

Interpreting and evaluating experiments proved challenging.

It is advisable for candidates to read the questions carefully to ensure they have answered all of what is being asked, this will help ensure that numerical answers are given to an appropriate number of significant figures and that written responses cover all aspects of the question, this was particularly evident in the planning question.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The standard of graph drawing was quite good although candidates need to remember that axes need to be labelled with quantity and unit and to read instructions carefully before drawing lines of best fit.

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

Explaining an answer requires more detail than stating an answer.

Candidates had sufficient time to complete the paper.

Comments on specific questions

Question 1

Testing nutrient content of milk and rice.

(a) (i) Most candidates drew a table with columns and rows clearly indicating food and testing reagent. Some did not include the testing reagents. A small number omitted the question.

(ii) Final positive colours were quite well known, starting colours were much less well known. Many candidates put positive and negative or tick and cross into the table rather than the colours observed or put colours without relating them to the testing reagents. A significant number omitted the question.

(iii) Nutrients were well known. Incorrect responses included carbohydrate and sugar for iodine solution and fat for biuret solution.

(b) (i) Candidates found this challenging. Whilst many appreciated it released the starch from the cells they did not discuss the starch going into the water so that it could be tested. Many thought it was to clean, soften or cook the rice.

(ii) Candidates found this very difficult and most repeated the stem of the question. Most able candidates appreciated that there is only one colour possible with iodine for a positive test. A significant number omitted the question.

(iii) Candidates found this very difficult with few discussing the colour of the milk masking the colour of the test. Incorrect responses included: they are not miscible, this is a not a fat test, ethanol does not work, milk does not contain fat and fat does not dissolve. A significant number omitted the question.

Question 2

Biological drawing.

(a) The majority of candidates drew a large, detailed diagram of the Euglena. Some drew outlines which were sketchy with multiple feathery lines and gaps, a small number were too small or did not include any internal detail.

(b) (i) Many candidates measured the length correctly, the most common error was to give the value in cm rather than mm. Other common responses included 600, 0.6 and 0.06.

(ii) Those that drew the line usually measured it correctly but many either did not draw a line and so the measurement could not gain credit or drew the line outside the euglena but a different length to that of the cell.

(iii) Many candidates calculated their value correctly. A small number inverted the division. Many did not give their answer to two significant figures and rounding was an issue for a significant number of candidates.

(c) Most candidates gained some credit with many identifying two differences and one similarity. Non-creditworthy responses included cell wall, vacuole, one has a nucleus and the other does not, one has one flagellum and the other has two, thick and thin walls, one has chloroplasts, one has no internal structures for the differences. For the similarity many repeated the stem of the question i.e. they are both one cell.

Question 3

Neutralisation.

(a) (i) The majority of candidates read the thermometers correctly. The most common error was recording the temperature at 4 minutes as 29 thus not following the pattern in the table where all temperatures were given to one decimal place. Other incorrect responses included 33, 30.5, 35.5 for 33.5 and 29.5 for 29.0.

(ii) Many candidates named a suitable piece of volumetric equipment. Incorrect responses included syringe, beaker and conical flask. Where a pipette is chosen candidates need to be more precise and name a graduated or volumetric pipette.

(b) (i) Candidates who followed the instructions were able to construct the axes and plot the points correctly. Some reversed the axes and a significant number omitted the label and/or the unit on the axes, many giving C°. Many started the temperature axis from 0 °C and so their points did not cover at least half of the grid. Some candidates did not use a linear scale. Plotting of the points was generally good except where scales were awkward and required the use of a calculator.

(ii) More able candidates followed the instructions and drew the two lines and extrapolated them to 2.0 minutes. Many candidates drew one line often as a curve. A significant number omitted the question.
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(iii) Those candidates who drew the two lines correctly usually read the values from the graph correctly. For those that did not draw the lines many used the values from the table. A significant number omitted the question.

(iv) The majority of candidates subtracted the two values correctly. A significant number omitted the question.

(c) The majority of candidates calculate the value of Q correctly. A significant number omitted the question.

(d) Candidates found this very difficult. Changing the beaker to metal or glass or reducing the temperature were common incorrect responses. A significant number omitted the question.

(e) Whilst many candidates appreciated that the temperature would decrease few quoted room temperature or explained why the temperature decreased. Many thought the temperature would decrease to 0 °C. A significant number omitted the question.

Question 4

Formation of silver chloride.

(a) (i) Many candidates measured the height correctly. 1.3 and 15 were common incorrect responses. A small number omitted the question.

(ii) Many candidates described the relationship correctly. The most common error was not to use the variables in the question. A significant number omitted the question.

