CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice (Core)

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

General Comments

The majority of candidates successfully selected the correct responses. Candidates should be reminded of the importance of reading the question carefully.

Comments on Specific Questions

Question 1

Almost equal numbers of candidates choose between the correct and two of the incorrect answers. A majority of candidates believed that expired air contained no oxygen, and a substantial number did not realise that air blown into a balloon would be expired air.

Question 2

Almost all candidates realised that an elongating root shows growth and movement, however, a common misconception was that it showed nutrition, rather than sensitivity.

Question 4

Candidates need to understand that nerve transmission is one way, and in the case of this reflex arc, this is only towards the muscle of the arm, stimulating the motor neurone can have no effect on the relay and sensory neurones.

Question 5

Many candidates believed that the vacuole contained the nucleus.

Question 6

Candidates must ensure that they know which structure undergoes implantation, many wrongly believing that it happens at the zygote stage, rather than the embryo.

Question 9

A majority of candidates got this question right. It is essential that candidates look at the graph; some assumed that the optimum temperature of the enzyme was 37 °C, despite the evidence of the graph.

Question 17

Some candidates chose the incorrect **A** rather than the correct answer, **C**, with as many other candidates choosing the incorrect **D** as chose the correct answer. Candidates are expected to be able to draw the structure of methane, and from that to be able to deduce its formula.

Question 18

Some candidates chose the incorrect **C** rather than the correct answer, **D**, recognising that hydrogen gas is produced by the electrolysis of dilute sulfuric acid, but choosing the incorrect electrode at which it forms.

Question 20

Candidates are expected to understand that catalysts both increase the rate of chemical reactions and that they remain unchanged at the end of the reaction.

Question 21

Although the majority of candidates chose the correct answer, **A**, some stronger candidates chose the incorrect **C**. Candidates are expected to recognise reduction as the loss of oxygen from a compound. In **B** there is no redox as the ratio of oxygen to phosphorus remains 3 : 2, whereas in **C** and **D** this ratio increases to 5 : 2, indicating oxidation has occurred.

Question 22

Candidates knew that both magnesium and magnesium oxide react with dilute sulfuric acid to form a salt, but many did not recognise that magnesium carbonate does react with the acid.

Question 23

Some stronger candidates chose the incorrect **B** rather than the correct answer, **C**. Candidates should understand that the test for nitrates involves reduction by aluminium to ammonia, and that this gas is then tested with damp red litmus, turning blue. They should also recognise that ammonia gas is also formed by warming ammonium compounds with aqueous sodium hydroxide.

Question 28

A large proportion of weaker candidates opted for **C**, confusing the distance-time graph shown with a speed-time graph.

Question 33

Many candidates believed that convection, rather than radiation was the method of heat transfer here along with conduction, despite the fire being in the open; this led them to choose option **A**.

Question 34

In this question on wave terms the most common error was to believe that the distance indicated represented 3 wavelengths rather than the correct $1^{1}/_{2}$.

Question 35

A large proportion of candidates thought that the image is formed at **A**, which is a point through which the reflected ray passes.

Question 36

Candidates need to ensure that they are familiar with the order by frequency of regions the electromagnetic spectrum.

Question 37

Similarly for this question about the range of human hearing, candidates need to ensure that they are familiar with the range of frequency audible to humans.

Question 39

The topic here was electrostatic charge, and option **A** was more popular than the correct response **B**. Candidates must read the question carefully.

Question 40

Candidates must ensure that they know the meaning of “isotope”.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General Comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Question 19**.

In the physics section **Question 33** proved challenging.

Comments on Specific Questions

Question 1

The majority of candidates realised that the bicuspid valve was found on the left side of the heart; however, many confused the direction of blood flow.

Question 2

Candidates must make sure that they know the colour change expected with iodine and starch and the effect of the enzyme on starch. It is important that candidates realise that a question may test knowledge from different parts of the syllabus at the same time.

Question 9

While a majority of candidates answered this question correctly, a substantial number believed that insulin raised blood glucose concentrations.

Question 10

Almost all candidates got this question right.

Question 15

Some stronger candidates chose the incorrect **D** rather than the correct answer, **B**. They recognised that colourless water is distilled and collected, but did not recall that copper sulfate (in its hydrated form) is blue.

Question 16

More candidates chose the incorrect **A** and **C** than chose the correct answer, **D**. These candidates thought that new substances are made during fractional distillation, not recognising that the substances obtained by fractional distillation are not made by chemical reaction and that they were previously part of a mixture.

Question 19

Candidates know very well that exothermic reactions result in temperature increase as they release heat energy.

Question 25

Candidates know well that ammonia gas is formed when ammonium compounds are warmed with aqueous sodium hydroxide.

Question 33

This question concerned wave motion, and many candidates chose option **B**, not noticing that the direction of vibration was at right angles to the wave direction. Weaker candidates also often chose **D**, recognising a transverse wave but believing sound to be an example of this type of wave.

Question 36

In this question on echoes, a sizeable proportion of weaker candidates made the common mistake of not doubling the distance to the wall when calculating the time, leading them to choose option **A**.

Question 39

The topic here was electrostatic charge and the question was well answered. However, several of the weakest candidates confused the repulsion of like charges with attraction, and vice versa; as a result they chose option **C**.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice (Core)

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

General comments

The majority of candidates successfully selected the correct responses.

Comments on Specific Questions

Question 5

Many candidates believed that the vacuole contained both nucleus and chloroplasts.

Question 6

Although many candidates chose the correct response, a substantial number believed that the term fertilisation meant movement of sperms.

Question 8

The majority of candidates realised that iodine did not test for either fat or protein. They realised that biuret tested for one substance, but were equally divided on whether Benedict's or ethanol tested for the second substance.

Question 10

Many candidates confused arteries and veins in this question.

Question 11

Almost all candidates got this question right.

Question 12

Some candidates seem to have confused X and Y chromosomes, and believe that X chromosomes are not found in females.

Question 15

Some stronger candidates chose the incorrect **B** rather than the correct answer, **C**. Candidates should appreciate that crystallisation is used to separate crystalline solids from aqueous solution, and that distillation is used to separate a solvent, collected as a liquid, from a solution.

Question 16

Some stronger candidates chose the incorrect **C** rather than the correct answer, **A**. Candidates are expected to recognise chemical changes as those which produce new substances, which are different from the original substances.

Question 17

More candidates chose the incorrect **D** than chose the correct answer, **C**. Candidates are expected to be able to draw the structure of methane, and from that to be able to deduce its formula.

Question 20

More candidates chose the incorrect **D** than the correct answer, **C**. Stronger candidates tended to choose the incorrect **B**. Candidates are expected to understand that catalysts both increase the rate of chemical reactions and that they remain unchanged at the end of the reaction.

Question 22

Candidates knew that both magnesium and magnesium oxide react with dilute sulfuric acid to form a salt, but many did not recognise that magnesium carbonate does react with the acid.

Question 24

Many more candidates chose the incorrect **B** and **C** than chose the correct answer, **A**. This question required data handling to link the melting point changes of elements in Group I and Group VII to the position of the elements within their group, and then to their relative reactivities within the groups.

Question 25

Some stronger candidates chose the incorrect **C** rather than the correct answer, **D**. The use of aqueous sodium hydroxide in the test for ammonium ions is expected knowledge.

Question 28

In this question on average speed, weaker candidates often did not convert the time to seconds and chose option **D**.

Question 30

Many of the stronger candidates opted here for the incorrect choice **C**, believing that volume, and not time, was required in order to calculate power.

Question 36

This question concerned echoes; the majority of all candidates made the mistake of not doubling the distance from the boat to the sea bed, therefore arriving at option **B**.

Question 39

Option **B** was particularly popular, with even the strongest candidates often believing that the 24 V from the battery was shared between the two resistors.

Question 40

Very many candidates, including a good proportion of the strongest, incorrectly chose option **D**; although this represented two nuclei of the same element, they were not different isotopes as they contained equal numbers of neutrons.

CO-ORDINATED SCIENCES

Paper 0654/21
Multiple Choice (Extended)

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

General Comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Question 15**.

In the physics section **Questions 35** and **38** were found to be challenging.

Comments on Specific Questions

Question 2

Almost all candidates got this question right.

Question 5

This question proved challenging, with almost equal numbers of candidates choosing between the correct and two of the incorrect answers. Although a slight majority of candidates gave the correct response, a significant number believed that expired air contained no oxygen, and a substantial number did not realise that air blown into a balloon would be expired air.

Question 6

Many candidates chose the correct response; the incorrect responses were divided between those who chose the exact opposite, presumably confusing foetal and maternal blood, and those who did not realise that the foetus uses glucose as well as oxygen.

Question 9

Many candidates appeared to confuse amino acids and fatty acids, with almost equal numbers choosing these options for absorption into the lacteal. A substantial number also believed that the lacteal transported water to the intestine.

Question 11

Most candidates realised that osmosis refers to the movement of water; however, few of them had it moving in the correct direction.

Question 13

Candidates must ensure that they know the difference between mitosis and meiosis, and the meanings of the terms diploid and haploid.

Question 15

The majority of candidates understood very well how to identify physical changes and chemical changes from experimental observations.

Question 18

The incorrect **A** was chosen a little more often than the correct answer **B**. Candidates knew well the names of the anodes to which positive and negative ions move, but they did not understand as clearly the reactions, in terms of electron loss and gain, at the electrodes.

Question 19

Candidates knew that both magnesium and magnesium oxide react with dilute sulfuric acid to form a salt, but many did not recognise that magnesium carbonate does react with the acid.

Question 21

Some stronger candidates chose the incorrect response **A** rather than the correct answer, **C**. They were able to predict that rubidium is more reactive than potassium by its relative position in Group I, but they did not know the melting point trend for the Group I metals.

Question 28

A fair proportion of weaker candidates did not calculate the distance travelled in this question, simply choosing the final displacement given, and therefore opting for **A**.

Question 32

What was needed here was to find the block with the smallest temperature rise (**D**), but many candidates opted for the one with the smallest physical size (**B**).

Question 33

Many candidates believed that convection, rather than radiation, was the method of heat transfer here along with conduction, despite the fire being in the open; this lead them to choose option **A**.

Question 34

In this question on wave terms the most common error was to believe that the distance indicated represented 3 wavelengths rather than the correct $1^{1}/_{2}$.

Question 35

Although many knew that the image formed was virtual, many, particularly the strongest, believed it to be inverted; a considerable proportion of all candidates chose option **B**.

Question 38

The incorrect option **B** was much more popular than the correct **C**; this value is obtained by calculating the current and multiplying it by the time taken, i.e. it represents the charge passing through the resistor rather than the energy transferred.

Question 39

There appeared to be a fair amount of guessing between the first three options by weaker candidates in this question on currents and potential differences.

Question 40

Weaker candidates often chose **D** here, correctly identifying two nuclei of the same element, but did not notice that they contained the same number of neutrons.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General Comments

The majority of candidates successfully selected the correct responses.

In the physics section **Question 35** proved challenging.

Comments on Specific Questions

Question 3

Almost all candidates got this question right.

Question 12

While the majority of candidates chose the correct response, a significant number also responded incorrectly. It is important not to make assumptions when interpreting data.

Question 13

Almost all candidates got this question right.

Question 16

Most candidates realised that hand warmers work by transforming chemical energy into thermal energy in an exothermic reaction. However, most of those who did not choose the correct answer, **C**, chose the incorrect **A**. These candidates understood the energy change occurring, but thought that this was an endothermic process.

Question 21

Most candidates knew the characteristic properties of metals that are shown by both sodium, a Group I metal, and nickel, a transition metal. However, most of those who did not choose the correct answer, **C**, chose the incorrect **B**. These candidates did not recall that transition metals form coloured, not white, compounds.

Question 29

The most common misconception among weaker candidates here was to believe that the limit of proportionality is the point beyond which the extension stops increasing.

Question 30

Option **A** was the most common incorrect response, this being the correct equation inverted.

Question 35

Even strong candidates often answered this question incorrectly, with the majority of them opting for **B**. Although they determined the correct pole at **X**, they believed that the rod would be repelled if the magnet were turned round.

Question 37

The incorrect option **B** was much more popular than the correct **C**. Candidates calculated the current and multiplied it by the time taken, which represents the charge passing through the resistor rather than the energy transferred.

Question 39

In this question on currents and potential differences, weaker candidates often knew the relationship between the potential differences, but believed that the current reduced from P to Q to R.

CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice (Extended)

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

General Comments

The majority of candidates successfully selected the correct responses.

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

In the physics section **Questions 31, 37** and, particularly, **34** and **39** were found to be challenging.

Comments on Specific Questions

Question 1

Almost all candidates got this question right.

Question 3

While this question was given in the form of a word equation, it was necessary for candidates to know the equation using symbols, which many of them did, and gave the correct answer. The others were fairly equally divided between the incorrect answers.

Question 6

A majority of candidates correctly responded to this question, but a substantial number believed that fertilisation was the movement of sperms through the uterus.

Question 11

Most candidates were aware that the testa is not part of a plant embryo, those who were not were equally split between the incorrect responses.

Question 12

This question required candidates to interpret a graph. A majority of candidates made the wrong choice regarding acidification of the lake. There seems to be a misconception that acidification is due to the use of pesticides, rather than the burning of coal.

Question 21

Many more candidates chose the incorrect **B** and **C** than chose the correct answer, **A**. This question required data handling to link the melting point changes of elements in Group I and Group VII to the position of the elements within their group, and then to their relative reactivities within the groups.

Question 23

Stronger candidates chose the correct answer, **D**. Candidates are expected to know the source of hydrogen and of nitrogen for the Haber process, and also how these gases are obtained from these sources.

Question 24

The incorrect **A** was chosen more often than the correct answer, **D**, with some of the stronger candidates choosing the incorrect **B**. Candidates are expected to be able to describe the manufacture of sulfuric acid by the Contact process.

Question 26

Candidates are well able to recognise alkanes, alkenes and alcohols from their structures.

Question 27

The incorrect **A** was chosen more often than the correct answer, **C**, with stronger candidates choosing the incorrect **D**. Candidates taking the extension paper are expected to know that ethanol is formed by the catalytic addition of steam to ethanol. Those candidates who knew the structures or formulae of ethanol and ethene would have appreciated that a molecule of ethanol contains two more hydrogen atoms and one more oxygen atom than ethene. This knowledge eliminates the incorrect **A** and **B** as possible answers.

Question 30

More candidates, including many of the strongest, believed that pressure is directly proportional to volume rather than that they are inversely proportional.

Question 31

In this question about thermal capacity many candidates chose the block with the smallest temperature increase (**A**) rather than the one with the largest increase (**D**).

Question 34

The topic here was converging lenses, and a large majority did not choose correctly. Most were not aware that a virtual image must be on the same side of the lens as the object, and consequently they chose **C** or **D**.

Question 37

The incorrect option **B** was much more popular than the correct **C**. Candidates calculated the current and multiplied it by the time taken, which represents the charge passing through the resistor rather than the energy transferred.

Question 39

In this question on electrical components, the incorrect option **A** was particularly popular, especially with the stronger candidates; who knew that a suitable component was a relay, but believed that the resistance of an LDR decreases when the light level on it is reduced.

CO-ORDINATED SCIENCES

Paper 0654/31
Theory (Core)

Key Messages

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

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

Calculations were frequently performed well, with working shown.

General Comments

Most candidates attempted all the questions, and many candidates answered most of the questions well. Performance depended on candidate's scientific knowledge along with their ability to understand the question and express themselves clearly.

Candidates should ensure that they read the stimulus material and each question carefully, and complete all the instructions contained within the question to be able to access the maximum credit available.

Learning the definitions specified in the syllabus allows candidates to earn credit directly. The definitions are also a useful aid for the candidate when choosing the language used in their explanations.

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

A number of candidates used the chemical formula of a substance rather than the words for a substance in their answers, for example CO_2 rather than carbon dioxide. This should be discouraged.

Comments on Specific questions

Question 1

(a)(i) Many candidates gained full credit here. All three responses were well known.

(ii) Some candidates did not answer this part.

(b) A number of candidates wrote the equation for respiration.

(c) Many candidates gained full credit here. All three responses were well known. Some candidates confused cell wall and cell membrane.

Question 2

(a)(i) All three particles were commonly identified. A number of candidates confused proton and neutron.

(ii) The atomic number of element **X** was frequently correctly stated. Four was the only incorrect answer given.

(iii) Lithium was generally given as the identity of element **X.**

(iv) Chlorine was the only incorrect answer given here.

(b) Most candidates gained full credit here for correctly linking chlorine and helium with their correct use and property.

Question 3

(a)(i) Geothermal and nuclear were rarely identified as the two types of power station for which the Sun is not the source of energy.

(ii) Either geothermal or hydroelectric was usually identified as the type of power station that uses a renewable energy source.

(iii) Few candidates were able to identify both gas-fired and oil-fired as the type of power station that produces carbon dioxide when generating power. Nuclear was commonly suggested.

(b)(i) Some candidates were able to explain that an increase in the cross sectional area of the cable would lead to a decrease in the resistance of the cable.

(ii) Most candidates suggested that the cable would expand in hot weather but very few explained what would happen to the cable during cold weather.

(c) Many candidates knew that a nucleus splits during nuclear fission.

(d)(i) A few candidates knew that the answer was gamma rays. Fewer were able to place gamma rays in the correct position in electromagnetic spectrum. Some candidates attempted to complete the electromagnetic spectrum.

(ii) Few candidates were able to place the radiations in the correct order.

Question 4

(a) Most candidates only gained partial credit. The candidates' knowledge about genes was limited.

(b) (i) This part was well answered. Most candidates were able to determine that it was Juan and Sara who could not roll their tongues.

(ii) 100% was the common and correct answer. 50% and 75% were sometimes suggested.

(iii) Few candidates explained that Ben was homozygous dominant or that Ben would always pass on a dominant allele.

(c) This part was well answered. The correct answer was the most popular answer. A number of candidates wrote letters **T** and **t** in a way that made them were almost indistinguishable from each other.

Question 5

(a)(i) Candidates were expected to quote 78% as the percentage of nitrogen in the air. This is the figure given in the syllabus.

(ii) Many candidates did not read the question carefully and gave the answer carbon dioxide. Few candidates suggested one of the noble gases.

(b)(i) This part was well answered. Most candidates were able to use the information given and determine why the iron nails did not rust in each case.

(ii) Many candidates appreciated that the iron nail would still rust but very few explained that the mass of the test-tube and contents would not change because nothing could enter or leave the test-tube.

(c)(i) Some candidates were able to give a suitable test for ammonia using either litmus or full-range indicator.

(ii) Nitric acid was not well known as the acid that reacts with ammonia to form ammonium nitrate.

(iii) Many candidates gained some credit here.

Question 6

(a) Few candidates referred to either the foam or air being a poor heat conductor and few referred to the trapped air being unable to move by convection.

(b)(i) Few candidates gained full credit but most were awarded some. Many candidates did not know the correct symbol for a battery or cell. Many candidates attempted to insert extra components into the circuit.

(ii) Many candidates knew that a vibration was needed to produce a sound.

(iii) A number of candidates simply defined amplitude and frequency. Many candidates referred to high amplitude rather than large amplitude.

(c) Many candidates were awarded some credit on this part.

Question 7

(a)(i) Most candidates gained at least some credit. Most referred to the maximum figure in 1985 and then the gradual decrease.

(ii) Most candidates showed good data handling skills and correctly determined the percentage change in new infections between 1990 and 2010.

(b)(i) Ways in which HIV can be spread were very well known.

(ii) Ways in which governments could try to reduce the spread of HIV were also well known.

Question 8

(a)(i) The only gas commonly identified was carbon dioxide for experiment **T**. Many substances suggested for experiments **Q**, **R** and **S** were not gases.

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

(iii) Many candidates stated that the pH increased in both experiment **R** and experiment **S**. Few candidates were able to offer a suitable explanation.

(iv) Many candidates determined that reaction **P** was endothermic and were able to explain why.

(b)(i) and (ii) Many candidates were able to gain maximum credit. Candidates' knowledge of the factors affecting the rate of a reaction was very good.

Question 9

(a) Only a few candidates drew an arrow pointing vertically downwards. A common error was to draw the arrow going down the slope.

(b)(i) Most candidates correctly determined a time when the snowboarder was accelerating.

(ii) Most candidates correctly determined a time when the snowboarder was travelling at her maximum speed.

(c)(i) Few candidates were able to give both reasons that identified **B** as the water. Candidates needed to state that the particles were close together and that the particles were randomly arranged.

(ii) Section **Y** was wrongly suggested by many candidates.

Question 10

(a) This part was quite well answered. A number of candidates confused the motor and relay neurones.

(b) The brain and spinal cord were well known as areas where the relay neurones are located.

(c) Many candidates gained full credit. The candidates' understanding of the reflex actions was good.

(d) The two parts of the human nervous system were not well known. Central nervous system and peripheral nervous system were the required answers.

(e) A few candidates answered this part well explaining that the brain is closer and that the impulse takes less time.

Question 11

(a)(i) Coal was well known as a solid fossil fuel. Carbon was a common incorrect answer.

(ii) The idea that fossil fuels take a long time to form was not well known.

(b)(i) Heating or cooking was well known as a use for refinery gas. A use for gas oil was often not clearly stated. Vague responses such as "for cars" were not accepted. Candidates needed to state that it was used as a fuel for cars.

(ii) Many candidates simply repeated the question as their answer. A reference to no new compounds being produced was required.

(c) This question was quite well answered especially identifying **L** as an unsaturated hydrocarbon. Few candidates appreciated that both **K** and **M** needed to be identified as alkanes.

(d)(i) Ethene molecules joining together to form poly(ethene) was well known.

(ii) Carbon monoxide, carbon dioxide and water were all commonly suggested as compounds produced by burning poly(ethene).

Question 12

(a) Many candidates identified the correct waves.

(b) Most candidates knew that the wavelength was the distance between two identical points on two consecutive waves but their drawing of the double headed arrow was not sufficiently accurate.

(c)(i) and (ii) Most candidates correctly identified kinetic in **(i)** and gravitational potential energy in **(ii).**

(d)(i) Most candidates correctly determined the resultant force as 20 N in a forward direction.

(ii) Few candidates stated that swimmer was accelerating or that the acceleration was due to the resultant force.

(e) Very few candidates gained any credit. There were few references to what the water molecules were doing.

(f) Many candidates determined the mass correctly. A number of candidates rearranged the formula for density, mass and volume incorrectly.

(g) Some candidates found this part challenging but other candidates produced good answers. Refraction needed to be shown at **X** and reflection at **Y**.

Question 13

(a)(i) All parts of the table were completed correctly by many candidates.

(ii) Valves were well known as the structures is veins that ensure a one-way flow of blood.

(b)(i) The function of red blood cells was well known.

(ii) White blood cells, plasma and platelets were well known as the other main components of blood.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key Messages

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

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

Calculations were frequently performed well, with working shown.

General Comments

Most candidates attempted all the questions, and many candidates answered most of the questions well. Performance depended on candidate's scientific knowledge along with their ability to understand the question and express themselves clearly.