(iii) Candidates found this very difficult. Fair test and accuracy of results were the most common non-creditworthy responses. A significant number omitted the question.

(b) Candidates found this drawing very difficult. Frequently the filter funnel was either missing or had no stem, the filter paper had a hole at the base or was laid flat over a beaker and there were no labels. A large number omitted the question.

(c) Candidates found this very difficult with few correct answers seen. The information needed was in the question stem at the top of page 10. White. cloudy and colourless were popular responses with few mentioning silver.

Question 5

Resistance.

(a) The majority of candidates knew the symbol for a voltmeter although a number drew a line through it. Many connected the meter in series rather than in parallel. A significant number omitted the question.

(b) The majority of candidates read the voltage correctly, 2.6 and 2.9 were common incorrect responses. Reading the ammeter proved to be much more difficult, 0.31, 0.3, 0.25, and 0.16 were common incorrect responses.

(c) (i) Whilst many calculated the value of resistance correctly, far fewer recorded the answer to 2 significant figures to match the other values in the table.

(ii) The unit of resistance was well known. Popular answers included N and J. A significant number omitted the question.

(d) Candidates found this very challenging. Common incorrect responses included to stop the current, to not be electrocuted and to reset the meters.

(e) (i) Candidates found this difficult. Many thought the other lamp would shine brighter, V and I would increase, the energy would increase or the power would increase. A small number omitted the question.

(ii) Candidates found this very difficult with few correct answers seen and many omitting the question. Opening or closing the switch were common responses. Few tested each lamp individually.

(f) Candidates found this difficult. Circuit 3 was common with the reason being parallel circuit, circuit 1 was quite common with the reason being it has less power.

(g) Candidates found this extremely difficult with few correct answers seen and many omitting the question. It was expected that there would be 2 calculations, the first either multiplying the

resistance of circuit 2 by 2 or halving the resistance of circuit 1. The second being a 10 per cent calculation of one of these values and a comparison to see if they were within 10 per cent or the ratio of these values and a comparison. Most did not do any calculations but simply stated that the values either were or were not within 10 per cent which was not creditworthy.

(h) The arrangement of the lamps in series and in parallel was well done by the majority of candidates. A few did not use three lamps or drew lines through the lamp symbol. A significant number omitted the question.

Question 6

Planning question.

Candidates found this planning question very difficult. Many did not read the question carefully and so described an experiment that did not enable the aim of the experiment to be investigated. Many described a Hooke's Law experiment measuring extension and some described a pendulum experiment. Consequently, a significant number did not give an answer which was creditworthy in any aspect or omitted the question.

The whole range of marks was seen, few candidates however gave detailed answers gaining full or almost full credit.

A significant number did not name the apparatus they were using, measuring length with no ruler or measuring diameter with no vernier or micrometer. Few repeated with samples of the same wire or then repeated for wires of different materials.

Safety measures were not well known.

Some candidates drew a results table, few contained units.

Control variables were not well known, many used different lengths of different wires.

Candidates continue to find processing results and drawing conclusions challenging. Where repeats have been undertaken, averaging is insufficient – the reason for averaging needs to be explained.

Citing a conclusion from previous knowledge or simply looking for a pattern in the results is insufficient. The use of the results to formulate a conclusion for the details of their investigation is required. For example, look to see when the material of the wire is changed does the mass required to break the wire increase, decrease or stay the same which means there is no relationship. A graph for this experiment was most likely a bar chart or a histogram.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical 62

Key messages

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

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

Candidates need to read the questions carefully to ensure they have answered all of what is being asked, and record values to the precision appropriate for the question and observations with the detail required.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The drawing of the bar chart was generally good although candidates need to remember that axes need to be labelled with quantity and unit and be able to differentiate between a bar chart and a histogram.

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

Candidates had sufficient time to complete the paper as only some of the more demanding questions were omitted.

Comments on specific questions

Question 1

Choice chamber

(a) (i) Most candidates counted the number of animals correctly. The most common error was 5 and 7.

(ii) Candidates found this very challenging with most having part animals, 1.5 and 6.5, rather than rounding to the nearest whole number.

(b) The drawing of the bar chart was generally good. Some candidates omitted the label on the axes or had a non-linear scale. Some drew a histogram rather than a bar chart or had the bars of unequal width.

(c) (i) Almost all candidates chose the correct chamber.

(ii) Candidates found this challenging with many citing fair test. The animal being able to choose or staying where it was put were also popular non-creditworthy responses.

(iii) Candidates found this very challenging and tended not to look back at the data to notice that the two results were very different and so more trials would be needed. Non-creditworthy responses included accuracy and reliability.