Candidates should ensure that they read the stimulus material and each question carefully, and complete all the instructions contained within the question to be able to access the maximum credit available.

Learning the definitions specified in the syllabus allows candidates to earn credit directly. The definitions are also a useful aid for the candidate when choosing the language used in their explanations.

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

Comments on Specific Questions

Question 1

(a)(i) This was answered quite well. The most common error was the site of fertilisation, which many candidates identified as the uterus

(ii) The function of the uterus was not well known. Many candidates thought that the uterus was where fertilisation takes place.

(b)(i) Some candidates wrote far more than was required.

(ii) A zygote was commonly known as the cell produced by fertilisation.

(c) This was well answered with many candidates gaining full credit. The most common correct answers were that sexual reproduction requires two parents and that sexual reproduction produces genetically dissimilar offspring.

Question 2

(a) This part was well answered.

(b)(i) This part was well answered.

(ii) Most candidates placed the metals in the correct order. The only error was to place copper in the wrong place.

(iii) The test for hydrogen gas was well known, but a few candidates confused it with the test for oxygen.

(c) Some candidates found it difficult to explain their answers.

Question 3

(a)(i) The angle of incidence was indicated correctly by most candidates.

(ii) Most candidates correctly stated that the angle of incidence was 30° and were able to explain that angle of incidence equals angle of reflection. Common errors were to state that the angle of incidence was either 15° or 60°.

(iii) This part was not well answered with a number of candidates giving the wrong form energy produced.

(b)(i) Few candidates were able to suggest a suitable radiation detector. Photographic film was not accepted in this particular question because the detector is measuring the count rate.

(ii) The identity of the electron as the particle identical to a beta particle was well known.

(iii) Few candidates were able to answer this part. A reference to background radiation or radioactive decay being a random process was required.

(iv) Few candidates were able to explain that the strontium-90 source was kept in a box lined with lead because beta radiation cannot penetrate lead.

(c)(i) Most candidates correctly determined that the force was 54 N.

(ii) Many answers were vague. The best answers given were that a force can change the speed or direction of motion of a body.

Question 4

(a)(i) This was well answered but a number of candidates produced the reverse. A number of candidates also produced a circular food chain including decomposition. This was not necessary.

(ii) Thorn acacias or plants were commonly identified as the producer of the food chain.

(iii) Desert mice were commonly identified as the herbivore of the food chain.

(b) Candidates should be reminded that it is the Sun rather sunlight that is the principal source of energy for all food chains.

(c) Natural selection was not defined well by many candidates. Candidates should be reminded to learn the definitions of the key terms mentioned in the syllabus.

Question 5

(a)(i) Most candidates gained at least some credit. The descriptions for carbon dioxide and iron oxide were often incorrect.

(ii) Candidates need to be able to describe clearly what the formula showed. There were many vague references to elements and molecules of carbon, hydrogen and oxygen.

(b)(i) Electrolysis was well known as process **P**.

(ii) Some candidates correctly described what would be observed at the anode and cathode. Some candidates' responses did not suggest observations.

(iii) This part was well answered.

(iv) The question asked for the reacting substance which was reduced. Therefore candidates who suggested lead rather lead oxide were not awarded credit.

Question 6

(a)(i) and **(ii)** Many candidates gained full credit for correctly explaining that amplitude was related to loudness and pitch was related to frequency.

(b)(i) Some candidates did not place **B** in the correct place. They placed it between one and two minutes.

(ii) The definition of the term boiling point needed to include the word temperature. Many candidates did this successfully.

(iii) Most candidates correctly identified the two correct diagrams but explanations were very vague.

(c) This part was well answered.

(d) Most candidates gave at least one correct error.

Question 7

(a)(i) Most candidates were able to link the types of tooth with the functions.

(ii) This was well answered. Most candidates gave at least one difference. A number gave more than one correct answer.

(b) Bacteria were well known as the organisms that cause tooth decay.

(c)(i) Many candidates' responses were very vague, suggesting answers such as damages health.

(ii) This was well answered with most candidates gaining full credit.

Question 8

(a)(i) Most candidates correctly suggested seven as the pH of pure water.

(ii) Salt and water were well known as the products of a neutralisation reaction between an acid and an alkali.

(iii) Most candidates explained that lime neutralised acids in soils, but few gained full credit.

(b)(i) Few candidates referred to the burning of fossil fuels and few referred to volcanos or hot springs.

(ii) Acid rain and its consequences were well known.

Question 9

(a)(i) Many candidates correctly suggested that the bicycle was accelerating.

(ii) Most candidates showed good data handling skills and correctly calculated the speed as 9.33 m / s.

(iii) Some candidates stated the main energy change as kinetic energy to thermal or sound energy.

(b) This was well answered by many candidates who calculated the volume of the block and then determined the density of the block as 2.78 g / cm^3. Candidates should take care when rounding their answers.

(c) Some candidates found this part challenging. The path of the ray of light should have been drawn as straight lines.

(d)(i) Most candidates correctly described the circuit as a parallel circuit.

(ii) Most candidates showed good data handling skills and correctly calculated the current as 2.4 A.

Question 10

(a) Geotropism was well known. A number of candidates suggested gravity. This was not accepted but gravitropism would have been allowed.

(b)(i) Most candidates correctly gave respiration as their answer.

(ii) The two other correct conditions were water and warm temperature. Many candidates incorrectly suggested light or sunlight. Light is not required for germination.

(c)(i) Many candidates gained credit here for suggesting that there was no light underground. Answers relating to a lack of chlorophyll were accepted.

(ii) The word equation for photosynthesis was well known.

(d) Magnesium was the most popular and the correct answer. Some candidates incorrectly suggested nitrate.

Question 11

(a)(i) Ethane was usually identified as the alkene shown.

(ii) Most candidates drew a clear diagram showing a carbon-carbon double bond, with two hydrogen atoms attached to each carbon atom.

(b)(i) Few candidates suggested that both the carbon dioxide and the water were the products of the complete combustion of propane.

(ii) Few candidates were able to suggest that the nitrogen and argon came from the air and that these gases were unreactive and so did not burn.

(c)(i) Calcium carbonate and calcium oxide were suggested by many candidates. Silicon dioxide was a popular incorrect answer for the compound that decomposed.

(ii) Many candidates correctly suggested cobalt oxide and copper oxide. Fewer candidates were able to explain that cobalt and copper were both transition metals and therefore formed coloured compounds.

Question 12

(a) Few candidates referred to friction as the cause of the build-up of a static charge or that the process involved a transfer of electrons.

(b) Many candidates were awarded maximum credit for inserting the correct words into the sentences.

(c) For the non-renewable energy source, a number of candidates suggested petroleum which was given in the question. Examples of renewable energy sources were well known.

(d) The use of a magnet was well known. Some candidates did not state how the magnet would be used. Some candidates suggested unsuitable methods such as waiting to see which one rusts.

Question 13

(a) The difference in population was invariably calculated correctly as 70.

(b)(i) Most candidates gave two good reasons for the declining population of gorillas.

(ii) Most candidates gave two undesirable effects of deforestation.

(c) Most candidates were able to give at least one step that governments may have taken to conserve the gorilla population.

(d) Water as a natural resource that should be conserved was well known. Many candidates found it difficult to suggest a second resource. Fossil fuels, metal ores and minerals were sometimes correctly suggested.

CO-ORDINATED SCIENCES

Paper 0654/33
Theory (Core)

Key Messages

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

Calculations were frequently performed well, with working shown.

General Comments

Performance depended on candidate's scientific knowledge along with their ability to understand the question and express themselves clearly.

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

Learning the definitions specified in the syllabus allows candidates to earn credit directly. The definitions are also a useful aid for the candidate when choosing the language used in their explanations.

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

Comments on Specific Questions

Question 1

(a) Most candidates gained some credit.

(b) Most candidates gained at least partial credit.

(c) This was quite well answered with some candidates gaining full credit. The most common correct answers were that sexual reproduction requires two parents and that sexual reproduction produces genetically dissimilar offspring.

Question 2

(a) Most candidates gained at least partial credit. The most common error was to suggest that the number of neutrons in one atom of hydrogen is 1.

(b) Neither of the answers was well known. The relative mass of a neutron was frequently stated as zero. The relative mass of an electron was frequently stated as either +1 or –1.

(c)(i) Transition metals were quite well known as the collection of metals in the Periodic Table that contains iron and cobalt.

(ii) The term alloy was not well known.

(iii) This part was well answered. A number of candidates incorrectly suggested that steel does not rust.

Question 3

(a) Few candidates gained most of the available credit. A common error was to replace liver in the fourth space with enzyme.

(b) This was quite well answered with many candidates gaining most of the available credit, usually for bungee jumping and riding a roller coaster.

(c) Many candidates were able to suggest one effect of adrenaline on the body. This was usually an increase in pulse rate or heart rate.

Question 4

(a)(i) Very few candidates suggested a suitable detector for gamma rays.

(ii) A few candidates stated the meaning of the term isotope.

(b)(i) Few candidates placed the radiations in the correct order. Frequently the order was reversed.

(ii) Most candidates were able to describe one effect of ionising radiation on the human body.

(c)(i) and (ii) Infra-red radiation was often suggested as the part of the electromagnetic spectrum used by the thermometer. Few candidates placed infra-red radiation in the correct place in the electromagnetic spectrum.

(d) The path of the ray of light through the optical fibre was often well drawn by many candidates.

Question 5

(a)(i) Many candidates correctly stated the optimum temperature for enzyme **A** as 14.5 °C.

(ii) The optimum range was between 65 °C and 95 °C. Many candidates were able to state this.

(b) Some candidates chose a suitable temperature and gave a correct explanation.

(c) Amino-acids were not well known as the end-products of the action of protease on a protein.

(d)(i) The chemical elements present in a protein were not well known. Many candidates were able to suggest one or two of the four elements.

(ii) Some candidates knew the biuret test for a protein. Candidates needed to make the connection between a protein and an enzyme.

Question 6

(a)(i) Many candidates correctly named the gas produced as hydrogen.

(ii) Some candidates gave a correct test for hydrogen gas. Other gas tests were sometimes described.

(iii) Some candidates correctly suggested that potassium would react more vigorously or rapidly with water than lithium.

(b)(i) A number of candidates were able to describe the trend as melting point increasing down the group.

(ii) Bromine was **X** and iodine was **Y.** Few candidates correctly named both although most candidates did identify two halogens.

(c)(i) More candidates chose exothermic rather than endothermic. Candidates needed also to be able to explain their statement.

(ii) Few candidates mentioned electron gain or loss or the formation of charged ions.

(iii) Few candidates suggested that argon is unreactive and therefore would not react.

Question 7

(a) Many candidates suggested radio waves. The correct answer was microwaves.

(b)(i) Many candidates suggested the microphone rather than the speaker.

(ii) Some candidates correctly suggested the battery as the part of the mobile phone that transfers electrical energy into stored chemical energy.

(c)(i) and (ii) Very common answers were 5300 for **(i)** and 50 for **(ii)**.

(d) Only a few candidates identified **P** and **Q** as the two sound traces.

(e) Very few candidates explained the difference between longitudinal wave motion and transverse wave motion.

(f) A few candidates correctly named the two quantities as force and distance. More candidates were able to name one quantity.

Question 8

(a)(i) Candidates must ensure that they are familiar with the pH values of an alkali and an acid.

(ii) Water was a popular correct answer. Sodium sulfate was rarely mentioned.

(iii) The question asked for a chemical test for water. Many of the tests suggested were physical tests, for example melting point and density determination. Some candidates suggested a pH test. This would not have been a suitable test to prove that the liquid was water. The question told the candidates that many colourless liquids, including water, have a pH of 7.

(b)(i) Calcium oxide was not often stated as the chemical name for lime.

(ii) A number of candidates correctly identified carbon dioxide as the other product in the process.

(iii) Thermal decomposition was rarely suggested as the type of chemical reaction.

(iv) Many candidates correctly stated that lime is used to reduce acidity in lakes or soil.

Question 9

(a)(i) Many candidates correctly determined that the bus travelled 1500 m.

(ii) Many candidates calculated the average speed of the bus using their answer to **(i)**. To calculate the maximum speed of the bus candidates needed to look at the distance-time graph and determine the section of the graph where the gradient was greatest. This was section **E** to **F**.

(b)(i) The driving force was commonly identified as **Q**.

(ii) The weight of the bus was commonly identified as **R**.

(iii) Many candidates did not suggest that forces **Q** and **S** would have equal magnitudes and act in opposite directions. Many candidates incorrectly suggested that force **Q** would be greater than force **S**.

(c)(i) Few candidates suggested that the particles exert a force on the tyre walls when they collide with the tyre walls.

(ii) Few candidates explained that the air particles would move faster and collide more frequently with the tyre walls.

(d)(i) Many candidates showed good data handling skills and calculated the current as 3.0 A.

(ii) Some candidates used the formula for resistances in parallel to calculate the correct answer. However this was not necessary. Candidates should have been able to select the correct resistance by remembering that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

(e) Few candidates suggested a suitable difference between the magnetic properties of iron and the magnetic properties of steel. Many candidates wrongly suggested that iron would rust.

Question 10

(a)(i) Few candidates suggested that **A** was the epidermis or that **B** was the spongy mesophyll.

(ii) Many candidates correctly identified where carbon dioxide enters the leaf. Some candidates incorrectly suggested that the carbon dioxide entered from the top of the leaf.

(iii) Many candidates incorrectly suggested photosynthesis as the process by which carbon dioxide enters the leaf. Diffusion was the correct answer.

(b)(i) Few candidates suggested that it is an advantage to the plant to have the largest concentration of chloroplasts in the palisade cells so that the chloroplasts can absorb more light. Some candidates suggested that more photosynthesis would occur.

(ii) This part was well answered. Many candidates suggested nucleus, cytoplasm or cell membrane. A common error was to suggest cell wall.

Question 11

(a) The word equation for respiration was quite well known.

(b)(i) Many candidates knew at least one use for the energy released by respiration in the body.

(ii) Most candidates gained at least partial credit usually for a reference to sweating. Some candidates described responses by the skin to decreasing body temperature.

(c) Many candidates calculated that difference in body temperature as 1.1 °C. Some completed the calculation to determine that the percentage increase as 3%

Question 12

(a)(i) The chemical formula of methane was quite well known.

(ii) Few candidates suggested that no change is seen when methane is bubbled through aqueous bromine. Many candidates incorrectly suggested that the aqueous bromine would lose its colour.

b)(i) The test for carbon dioxide gas was well known.

(ii) The idea that fossil fuels take a long time to form was not well known.

(iii) Few candidates named chemical energy as the type of energy stored in fuels such as methane.

(iv) Few candidates suggested that biogas contains less flammable gas or less methane than natural gas.

(c)(i) Few candidates suggested sulfur dioxide.

(ii) A number of candidates suggested acid rain or a consequence of acid rain as a harmful effect of sulfur dioxide.

Question 13

(a)(i) Many candidates gave a sensible explanation. There were a number of different correct explanations given.

(ii) Very few candidates explained the term efficiency.

(b)(i) Many candidates explained why the graph showed that water boils at 100 °C. Some candidates vaguely referred to a straight line rather than a horizontal line.

(ii) Most candidates gave the correct answer of 80 °C. A few candidates suggested 100 °C.

(iii) Most candidates gained some credit. Some gained full credit.

CO-ORDINATED SCIENCES

Paper 0654/41
Theory (Extended)

Key Messages

Many candidates were evidently well prepared for this examination. Candidates should be aware that their answers should add to, rather than repeat, information supplied by the question. They should read the question thoroughly and pay attention to the difference in the meaning of terms such as *state, describe* and *explain.* Candidates should be aware that not all questions have answer lines and must take care not to omit questions requiring additions to diagrams.

General Comments

Good answers were seen in all topics covered by the examination. Some candidates experienced challenges with recall of the biological definitions, the recall of the industrial chemical process, completion of the nuclear equation and the description of the difference between longitudinal and transverse waves. It was noticed that many candidates suffered from the misconception that ozone plays a significant part in global warming. It is worth emphasising the comment for **Question 4(c)(i)** that the effect on the role of ozone depletion in global warming is negligible, and is not an acceptable answer to this type of question.

Comments on Specific Questions

Question 1

A considerable number of candidates did not respond to **Question 1(a)(ii)** which required a letter to be drawn on the diagram.

(a) The labelling of the male reproductive system was usually correct. Candidates should be aware that although allowances are made for phonetic spelling there should not be ambiguity with the names of other organs.

(b)(i) Many definitions of the term meiosis included the fact that haploid cells are created from diploid cells. The most accurate stated that the number of chromosomes is halved rather than split or divided. There were very few references to reduction division.

(ii) Most candidates selected two differences between male and female gametes in terms of size, chromosomes, or whether they had a tail. Many identified the ability to swim, although motility was often confused with mobility.

(iii) The fusion of gametes was usually correctly named as fertilisation.

Question 2

(a) Many candidates knew that there are two elements in the first period. Six was also a popular answer.

(b)(i) The number of protons was included in most definitions of atomic number. It was not always made clear that this is a property of the nucleus of an atom, rather than the element.

(ii) Successful explanations of the relative masses of sodium and hydrogen atoms referred to atomic structure, as required by the question. They included comparisons of the numbers of particles in the nuclei, rather than comparing relative atomic masses or the masses of atoms.

(c) The electronic structure of magnesium was usually stated correctly.

(d) Many candidates correctly named the product of the electrolysis as chlorine. Some gave the correct formula as Cl_2, but Cl and Cl^- were common.

Question 3

(a) Most correctly identified the power stations with boilers and those using renewable energy sources.

(b)(i) The majority of candidates knew that a transformer steps up voltage.

(ii) There were some good calculations of the resistance of the thicker cable. They showed logical use of the relationship between resistance and diameter. Many knew that the resistance is reduced but simply halved the original resistance.

(c)(i) Some descriptions of nuclear fission stated precisely that the nucleus is split rather than the atom being broken up.

(ii) Those who knew the symbol for an α-particle often deduced the symbol for the thorium isotope.

Question 4

(a) A few candidates suggested the use of more fuel in winter or the increase in photosynthesis in the summer as reasons for the fluctuations of carbon dioxide emissions. The majority misread the question and suggested reasons for the overall trend in emissions.

(b) Most candidates correctly named methane as a greenhouse gas.

(c)(i) The best explanations of how increased carbon dioxide concentration leads to global warming included a description of the entry of solar radiation into the atmosphere and its reflection, or absorption and radiation, from the Earth's surface. They described the absorption of some of this radiation by carbon dioxide in the atmosphere, and subsequent radiation back to Earth. Many responses involved damage to the ozone layer. Candidates should be aware that the effect on the ozone layer and the role of ozone depletion in global warming are both negligible, so are not included in the Co-ordinated Science syllabus, and are not acceptable answers to this question.

(ii) Most candidates could describe two effects of global warming on the environment.

(iii) There were many sensible suggestions for ways in which governments could encourage the reduction in carbon emission. Others gave methods in which industry or individuals could change their practices.

Question 5

(a) Most candidates described the composition of air accurately. Some responses incorrectly suggested carbon dioxide as a gaseous element.

(b)(i) The azide ion was usually given a negative charge. The formula of the ion was sometimes written correctly, with N^{3-} and NaN_3 among a range of incorrect responses.

(ii) There were many correct answers to this calculation. Common errors were to double the formula mass of sodium azide and to fail to use the equation to deduce the number of moles of hydrogen from the number of moles of the azide.

(c)(i) The production of nitrogen by the fractional distillation of liquefied air was not widely stated.

(ii) A minority of candidates could state the word equation for the reaction occurring in the Haber process. Some attempted to write a symbol equation. Candidates should be aware that where a symbol equation is written when a word equation is required, only completely correct, balanced equations gain credit.

Question 6

(a)(i) Most diagrams of the series circuit were drawn with care using conventional symbols. Candidates should avoid leaving gaps in a circuit and should show connections to terminals rather than to the body of the symbol. They should avoid drawing lines that could be construed as shorting a device.

(ii) Most candidates correctly described the role of vibration in the production of sound.

(b)(i) Most responses made use of the relationship between energy supply and temperature change. Candidates should be aware that where they are asked to show that a given numerical result is valid, they should carry out the calculation as if the result was not supplied. They cannot gain full credit by substituting the result into a formula and then highlighting the equality of both sides of the equation.

(ii) Some candidates correctly suggested that the water will not reach the temperature due to loss of heat. Others made statements suggesting that 60 °C is above the boiling point of water or contradicted information given in the question.

Question 7

(a)(i) Many descriptions of the loss of water from a leaf mentioned transpiration involving evaporation from the stomata. A minority answered the question in terms of liquid water running off the surface of the leaf.

(ii) Good explanations of how water moves up the plant stated that transpiration reduces water potential at the top, causing water to move along the xylem, down the water potential gradient, and referred to the cohesion between molecules. Others made inappropriate references to differences in concentration and to osmosis.

(b)(i) The vast majority of candidates correctly calculated the loss in mass of the leaf.

(ii) A few suggested correctly that the difference in the loss of water is due to more stomata being on the lower surface of a leaf, rather than implying that all the stomata are on the lower surface. Others were less precise in just stating that most water is lost from the lower surface.

(iii) Most candidates correctly predicted that higher temperature would result in more mass loss. A few realised that there would still be no water loss from the leaf covered on both surfaces.

Question 8

(a)(i) Most candidates correctly identified some of the products in the experiments. Not all noticed that where a reaction occurs the gaseous products were required.

(ii) Some candidates identified the pH changes and gave explanations in terms of the reaction products. Responses that gave a single pH value or a qualitative description of the acidity were not sufficient to answer the question. Many candidates gave the product of reaction of calcium with water as calcium oxide rather than calcium hydroxide.

(iii) Most correctly deduced that the decrease in temperature suggests an endothermic reaction and a decrease in kinetic energy.

(b)(i) Most descriptions of the relationship between concentration and rate of reaction were correct. Some identified direct proportion.

(ii) Most explained the relationship in terms of greater collision frequency due to the increased number of reacting particles, although increased concentration of particles would have been more precise.

Question 9

(a)(i) The speed of the snowboarder was usually found from the graph and those that knew the formula generally calculated the correct kinetic energy.

(ii) Most candidates knew that the acceleration could be found from the gradient of the graph, although errors were made in obtaining the correct data. Many answers included the correct unit.

(iii) The correct force was usually obtained from the acceleration found in **(a)(ii)**.

(b)(i) Some candidates could place both radiations in the electromagnetic spectrum.

(ii) Most knew that all electromagnetic waves travel at the speed of light. Quoting the speed in km / s proved more difficult.

(c) Stronger candidates explained that energy is used to melt the snow. They clearly stated that the snow is melting over the time period **X**, rather than suggesting that the change of state is instantaneous. Some stated that latent heat is used to overcome attractive forces between molecules. Candidates need to ensure that they know the difference between heat and temperature and latent heat of fusion and melting point.

Question 10

(a)(i) and (ii) Most candidates suggested eating as the reason for the increase in blood glucose concentration and obtained the time to return to the starting concentration from the graph.