Question 2

Movement of molecules through a partially permeable membrane.

(a) (i) The majority of candidates read the scales correctly. The most common errors were 5.1 and 10.4.

(ii) Almost all candidates subtracted the values correctly.

(iii) The majority of candidates calculated the rate correctly, the unit was a little more challenging. Common responses included m / s, cm / m, cm^3 / min and cm / s used alongside the numerical answer for cm / min.

(b) Many candidates appreciated that the water molecules moved into the bag, few explained that the sugar molecules could not move out of the bag. The difference in water potential was well known but few appreciated that if more molecules are inside the bag the volume would be larger and so the solution would need to move up the tube.

(c) Candidates found this very challenging. Many discussed a decrease in water in the tube because the water molecules were moving out of the bag. Few appreciated that the water potential would be the same either side of the bag and so the rate of molecules moving into the bag would be the same as the rate of molecules moving out of the bag.

(d) (i) Benedict's solution was very well known. A small number gave biuret solution.

(ii) The colours of Benedict's solution were very well known. Some gave purple for the colour when reducing sugar present and green, turquoise or colourless for the colour when reducing sugar is not present.

Question 3

Combustion of alcohols.

(a) (i) More successful candidates appreciated the role of stirring. The most popular non-creditworthy response was accuracy.

(ii) Many candidates gave a correct suggestion for reducing both energy losses. Common non-creditworthy responses included stirring for heat loss from the water and insulating the flame for the flame as it heats the water.

(b) (i) More successful candidates recorded both temperatures correctly. The most common error was not recording to the nearest 0.5 °C and recording just 20 rather than 20.0, 38 was also quite common.

(ii) All candidates subtracted their values correctly.

(c) (i) Most candidates recorded the values to 2 decimal places. A small number did not round and so gave 26.63 or recorded both values to 3 decimal places.

(ii) The majority of candidates calculated both quantities correctly. The most common incorrect response was recording the value of Δn as 3.67.

(d) The majority of candidates calculated their value of E correctly. Some used a value of T rather than ΔT or Δm rather than Δn and a small number omitted the question.

(e) (i) Candidates found this very challenging. Most chose the correct result but explained the result was anomalous because it did not fit the pattern rather than suggesting what would have caused the result to be anomalous. Other non-creditworthy responses included human error and misreading the thermometer.

(ii) The majority of candidates stated the relationship. The most common error was not to use the variables in the question.

Question 4

Planning Question.

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

The whole range of marks was seen and a significant number of candidates gave detailed responses gaining full or almost full credit.

A significant number omitted to name the apparatus they were going to use, or simply listed apparatus but then did not use it in the method. Scale is insufficient for balance. Some drew a labelled diagram which helped with the description of the method.

More successful candidates used five different masses of sodium carbonate in order to draw a graph and repeated each one to identify any anomalies. Some used only one or two different masses. Many named a safety precaution without explaining why it was to be used. Some timed the reaction rather than allowing the reaction to reach completion.

Many candidates cited the measurements to be made, amount is insufficient for mass and height.

Whilst not required, some candidates drew a clear results table which showed repeats, five masses, measurements and units.

Control variables were well known. Some controlled the mass of sodium carbonate instead of it being the independent variable.

Candidates continue to find processing results and drawing conclusions challenging. Where repeats have been undertaken, averaging is insufficient, the reason for averaging needs to be explained. Citing a hypothesis or a conclusion from previous knowledge or simply looking for a pattern in the results is insufficient. The use of the results to formulate a conclusion for the details of their investigation is required. If a graph is to be drawn, then the quantities on each axis need to be specified.

Question 5

Images formed by a converging lens.

(a) (i) Most candidates recorded the distance correctly to the nearest 0.1 cm. The most common incorrect response was 3.90.

(ii) The vast majority of candidates calculated the value correctly. Some divided by 5 and a significant number reversed the answers to **(a)(i)** and **(a)(ii)**.

(iii) Almost all candidates used **(a)(ii)** correctly to determine the distance.

(iv) Almost all candidates calculated the value correctly. The most common error was either not quoting the value to 3 significant figures or not rounding their answer correctly.

(b) (i) The vast majority of candidates calculated the value correctly.

(ii) Almost all candidates calculated the value correctly. A small number only divided V_1 by 80.

(c) The vast majority of candidate calculated the average correctly. Some did not divide their addition by 2.

(d) Candidates found this very difficult. The most common response was avoiding parallax.

(e) The majority of candidates interpreted the results correctly and drew two correct diagrams. The most common errors were drawing both diagrams upright or drawing the right hand side diagram the same size.