(iii) Those who interpreted the question as requiring an explanation of why the blood concentration returns to its starting concentration identified at least part of the process. This involves the pancreas detecting the rise in concentration and producing insulin to cause the liver to convert glucose to glycogen.

(b) Exercise or starvation was often quoted as a situation where blood glucose concentration falls dramatically.

(c)(i) Explanation of the term negative feedback proved to be a challenge. The best answers defined the term as the response to a change in a variable returning the system back to normal.

(ii) Temperature control was a good example of negative feedback in the human body. Correct answers described the control of a variable rather than the means by which it is controlled, i.e. temperature control rather than sweating.

Question 11

(a) The best suggestions for why petroleum is described as a fossil fuel recognised that, unlike wood, they were formed over millions of years.

(b)(i) Most candidates correctly stated that evaporation and condensation were the two physical changes involved in fractional distillation. Others simply named two states of matter such as liquid and gas.

(ii) Many explanations of the relative boiling points of gasoline and gas oil included a comparison of molecular size and intermolecular force. The best responses linked this to the energy required to separate molecules.

(c) Inspection of the equation often yielded the correct formula.

(d)(i) Compound **W** was often named correctly.

(ii) The test for alkenes was recognised by a few of the candidates who had identified **W** as propene. Candidates should be aware that generally, where a change in colour is required by a chemical test question, the response should state the initial and final colours.

(iii) Those who deduced the correct formula of compound **X** usually drew the correct structure.

Question 12

(a)(i) The size and direction of the resultant force were usually correct.

(ii) The best responses explained that the swimmer is accelerating because the resultant force acts in the direction of movement. Others attempted to describe the variation in speed between strokes and as a result of fatigue.

(b)(i) Some candidates described a difference between a compression and a rarefaction in terms of pressure or density. Others misinterpreted the diagram and involved proximity of waves in their description.

(ii) The best descriptions of the difference between transverse and longitudinal waves compared the direction of oscillation with the direction of propagation. Others described oscillation using terms such as movement of waves. Some candidates drew useful diagrams which supported their description where the directions of oscillation and propagation were identified.

(c) Those who understood the significance of critical angle could predict the paths of the rays by comparing critical angle with the angle of incidence. A few candidates could explain that the ray was refracted away from the normal by referring to the relative densities of water and air.

Question 13

(a)(i) Many candidates correctly suggested that the water-filled jacket controlled temperature, rather than acting as an insulator. Few explained the importance of temperature regulation on the activity of yeast and the rate of fermentation.

(ii) A few candidates suggested that stirring ensures that all the yeast accesses the nutrients or maintains an even temperature.

(b)(i) Some candidates could recall the word equation for anaerobic respiration.

(ii) Most stated a difference between anaerobic respiration in yeast and that in animals in terms of the production of lactic acid, ethanol or carbon dioxide. Others attempted to answer in terms of energy requirement.

(c) Most candidates knew that anaerobic respiration is used in making bread.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key Messages

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

Calculations were generally done well with working shown. They are expected to give correct units with their answers and round their answers up or down to an appropriate number of significant figures. A skill that would be beneficial for candidates to practise is the conversion of units, for example from cm^3 for dm^3.

General Comments

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

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

Comments on Specific Questions

Question 1

(a)(i) Most candidates gave the correct answer of oxygen transport. A minority of candidates incorrectly stated carbon dioxide transport. Carbon dioxide is carried in the blood plasma and not in red blood cells.

(ii) The answers of no nucleus, haemoglobin or reference to biconcave shape giving a large surface area were frequently seen.

(b) The majority of candidates could state two other components of blood.

(c)(i) Most candidates recognised that water left the red blood cell. Fewer were able to correctly explain the mechanism for this. A common misconception was the salt solution moved rather than water. However, many could name the correct process of osmosis.

(ii) This question was answered well with most candidates describing the red blood cells swelling or bursting due to movement of water into the cell.

Question 2

(a)(i) The majority of candidates could correctly identify the elements that had one electron in their outer shell. A common incorrect answer was iron. Most candidates correctly identified elements in the same period. A common error was to state elements that are in the same group rather than in the same period.

(ii) Often the alkali metals were placed in the correct order of reactivity. Occasionally the alkali metals, although placed in the correct order in respect to each other were not placed in the correct order when iron and copper were included.

(b)(i) The correct answer of hydrogen was commonly seen. Other incorrect gases were sometimes seen as well as lithium hydroxide.

(ii) The reactant of sulfuric acid was commonly given. The correct product was less frequently seen. The most common incorrect response was hydrogen.

(c)(i) The question asked for the change in appearance. Some candidates gave the response that bubbles could be seen. This question should have prompted candidates to describe a colour change. Some candidates gave the colour of chlorine rather than bromine.

(ii) Several candidates did not recognise that chlorine and bromine exist as diatomic molecules and therefore did not gain credit. However, it was pleasing to see the candidates that did recognise that chlorine and bromine exist as diatomic molecules, generally were able to balance the equation correctly.

Question 3

(a)(i) Most candidates were able to state the correct energy transfer, with a minority giving the reverse of sound to electrical energy.

(ii) This question was generally well answered, with many candidates gaining at least partial credit. Metal being a good conductor of heat was frequently seen. A common misconception was linking the fins being black to absorption of radiation rather than emission.

(b)(i) Few candidates recognised the random nature of decay or background radiation would have an impact on the count rate. Reponses referring to the user error were ignored. A common misconception was that radioactive decay increases with time.

(ii) Most candidates could give the correct nuclide notation for the beta particle. Some candidates tried to halve the figures. Few candidates displayed good knowledge of conservation of mass and charge in nuclear decay processes.

(c)(i) Some candidates found this question challenging. The commonest acceptable response generally referred to change in speed or direction. Vague responses such as motion with no further qualification were not accepted. A number of candidates repeated the example given in the question of stretching.

(ii) The vast majority of candidates were able to correctly predict the force. Any incorrect answers were due to inaccuracies reading from the graph rather than genuine errors.

(iii) Many candidates had the correct idea but did not express themselves clearly enough to gain credit. Candidates needed to say the force needed to extend a spring is directly proportional to the extension. Some candidates vaguely referred to the extension increasing with force or following the best fit line. Credit was given for reference to following a line of the same gradient.

Question 4

(a) Some very good answers were seen. The vast majority of candidates were able to identify the trend and most used data from the graph to support their answer.

(b) Most candidates could define a mutation. Definitions should be learnt as quoted in the syllabus.

(c) There were some excellent responses here. It was clear the development of antibiotic resistance in bacteria is particularly well understood. Candidates could explain in detail the development of antibiotic resistance with correct reference to natural selection. It was very pleasing to see that only a minority of candidates held the misconception that individual bacteria became resistant on exposure to antibiotics.

Question 5

(a)(i) The vast majority of candidates identified the monatomic particle. Most of these could relate this to a complete outer shell or being inert. There were a number of candidates that incorrectly stated this element would be a halogen rather than a noble gas.

(ii) Again, most candidates could identify the compound in the diagram. Only a small number of candidates were not specific in their responses and referred to more than one atom rather than a compound consisting of more than one type of atom. A minority of candidates referred to the compound as being a mixture. These responses did not gain any credit.

(b) The formation of an ionic bond by the transfer of two electrons from magnesium to sulfur was well understood. A small minority of candidates confused this with covalent bonding and sharing electrons. Not all the candidates choose to include a diagram to aid their written response. Very occasionally, candidates contradicted their written response by drawing a diagram of covalent bonding but describing ionic bonding.

(c)(i) The majority of candidates gave the correct response of electrolysis.

(ii) Candidates that understood the meaning of the term reduction generally gained most credit, stating that an aluminium ion would gain three electrons. Some candidates went into unnecessary detail and included what would happen at the anode.

(iii) The strongest candidates gave the correct answer of carbon monoxide. Carbon dioxide was the most common response seen.

Question 6

(a)(i) Most candidates gave the correct frequency. It was pleasing to see only a very few candidates forgot to include the units.

(ii) Fewer candidates stated the correct power often giving the voltage instead. Some candidates choose to convert the units to watts, whilst this was unnecessary, credit was given for the correct conversion.

(b) Both answers were required for the credit to be awarded. Most candidates stated that speed would be the same. The wavelength was more problematic with some candidates stating the wavelength would be higher.

(c)(i) The question specifically asked for what happens to the water molecules. There were a number of vague responses referring to an increase in temperature. Candidates that recognised the response should refer to water molecules generally gained credit.

(ii) There were many vague responses. The strongest candidates were able to explain boiling in terms of potential and kinetic energy of the molecules. Some candidates were able to gain partial credit by referring to the energy being used to break the intermolecular bonds. Few candidates used the term latent heat of vaporisation correctly or showed their understanding of its meaning.

Question 7

(a) Some excellent responses were seen. Most candidates referred to the line of the graph rather than describing changes to the breathing pattern.

(b) Most candidates recognised that breathing rate would be faster. There was some confusion with depth of breathing with some candidates stating that breathing would be shallower rather than deeper during intense exercise. Fewer candidates explained this in terms of requiring more oxygen and fewer still related this to an increase in respiration rate.

(c) Again, most candidates recognised that pulse rate would increase because the heart would beat more frequently. Some candidates tried to link this to breathing rate rather than transport of oxygen to respiring tissues.

(d)(i) Candidates that recognised that anaerobic respiration had taken place generally gained the majority of the credit.

(ii) Repaying of the oxygen debt was a common response. The strongest candidates were able to describe this in terms of oxygen required to breakdown the lactic acid.

Question 8

(a) A large number of candidates stated that carbon dioxide was a neutral gas. This was the most common incorrect response. Generally, candidates could identify the alkaline gases and state that nitrogen dioxide was an acidic gas.

(b)(i) A number of candidates stated the concentration of acid would increase or stay the same. It was apparent there was some confusion between concentration and pH.

(ii) A number of candidates described the volume of hydrogen being produced rather than the rate of reaction as instructed by the question. Those candidates that did refer to rate of reaction mostly gained credit for stating the rate of reaction decreased. Very few recognised that the initial rate of reaction would be steady and mostly referred to an increase in the rate of reaction.

(iii) Candidates that attempted this question generally gained at least partial credit. The majority showed an initial greater volume of hydrogen being produced. A common error was to extrapolate that for the duration of the line rather than levelling off at the same value.

(c) Some excellent responses were seen. Common errors included doubling the number of moles of hydrogen and errors with the conversion of units from dm^3 to cm^3.

Question 9

(a) This question proved challenging for many candidates. There was some confusion with the homeostatic mechanisms of regulation of body temperature. This question asks for an explanation in terms of molecules. Few candidates included references to molecules or energy in their responses. The strongest candidates could explain the most energetic molecules escape. Very few candidates explained that the remaining molecules had less energy, often referring to hotter and cooler molecules instead.

(b) Most candidates drew the reflection at the correct angles. There were some candidates that did not realise the ray of light returned and instead drew the ray of light emerging from the other side of the prism.

(c) Candidates need to be clear about the difference between motors and generators. Some candidates provided detailed and accurate responses referring correctly to the rotating coil experiencing a changing magnetic field and the induction of an electromotive force. A minority of candidates incorrectly thought that e.m.f. referred to an electromagnetic field.

(d)(i) Few correct responses were seen. Some candidates used the incorrect formula to calculate the frequency. Some common incorrect responses included 2.5 and 250 Hz.

(ii) Many candidates stated the correct amplitude of 5 V.

(e)(i) The vast majority of candidates identified this as a parallel circuit.

(ii) This formula is clearly well known with many candidates gaining full credit.

(iii) Some candidates did less well here, often using the incorrect formula of $R = 1/R_1 + 1/R_2$ and dividing three by ten rather than the other way around to give the incorrect answer of 0.3 Ohms.

Question 10

(a)(i) Many could state the correct name of the cornea. Common incorrect names given included the pupil and retina.

(ii) Most candidates could identify the iris and used a neat ruled line. There were some inaccuracies with drawing and credit was only given if it was clear that the label line was pointing to the iris. Occasionally some label lines stopped short of the iris or appeared to point towards the pupil. Candidates should be reminded that when labelling the label lines should touch the structure that it is intended to label.

(b)(i) The difference between accommodation and the pupil reflex needs to be understood; with some candidates referring to contraction of ciliary muscles and relaxation of suspensory ligaments. However, many candidates gave good responses identifying the contraction and relaxation of the correct muscles and the effect on the pupil.

(ii) A misconception seen was that the pupil reflex is not controlled by the body. It is important for candidates to realise the pupil reflex is controlled but that this is not under conscious control. Many candidates correctly identified the response as being automatic.

(iii) The strongest candidates could identify the retina and the brain. Candidates must ensure that they understand the function of the retina as the light receptor.

(c) Candidates that did attempt this question generally gained most of the available credit and could describe the differences between nervous and hormonal control.

Question 11

(a)(i) The correct answer of propane was frequently seen. The compound was mostly identified as an alkane but some candidates used the incorrect prefix of but-.

(ii) The majority of candidates understood this compound required a double bond. Sometimes the double bond was incorrectly placed between a carbon and a hydrogen. Sometimes more than one double bond was included. The most common error was to have the correct number of double bonds but to have two hydrogens attached to each carbon.

(b)(i) Some candidates referred to argon as being inert but did not mention nitrogen. Some candidates realised that nitrogen was present in the air but did not mention argon. A minority of candidates stated that nitrogen and argon were produced in the reaction.

(ii) Few candidates stated the correct products of combustion, often giving hydrogen as a product.

(c)(i) This was well answered with many candidates stating the correct compounds. Some candidates gave the elements rather than compounds as requested by the question. Many candidates described that transition metals gave coloured compounds.

(ii) Some candidates referred to the energy required to break the bonds between atoms rather than the intermolecular bonds. Candidates should be reminded it is the intermolecular bonds that are broken during melting rather than the bonds between the atoms.

Question 12

(a)(i) Many candidates correctly described friction and the transfer of electrons. Some candidates incorrectly referred to positive electrons being transferred.

(ii) Many correct calculations were seen. Candidates frequently gave the correct formula but had problems converting the units. This is a skill that should be practised.

(iii) Candidates had to use their answer from **(ii)** to answer this question. Credit was given for correct working if the answer to **(i)** was incorrect. Often an incorrect formula was used.

(b) The vast majority of candidates could correctly identify a compression and a rarefaction.

(c) The use of a magnet was frequently seen. Some candidates did not explain what they would do with the magnet to identify whether the wheel was made of steel. The question asked for a simple way to identify the material and so responses relating to identifying the melting / boiling point were ignored.

(d) Candidates showed good knowledge of the difference between speed and velocity with some excellent responses seen.

Question 13

(a) The vast majority of candidates correctly identified the process of respiration.

(b) The vast majority of candidates were also able to give the correct response of decomposers. Examples of decomposer were also credited.

(c) Candidates need to know the difference between the enhanced greenhouse effect and the ozone layer. Responses referring to the ozone layer were not credited. The strongest candidates correctly described the radiation entering the atmosphere and being re-radiated from the Earth's surface as longer wavelength radiation.

(d) The implications of deforestation were well known with many candidates gaining credit.

CO-ORDINATED SCIENCES

Paper 0654/43
Theory (Extended)

Key Messages

Candidates are advised to take note of the terms used in each question which act as a guide to the detail required. Terms defined in the syllabus include *state, describe, suggest, predict and explain.* The number of marks and the space available are good measures of the length of answer required. Candidates should read each question thoroughly and not anticipate its content having seen similar questions on previous papers.

General Comments

Most candidates have been well prepared to answer numerical questions in this examination. They stated the formula or principle on which the calculation was based and showed all the stages involved in reaching the final answer, with the unit if required. Nevertheless it is inevitable that some arithmetical errors are made in an examination, but the examiner does give credit for correct method and errors carried forward, as long as the working is shown.

Comments on Specific Questions

Question 1

(a) The parts of the alimentary canal were usually identified correctly.

(b) Most candidates described how bile aids digestion in terms of the emulsification of fat to increase surface area. Some went on to explain how this facilitates the action of enzymes.

(c) Many candidates explained the importance of villi in terms of the increase in surface area for absorption in the small intestine. A few confused the role of intestinal villi with that of the cilia in the bronchi.

(d) The best suggestions of long term effects of Crohn's disease described changes in the health of an individual based on the function of the small intestine, rather than merely describing the change in the efficiency of absorption by the intestine.

Question 2

(a)(i) and (ii) These questions, requiring candidates to process atomic data, were answered well.

(iii) Those who understood the meaning of the term relative atomic mass usually used the data correctly to calculate its value. Some used the atomic number to find the element in the Periodic Table, which was another satisfactory method.

(iv) Most predicted there would not be many compounds of **Z** and explained in terms of its complete outer electron shell. The best answers made reference to the stability of the electronic structure.

(b) Candidates who realised that the **W**-**Y** bond is formed by two shared pairs of electrons usually drew the correct electron arrangement in the molecule.

Question 3

(a) Most candidates suggested that the half-life is long enough to permit detection of radiation. Some knew that overexposure increases the risk of damage. Candidates need to ensure that they understand the differences between the diagnostic and therapeutic uses of radio-isotopes in medicine.

(b)(i) Most representations of the transmission of light down an optical fibre showed total internal reflection. Some candidates did not ensure that all rays were straight and that reflections occurred at points on the edge of the fibre.

(ii) Those who understood the use of the term critical angle could describe the importance of the comparison of the angle of incidence with the critical angle, and related that to the occurrence of refraction and total internal reflection.

Question 4

(a)(i) and (ii) Those who knew the male and female genotypes could usually complete the Punnett square.

(b) The best suggestions of a disadvantage of sexual reproduction were based on the need for two parents. Few answers correctly identified the possibility of harmful variations. Some responses made vague reference to increased time or energy requirement.

(c)(i) The best definitions of the term mutation were based on the syllabus which describes it as a change in a gene or chromosome. Some made incorrect statements while attempting to provide more detail than is required by a simple definition.

(ii) Most valid suggestions for the advantage to the birds of the mutation involved enhanced visibility to potential mates, rather than camouflage effects.

(d) There were many correct references to the term natural selection in the descriptions of how all the male birds became red. Most recognised that red males are more likely to reproduce and so pass on the characteristic. There were few references to inheritance of genes.

Question 5

(a)(i) Most candidates knew the test for hydrogen.

(ii) The correct formula of the hydroxide ion was often deduced, with that of the lithium ion or a lithium compound sometimes suggested. There were a few good explanations for the charge in terms of charge balance. Candidates should make the context clear when using terms such as neutralise.

(iii) This question required the use of atomic radius data to suggest reasons for differing reactivity. Many candidates appreciated the dependence of reactivity on the ease in which electrons are lost. Fewer explained in terms of the force between the nucleus and electrons.

(b)(i) Most knew that chlorine is the product of electrolysis of molten lithium chloride.

(ii) Many stated that the Li^+ ion gains an electron but fewer described the change as a discharge or the formation of an atom.

(iii) There were some good responses stating that hydrogen is formed by the electrolysis of the aqueous solution. Others were mistaken in suggesting that the solution would not conduct electricity.

Question 6

(a)(i) A few candidates knew that mobile phones utilise microwaves. The use of radio waves was a common suggestion.

(ii) There were a wide range of values given for the speed of light. Where the quantity was correct, units were often omitted.

(b) It was pleasing that many candidates knew a formula for calculating the number of turns on the transformer. There was less success in rearranging the expression.

(c) Most candidates could match the waveforms with the sounds.

(d) The correct formula for calculating work done was usually selected. The need to change the unit of length was often neglected.

Question 7

There was evidence of confusion between seed distribution and pollination throughout this question.

(a) The functions of most of the parts of the flower were usually correct.

(b) Adaptations for wind-pollination were often correctly identified. Candidates should be aware that where visible adaptations are required only those features obvious from the photograph are suitable suggestions.

(c) Many candidates suggested that the chances of pollination are increased by a greater quantity of pollen.

(d) Some candidates showed a good understanding of the advantages of self-pollination. Others made questionable statements about the perpetuation of advantageous traits or confused self-pollination with asexual reproduction.

(e) Most candidates stated animal dispersion of seeds as an alternative to wind dispersion.

Question 8

(a)(i) The oxides which do not react with water were usually correctly identified. Several responses explained by describing the oxides as neutral rather than describing the mixture with water as neutral.

(ii) and (iii) The measurement of boiling point was a common suggestion for a test for water. A chemical test was less well known and tests involving indicators were common. Candidates need to ensure that they understand the difference between physical and chemical testing.

(b)(i) Most candidates described at least two features of the pH / volume graph. Many used the numerical data to illustrate the changes.

(ii) The vast majority of candidates found the end-point for the titration from the graph.

(iii) The relative formula mass of sodium hydroxide was usually calculated correctly. Errors in finding the value of 0.2 moles from M_r meant that only some of the credit could be awarded.

(iv) Candidates who gained most credit used a learned formula or regarded the question as simply asking for the number of moles of sodium hydroxide in 25 dm^3 taken from 1 dm^3 of a solution containing 0.2 moles.

Question 9

(a)(i) Most candidates had learned the equation for photosynthesis. Those who attempted to derive the equation from first principles were rarely successful.

(ii) The raw materials needed for respiration were usually correct. There was some confusion with the requirements of photosynthesis.

(b)(i) The time for the greatest rate of photosynthesis was almost always read correctly.

(ii) Most stated that carbon dioxide is produced all the time because respiration occurs all the time, and that oxygen is produced at certain times because photosynthesis only occurs when there is

light. Some candidates were less clear in naming the processes responsible for the production of each gas.

(iii) The best responses recognised that there was an increased rate of photosynthesis due to the increase in light intensity at this time. Others made vague reference to sunrise rather than describing the change in light intensity over the period in question.

Question 10

(a)(i) Many candidates found the correct value for the distance travelled. Those who made an arithmetical error could be given credit for method if their calculation showed sufficient evidence of knowing that the distance could be found from the area under the speed-time graph. A few responses removed any doubt by stating this principle.

(ii) The formula for kinetic energy was well known. The most common errors included reading the wrong speed from the graph, omitting to square the speed or failing to halve the product.

(b)(i) and (ii) Most candidates knew that the pressure of a gas is due to collision of particles with the walls of the container. A smaller number related the collision to the force on the walls. The majority could explain the increase in pressure with temperature in terms of the increase in molecular speed causing an increase in the rate of collision. Again, the effect on the force on the walls was not often mentioned. Several candidates did not read the questions carefully and explained the effect of temperature increase in both parts.

(c)(i) Those who applied the correct formula for charge did not always realise that the charge through both lamps was required. The unit for charge was sometimes correct.

(ii) The total resistance was often calculated correctly. The most common error was to apply a version of the formula $R = 1/R_1 + 1/R_2$.

(d) Most candidates correctly compared the speed of magnetising or demagnetising iron and steel. Others made vague statements about the ease of magnetising.

Question 11

(a)(i) The majority showed that they knew the prefixes and suffixes used to name hydrocarbons.

(ii) Successful explanations for why there are no alkenes with one carbon atom relied on candidates realising that two carbon atoms are required to form a C-C double bond.

(b)(i) Most candidates knew that carbon dioxide turns limewater milky. Others described the bubbles which did not show the presence of a particular gas.