Question 6

Resistance of two wires.

(a) Many candidates drew the symbol for a voltmeter and connected it in parallel. Common errors included drawing a line through the voltmeter, connecting the voltmeter in series or connecting the voltmeter across only part of the resistance wire. A significant number omitted the question.

(b) Almost all candidates recorded the potential difference correctly. The most common error was misreading the current as 0.23 A.

(c) Most candidates calculated the value correctly. The most common error was not recording the value to 2 significant figures to match the other value in the table.

(d) Most candidates used the values in the table to calculate the two values correctly. A small number divided by the current.

(e) Candidates found this challenging but are beginning to understand what is required by this style of question. It is expected that either 10 per cent of one value is calculated and either added to or subtracted from the original and this compared to the other value or that the ratio of the two values is calculated and compared to 0.1 or 0.9. The most common non-creditworthy response was stating that the values either were or were not within 10 per cent with no calculation. A small number omitted the question.

(f) Candidates found this difficult. The most common response was covering the wire in insulation to keep the heat in.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical 63

Key messages

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

Answers to the planning question were often detailed and logical.

Candidates found interpreting and evaluating experiments difficult.

It is advisable for candidates to read the questions carefully to ensure they have answered all of what is being asked, this will help ensure that numerical answers are given to an appropriate number of significant figures and that written responses cover all aspects of the question.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The standard of graph drawing was high although candidates need to remember that axes need to be labelled with quantity and unit and a line of best fit needs to be a single line and should not include any anomalous points.

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

Candidates had sufficient time to complete the paper.

Comments on specific questions

Question 1

Enzyme controlled reactions.

(a) (i) The majority of candidates recorded the times correctly. The most common incorrect response was copying the stop-watch readings into the table without quoting to the nearest second.

(ii) The vast majority of candidates calculated the average correctly. The most common incorrect response was 81 which is the average of 58 and 104.

(b) The vast majority of candidates appreciated that beans contained more enzymes. The most common incorrect response was the enzyme in beans reacting more quickly.

(c) Candidates found this very difficult with most discussing the enzyme being able to react with the hydrogen peroxide rather than the enzyme being able to reach or mix with the hydrogen peroxide. The other common response was to increase the surface area. A small number omitted the question.

(d) Candidates found this difficult. Non-creditworthy responses included mix, surface area changed or for an even temperature. A small number omitted the question.

(e) Candidates found this very difficult. Common incorrect responses included ruler, beaker, test-tube, pipette and dropper. The volume needing to be measured was 1 cm^3 and so measuring cylinder was insufficient but a 5 cm^3 or 10 cm^3 measuring cylinder was credit worthy.

(f) (i) Candidates found the diagram challenging and a significant number omitted the question. Some did not include a bung in the top of the test-tube, delivered the gas into a non-volumetric piece of apparatus such as a test-tube, beaker or conical flask which were also not upturned and in water. The name of the delivery tube was not well known. A significant number omitted the question.

(ii) Candidates found this very difficult. Many repeated the stem of the question or thought that timing does not measure volume or that human reaction time would cause the most inaccuracies. Some omitted the question.

(iii) More successful candidates remembered the test for oxygen gas. Common incorrect responses included relighting a lit splint, blown out splint, litmus and ethanol. A significant number omitted the question.

Question 2

Planning question.

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

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

Many named a thermometer for measuring the temperature but had no means of changing the temperature. Few used a spotting tile.

Many candidates placed all three reagents in a test-tube and waited for the colour to change rather than using a sampling technique at timed intervals. Many also thought the colour would change to blue-black rather than returning to brown as the starch is broken down. Some discussed noting the time when the starch was broken down with no observation which would tell them when this occurred when both starch was included in the reagents and also when it was not. Whilst many could name a safety precaution few could explain why it was needed.

Many measured the time for the reaction to go blue-black rather than brown. Few repeated at the same temperature so that anomalies could be identified or did the experiment at 5 different temperatures so that a graph could be drawn.

The control variables were quite well known. Keeping the volumes of the solutions the same is insufficient, the reagents of the experiment should be named.

Candidates continue to find processing results and drawing conclusions challenging. Where repeats have been undertaken, averaging is insufficient – the reason for averaging needs to be explained. Citing a conclusion from previous knowledge, stating a hypothesis or simply looking for a pattern in the results is insufficient. The use of the results to formulate a conclusion for the details of their investigation is required, for example does the time increase, decrease or stay the same when the temperature is raised or does the graph show a linear or proportional relationship between the variables.

Question 3

Percentage purity.