(ii) It was pleasing to see so many candidates extracting the information from the question to construct a correctly balanced equation.

(iii) Most correctly defined reduction as the gain in electrons.

(iv) Many realised that natural gas is the result of a fossilisation process in that it is the remains of a once-living thing. This answer alone did not add enough to the information in the question unless reference was made to the age of the organisms, typically of the order of millions of years.

Question 12

(a)(i) Most correct responses made use of the relationship between current, power and voltage. Candidates should be aware that where they are asked to show that a given numerical result is valid, they should carry out the calculation as if the result was not supplied. They cannot gain full credit by substituting the result into a formula and then highlighting the equality of both sides of the equation.

(ii) Most candidates understood the function of a circuit breaker. The best responses described the action of the circuit breaker with this current rating in this particular circuit. They went on to explain

that the current rating of a circuit breaker needs to be more than the working current of the device in the circuit it protects.

(b)(i) The area unit conversion was usually successful.

(ii) Most candidates used P = F / A successfully to find the pressure exerted on the hotplate.

(c)(i) Those who knew the relationship between energy supplied and specific heat capacity usually obtained the correct value. A common error was to use the final temperature of the water rather than the temperature change.

(ii) The vast majority of candidates could state two differences between evaporation and boiling. A minority seemed to be under the impression that boiling is the process of increasing the temperature to the boiling point.

Question 13

(a) The best descriptions of adaptations of root hair cells were related specifically to their primary function of absorbing water.

(b) There were some succinct descriptions of how water enters root hair cells. They described osmosis as the movement of water across a partially permeable membrane down a water potential gradient. Others gave less precise descriptions of movement between solutions of different concentration.

(c) Most descriptions of water movement from roots to leaves included the route taken by water through the plant. They referred to evaporation from the leaves and movement through the xylem. The best responses explained the cause of movement as the reduction in water potential at the top of the plant so that, because of cohesion between molecules, water moves up the plant, down a water potential gradient.

(d) Some suggested correctly that increased humidity causes less transpiration and hence slower movement of water. Other candidates had the misconception that water loss is increased making a false analogy with sweating.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

Key Messages

Candidates need to be more specific with their descriptions of solutions and precipitates, particularly in the Chemistry question.

General Comments

Candidates were able to carry out all three practical exercises and obtain useful results.

Comments on Specific questions

Question 1

Many candidates inserted minutes instead of seconds when completing the column heading. In **(b)** it was surprising to see that a significant number of candidates found that it took a shorter time for the milk to clear as the concentration of the enzyme added decreased. This was contrary to the results given by the supervisors. Candidates were also asked to give the time values to the nearest second; answers were often incorrectly given in minutes or a combination of minutes and seconds.

The missing values of enzyme concentrations were almost always correctly entered into the table.

Greater care was needed when drawing the graph. Graphs should be tidy, with accurate plotting of points and careful judgement as to where the best-fit line should be drawn. A minority of candidates plotted the time for the milk to clear against the volume of the enzyme solution.

In **(d)(ii)** and **(iii)** most candidates had little trouble predicting the time for a 1.5% enzyme solution to clear and using their graph to describe the relationship between the two plotted quantities. A common misconception was that any straight line indicates direct or inverse proportion.

For **(e)(i)** most candidates were able to gain partial credit but far fewer obtained full credit. Some unrealistic temperatures were seen such as ones well below 0 °C and some as high as 500 °C.

Candidates had more success in **(e)(ii)** suggesting two variables that should be kept constant.

Question 2

Most candidates recorded sensible temperatures, which showed an increase after solid **H** reacted with the water. The observations stated were often too vague to be credited, and “white solution” was not accepted.

The remainder of **(a)** was carried out well.

In **(b)(i) J** was usually correctly identified as copper nitrate however the observations which led to this conclusion were often not clearly expressed. It was often difficult to determine, from what the candidate had written, which of the solution or the precipitate was the darker blue.

Most candidates missed the blue precipitate that was formed in **(b)(ii)**, and wrote that the solution had turned blue.

The changes in temperature were usually calculated correctly in **(c)**, although most candidates omitted to add a plus or minus sign, as appropriate. The reaction was usually described as being exothermic. A small number thought that a rise in temperature indicated an endothermic reaction. In **(c)(iii)** the reagent was usually identified correctly as sodium hydroxide although ammonia was a common incorrect answer.

The oxide **H** was usually classified correctly as basic or metallic.

In the last part calcium (oxide) was rarely given as the answer. A common incorrect answer was sodium. When calcium was correctly identified, the stronger candidates were able to give a convincing reason for their choice.

Question 3

The measuring and recording of the various currents and potential differences were well done by most candidates. Occasionally currents of more than 10 A were seen which suggests that candidates had read the meters incorrectly.

In **(b)** the stronger candidates realised that, since the lamp carried a current, its filament could not be broken. A more popular, but incorrect answer, was that there was a voltage across the lamp. If the filament of the lamp had broken, there would still have been a reading on the voltmeter which would have been the e.m.f. of the cell.

The resistance values were usually calculated correctly; the values needed to be given to three significant figures. Few candidates offered a suitable reason as to why the current is switched off between readings. A common incorrect answer was to avoid electrocution.

In **(d)** the unit of electrical power was well known. Occasionally it was given as J rather than W. The power values were usually calculated correctly and decreasing.

In **(e)** the majority of candidates thought that if the power of the lamp increased as the current through it increased, then this was a sufficient condition for direct proportionality. Partial credit was awarded for a statement such as this.

A few of the strongest candidates showed that the ratio of the current to the power did not have a constant value and so these quantities were not directly proportional.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

Key Messages

A solid formed when one solution is added to another should be described as a precipitate.

General Comments

Candidates were able to carry out all three practical exercises and obtain useful results.

Comments on Specific Questions

Question 1

Some drawings were too small but generally the quality of drawing was good. Labelling of the root and stem was usually accurate and clear.

In **(b)** the marking of the equivalent distance on the drawing needed to be carefully drawn and to be the length of the seed excluding the root and the stem. Most lengths had been measured in millimetres as instructed. Calculation of the magnification rarely caused a problem. A very small number of candidates calculated the reciprocal of the magnification.

Few candidates gained full credit for **(c)**. The most common correct response was connected with water. A significant number of candidates discussed light and oxygen.

"Benedict's" for **(d)(i)** was widely known as were the nutrients being tested for. It is pleasing to see that more candidates are specifying "reducing sugar" rather than just "sugar" or "carbohydrate". Credit was given if centres did not produce the expected results if this was stated in the Supervisor's Report. The use of "purple" for the iodine test could be discouraged, particularly when the biuret test is also being used. In **(d)(iv)** candidates made good conclusions and credit was given when candidates made correct conclusions for wrong observations.

Question 2

Most candidates were awarded credit for constructing the table and went on to complete it correctly. "Cloudy" should not be used as the description and colour of a precipitate. In **(a)(ii)** the test for ammonia with litmus paper caused few problems.

In **(b)**, most candidates were able to discuss the similarity to the reagents used in qualitative analysis. Fewer stated that the results were different and fewer still discussed the implications of the ammonia test. The use of iron(II) sulfate as a further test was widely stated.

The limewater test worked for virtually all candidates and most were able to gain full credit in **(c)(ii)**. Those that gained most credit in **(c)(ii)** usually realised that the white precipitate formed from **H** and barium nitrate solution was barium carbonate.

(c)(iv) proved to be challenging with relatively few giving a good answer.

Question 3

Most candidates gained full credit in **(a)**. Just occasionally the times were stated incorrectly, sometimes as minutes. **(b)** was usually correct.

Part **(c)** was not well answered.

Graphs were plotted quite well. Some candidates used difficult scales making it problematic for them to plot and interpret the graphs. Such scales were not credited.

Most candidates were unable to explain why the graph showed that the rate of cooling is greater at the start. It was hoped that gradients would be known from rate of reaction practical exercises.

In **(f)** most candidates could see if their results supported the suggestion. Many candidates found it difficult to express themselves to justify the statement.

“Room temperature” and “initial water temperature” were the two common responses to **(g)**. Many candidates used “water temperature” but this was not credited.

CO-ORDINATED SCIENCES

Paper 0654/53
Practical Test

Key Messages

Candidates should pay particular attention to the instruction for drawing the best-fit line on a graph.

General Comments

Candidates were able to carry out all three practical exercises and obtain useful results.

Comments on Specific Questions

Question 1

Most candidates were able to generate four useful readings. Readings needed to be recorded to the nearest 0.1 cm. In **(a)(ii)**, surface area units were often given as cm^3. When this happened the error was carried forward to the labelling of the axes of the graph so that candidates were not penalised twice for the same error.

Graph plotting in **(b)** could have been improved by choosing suitable scales, accurate plotting and drawing the best-fit line through the origin as instructed. It is important that candidates look at the instruction for drawing the best-fit line before deciding on scales. In **(b)(ii)** the quantities referred to did not match those plotted; despite this many candidates were able to work out the appropriate relationship. Most candidates were able to take the reading for **(b)(iii)** from the graph but many did not mark this on the graph. It is always better to use full length lines to show how the reading was taken.

Most candidates knew the test for oxygen. To be awarded the credit candidates needed to give an appropriate description of a glowing splint. "An extinguished splint" was not credited.

Many candidates scored partial credit only for **(d)**, the most common responses being "temperature" and "use of same potato". "pH" was rarely seen.

Very few good answers were seen for **(e)**. Responses which did not discuss the contact between peroxide and the enzyme were not awarded credit.

Question 2

Most candidates were familiar with the apparatus in **(a)(i)** but many did not have the delivery tube going into the limewater. When **H** is heated it turns yellow and returns to a white colour when cooled. Very few candidates recorded both colour changes in **(a)(ii)**. Most candidates obtained a white precipitate in the limewater. "Milky" is always an acceptable alternative to "white precipitate" but "cloudy" is an inadequate description of something that is white and should be reserved to describe turbidity. A relatively small number of candidates continued long enough to observe the precipitate disappearing.

In **(b)(i)** "bubbles" were often recorded whereas it was rare to see "colourless solution". In **(b)(ii)** most candidates obtained a white precipitate. Again "cloudy" is an inadequate description of something that is white. Few candidates observed the precipitate disappearing.

Candidates often identified zinc or carbonate but relatively few identified **H** as zinc carbonate. The tables in **(d)** were very minimal but usually gained credit. Filling in of the table was done well. Some candidates recorded a white precipitate rather than a yellow one. This error was then carried forward to allow chloride

as a conclusion in the next part. In **(iii)** one centre had provided chlorine water which was too dilute and no colour change was observed. All possible answers were seen for the last part. A common error was to conclude that chloride was present when a yellow precipitate had been obtained with silver nitrate solution.

Question 3

(a) did not cause any difficulties and generally was well done.

The graph in **(b)** was usually done adequately. Odd scales were used too often and plotted points were sometimes too big or too indistinct to be seen. The gradient was often correct but the triangle drawn to calculate this was often too small. Some candidates used points that were not on the line to calculate the gradient and this will always be wrong. A small number of candidates did not mark on the graph how they obtained the data for their gradient.

Candidates usually chose a sensible number of significant figures for the answer in **(b)(iii)**. Many did not gain credit for accuracy despite the generous range.

In **(c)** it was rare to see two points made. The most common answer was a comment about the light source or about using a darkened room.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper so that they are able to accurately describe experimental procedures. Candidates should have used standard laboratory apparatus, be able to read values from a range of measuring equipment and record values to the requested number of significant figures. Candidates need to be able to draw graphs accurately and construct lines of best-fit. Knowledge of identification tests for ions was limited.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of an excellent standard. The standard of graph drawing was generally high, but candidates need to remember to choose scales that cover at least half of the grid. Best-fit straight lines should be drawn with a ruler, be one single line of constant gradient and take into account all of the plotted points except where anomalies are clearly identified. Drawing diagrams of apparatus proved challenging for many candidates, as did subsequent labelling.