(a) (i) Most candidates recorded the masses to two decimal places. Common incorrect responses included 27.6 and 27.1, 27.05 or copying the readings to three decimal places.

(ii) Many candidates named a safety precaution, but few could explain why it was necessary.

(b) (i) Almost all candidates calculated the mass correctly. A very small number gave 0.56.

(ii) Almost all candidates calculated the mass correctly. A very small number gave 1.98.

(iii) Most candidates calculated their value of percentage purity correctly however a significant number did not give the answer to three significant figures.

(iv) Candidates found evaluating the method difficult. Common non-creditworthy responses included repeat (with no explanation), use a stop-watch to measure 3 minutes and measure the mass outside the test-tube rather than in the test-tube.

(c) (i) Candidates found this observation a little challenging. Incorrect responses included fumes, a gas is given off, changes colour, carbon dioxide given off and weight decreases.

(ii) Successful candidates appreciated that this was asking for the test for carbon dioxide gas. Incorrect responses included forms a solution or an emulsion instead of a precipitate. A significant number omitted the question.

(iii) Candidates found identifying the carbonate ion difficult. Incorrect responses included oxygen, carbon, nitrate and chloride.

(d) (i) A small number of candidates remembered how to do a flame test and a significant number omitted the question. Many thought that a beaker or test-tube of the solution should be heated, some described gas tests using a splint, some used tongs, rods, tweezers or scissors to put the solution into the flame or squirted the solution into the flame. A blue flame was rarely used.

(ii) The flame colour of copper was not well known. Blue or green were common incorrect responses, red and orange were also seen.

(iii) Most candidates could not remember this test and many omitted the question. Common incorrect responses included white precipitate, cloudy, gives a precipitate but no colour, bubbles and green precipitate.

(e) (i) Candidates found this very difficult and many omitted the question. Sulfate rather than the acid was the most common response. Hydrochloric acid and nitric acid were also quite common.

(ii) Candidates found the drawing difficult and many omitted the question. Frequently the filter funnel was either missing or had no stem, the filter paper had a hole at the base, was missing or was laid flat over a beaker or a sieve was drawn. There were often no labels or the residue and filtrate labels were reversed.

Question 4

Oscillations of a pendulum.

(a) (i) The vast majority of candidates measured the line correctly. 70.5 was the most popular incorrect response.

(ii) This proved a little difficult for candidates. Those that appreciated the value should be 10 times larger often recorded the value as 75 rather than 75.0 which follows the pattern in the table. Many thought the value should be 70.0 or 80.0 despite measuring the value in **(a)(i)** correctly.

(iii) Candidates found this difficult with few describing how to avoid parallax errors. The most common response was to use a ruler.

(b) (i) Most candidates recorded the time correctly. The most common incorrect response was the stop-watch reading recorded to two decimal places.

(ii) The vast majority of candidates calculated the period correctly. 1.5 and 1.42 were common incorrect responses.

(c) (i) The standard of graph drawing was generally quite good. Some candidates reversed the axes and a significant number omitted the label for the quantity and/or the unit on the axes. Some scales did not start at (0,0) or were non-linear. Plotting of the points was generally good except where scales were awkward and required the use of a calculator when points were usually plotted incorrectly.

(ii) Drawing the best-fit curve proved very difficult. Most candidates included the anomalous point or drew a straight line. Curves were often feathery or had multiple lines.

(d) (i) The majority of candidates read the correct value from their graph. Incorrect responses included 20.4 and 20.5 instead of 24 and 25.

(ii) Most candidates gave a correct response. A small number thought the value decreased.

(e) Candidate found this very difficult, and some omitted the question. Most thought the relationship to be proportional due to one variable increasing as the other variable increased. However, a graph of proportional variables would be a straight line passing through the origin. Also the ratio of length to time (or time to length) must be constant.

Question 5

Cooling of hot water.

(a) (i) The majority of candidates recorded the temperature correctly. 80 and 80.0 were popular incorrect responses.

(ii) Candidates found this very difficult. Incorrect responses included accuracy, reliability and to allow water to warm up or cool down.

(iii) Many candidates discussed the water needing to be an even temperature throughout. Incorrect responses included accuracy and mixing.

(b) The majority of candidates chose the lid and used the fall in temperature in the reasoning. The most popular incorrect reason compared the final temperature at 180 seconds.

(c) Many candidates discussed thicker insulation. Adding a lid or cooling the room temperature were common incorrect responses.

(d) The vast majority of candidates named a control variable. Room temperature with no indication of higher or lower, same water temperature without specifying when were common responses.

(e) Many candidates gave the correct temperature. Many answers were above room temperature or 0 °C.