Comments on Specific Questions

Question 1

(a) Candidates found this challenging with the vast majority choosing a measuring cylinder. The responses beaker and test-tube were also seen quite often.

(b) Most candidates gained credit.

(c) The points on the graph were usually plotted correctly. The units must be included on the axes. The axes were often reversed, the *x*-axis sometimes started from 4 and counted down, and drawing the best-fit straight line caused some challenges.

(d) The majority of candidates described the relationship but a significant number did not use the variables in the question, often describing temperature and time rather than rate.

(e) (i) Most candidates suggested temperatures below 100 °C; candidates needed to recognise that the enzymes would denature at high temperatures and choose temperatures less than 50 °C. Many candidates gave only one temperature, often using terms such as room temperature or body temperature.

(ii) Candidates found this challenging, with many giving just the terms concentration and volume without specifying the substances being considered. Temperature and time were also common responses.

Question 2

(a) (i) The majority of candidates gained credit for T_1 but a very few appreciated that in order to read the temperature to the nearest 0.5 °C, T_2 required the 0 after the decimal point.

(ii) Most candidates subtracted the values correctly, but a small number included an incorrect minus sign.

(iii) The term exothermic was not well known. Common incorrect responses included chemical reaction, endothermic and thermic.

(b) (i) Many candidates gained credit, but a significant number gave a generic answer without applying the result to the experiment.

(ii) Few candidates gained credit. Carbon dioxide was the most popular response. Nitrogen, hydrogen and sodium were other common responses.

(iii) Few candidates gained credit. Common incorrect responses included ammonia, sodium, copper, magnesium, hydrogen and iodine.

(c) Very few candidates gained credit. Many considered the blue precipitate and so gave the answer as copper. Magnesium, carbon, iron and hydrogen were other common responses.

(d) Few candidates gained credit. Chlorine was a response given by many. Copper, iron, sulfate, nitrate and carbon were other frequent responses.

Question 3

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

(b) (i) Few candidates gained credit, with the majority thinking that the next reading would add to the previous reading. Other candidates thought switching off the circuit was to prevent electrocution.

(ii) Candidates found this challenging. Many thought that the glow of the lamp could still be seen.

(c) (i) The unit for power needs to be remembered. J and ($V \times I$) were common incorrect responses.

(ii) Many candidates calculated the two values correctly, and recorded the values to the correct number of significant figures commensurate with the values already printed in the table.

(d) (i) Many candidates gained credit for the straight line, but fewer drew the line through the origin. A number of curves were seen.

(ii) Candidates found this challenging. Many repeated the question stem.

Question 4

(a) The cell was reasonably well recognised but palisade, root and plant cell were common responses.

(b) (i) The drawings were usually magnified but fewer had the correct shape and many had a cell membrane. A significant number were not labelled.

(ii) Many candidates measured correctly, but 30.4 and 3.4 were frequent incorrect responses.

(iii) Most candidates gave a value but far fewer added points **C** and **D** to their drawing.

(iv) The calculation was performed well by stronger candidates. The formula was frequently inverted or the two values added or multiplied.

(c) The test was well known.

(d) Stronger candidates gained partial credit for microscope but far fewer named the anther or removed the pollen from the flower. A significant number removed the pollen from a bee or the stigma.

Question 5

(a) (i) Most candidates gave the masses to two decimal places.

(ii) Most candidates subtracted correctly but some either did not include the + and – sign or reversed them.

(b) Candidates found this part challenging.

(c) (i) The strongest candidates gained credit. Many reversed the electrodes. Candidates also needed to include an explanation in their answers.

(ii) Many candidates gained credit. Electrolysis and electrolyte were common incorrect responses.

(iii) Stronger candidates gained at least partial credit. Many described bubbles or rusting at the electrodes, and the electrolyte losing colour or rusting.

Question 6

(a) (i) Many candidates gained credit but many put the ball in the middle of the line.

(ii) Despite most candidates calculating the correct value, many did not round the final answer correctly. 0.86 was seen often.

(iii) Candidates must be able to determine why values are given to a limited number of significant figures.

(b) (i) Candidates found squaring the values challenging.

(ii) The points on the graph were often plotted correctly, but candidates found drawing the best-fit straight line challenging. Many drew a curve, joined the points or disregarded several of the points.

(iii) Few candidates showed on their graph how the values were obtained to calculate the gradient, and those that did often used a very small part of their best-fit line. A significant number inverted the division.

(c) (i) This calculation was generally performed well.

(ii) Candidates found this challenging with most repeating the question stem. Increased acceleration and faster speed were common responses.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper so that they are able to accurately describe experimental procedures. Candidates should have used standard laboratory apparatus, be able to read values from a range of measuring equipment and record values to the requested number of significant figures. Candidates should have performed identification tests on the range of substances detailed in the specification.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of an excellent standard. The standard of graph drawing was generally high, but candidates need to remember to choose scales that cover at least half of the grid. Best-fit straight lines should be drawn with a ruler, be one single line of constant gradient and take into account all of the plotted points except where anomalies are clearly identified. Drawing diagrams of apparatus proved challenging for many candidates, as did subsequent labelling.

Comments on Specific questions

Question 1

(a) The drawing was usually magnified and often accurate, although there were a number of non-continuous or feathery outlines. Drawings should be accurately labelled.

(b) (i) Many candidates gained credit, although a large number measured the whole seedling. A few gave the measurement in centimetres.

(ii) Most candidates gave a value, but far fewer added the line to their drawing.

(iii) The calculation was performed well by stronger candidates. The formula was frequently inverted or the two values added or multiplied.

(c) (i) Most candidates gained at least partial credit. However, a large number thought that light or oxygen was required.

(ii) Tests were well known, although some candidates gave only one nutrient and some added sugar.

Question 2

(a) (i) Candidates found this challenging. Many thought that because there was no reaction with ammonia the reagent could not be used for identification of cations.

(ii) Stronger candidates gained credit. Magnesium and calcium were common incorrect responses.

(iii) Although many candidates did not know the test, many could describe the expected observations. A common error was adding the litmus papers to the solution.

(b) (i) The test was quite well known although silver nitrate was a common response**.** Some candidates correctly described the test but then gave white precipitate as a result for the reaction of the carbonate.

(ii) Drawing apparatus proved challenging for many candidates. Many candidates drew acid being added to the carbonate. Of those who drew the correct apparatus, most had both test-tubes with bungs or had the delivery tube in the acid or not in the limewater.

(iii) Stronger candidates gained credit but descriptions of the bubbling were common.

Question 3

(a) (i) Most candidates read the temperature correctly, although a small number omitted the zero after the decimal point.

(ii) Most candidates read the temperature correctly.

(b) (i) Most candidates knew the units, but incorrect responses included m for minutes and cm^3 for temperature.

(ii) Most candidates gained credit. A small number gave only integer minutes.

(c) Stronger candidates gained credit. Many candidates thought that the time was needed to allow the water temperature to become uniform throughout.

(d) Candidates found this challenging; most repeated the stem.

(e) Candidates found this challenging and often gave vague statements with no reference to the data. Many of those who gained partial credit did not appreciate that the temperature changes should be considered over the same time period.

(f) Stronger candidates gained credit. Many incorrectly referred to the apparatus.

Question 4

(a) (i) The majority of candidates read the scale correctly. A significant number read to the left hand side of the bubble.

(ii) Most candidates calculated the three values correctly.

(iii) Many candidates calculated the values correctly, although a significant number repeated the value for 10 minutes.

(iv) Stronger candidates gained credit. Many did not use the variables in the question and referred to the movement of the bubble or the increased water-uptake.

(b) Although this appeared to be well-known, many candidates only discussed one improvement.

(c) (i) This was reasonably well-known but diffusion, osmosis and evaporation were other common responses.

(ii) Many candidates gained credit. Others referred to humidity or temperature affecting the water-uptake.

(d) Candidates found this challenging, with many giving the prediction with no explanation.

Question 5

(a) (i) Stronger candidates gained credit. The most common incorrect response was hydrochloric acid. Sulfate acid and sulfur acid were other common responses.

(ii) Many candidates gained credit. 'No more reaction' was a common response not worthy of credit.

(iii) This was reasonably well answered, but some candidates tested to show acid was still present.

(b) (i) Stronger candidates gained credit. Many candidates omitted the filter paper or used a dashed line, some omitted the funnel and labels were often missing or reversed.

(ii) Stronger candidates gained credit. Solid was the most common response not worthy of credit.

(c) Stronger candidates gained credit. Many thought the solid would evaporate or decompose.

(d) (i) Stronger candidates gained credit.

(ii) Candidates found this part challenging. Many only added the substances together and evaporated.

Question 6

(a) Candidates found this challenging, with few candidates showing their working.

(b) Most candidates calculated the values correctly.

(c) (i) The plotting of the points and drawing of the line usually gained credit. The scales need to be large enough, using more than half of the grid. A significant number plotted *d* against *p.*

(ii) Few candidates showed on their graph how the values were obtained to calculate the gradient, and those that did often used a very small part of their best-fit line. A significant number inverted the division.

(iii) Most candidates who attained a gradient in **(c)(i)** calculated the value correctly.

(d) Stronger candidates gained credit; many gave a generic response with no application to this experiment.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper so that they are able to accurately describe experimental procedures. Candidates should have used standard laboratory apparatus, be able to read values from a range of measuring equipment and record values to the requested number of significant figures.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of an excellent standard. The standard of graph drawing was generally high, but candidates need to remember to choose scales that cover at least half of the grid. Drawing diagrams of apparatus proved challenging for many candidates. Data entered into a table should follow the pattern of the data already included.

Comments on specific questions

Question 1

(a) (i) The points on the graph were usually plotted correctly. Although the scales were linear, some candidates did not use at least half the grid. A significant number did not start the axes at the origin, and of those who did some did not extend their best-fit straight line to the origin.

(ii) Many described the relationship, but relating surface area to amount of foam or rate or distance were common errors.

(iii) Most candidates gave a correct value from their graph but a significant number did not mark their graph to show this value.

(b) Many gained credit, but amount of hydrogen peroxide and time were common responses.

(c) The test was quite well-known but many candidates described a lit or an extinguished splint relighting.

Question 2

(a) (i) Stronger candidates gained full credit. Common errors included limewater and **H** in the same test-tube, bungs in both test-tubes, no bungs in either test-tube and delivery tube not under the level of the limewater.

(ii) Few candidates gained credit. Common responses not worthy of credit included general safety points, not to give too much gas to the limewater, not overheating, to see what has happened and not to let too much pressure build up.

(iii) Majority of candidates gained credit. Oxygen was a common incorrect response.

(iv) Stronger candidates gained credit. Common incorrect responses included oxide, metal, iodine, carbon and zinc.

(v) Stronger candidates gained credit. Common incorrect responses included zinc, zinc oxide and oxide.

(b) (i) The majority of candidates knew the correct colour. Colourless and milky were common incorrect responses.

(ii) Candidates found this challenging with most describing bubbling, dissolving or decolourising.

(c) (i) Many candidates gained credit, but some used different results to those given.

(ii) Few candidates gained credit, with iodine and starch being the most common incorrect responses.

Question 3

(a) (i) Most candidates read the scale correctly. Some candidates gave 29.8.

(ii) The majority of candidates calculated the value correctly. A small number repeated the value from **(a)(i).**

(iii) Whilst the majority calculated the values correctly, many did not follow the pattern of data in the table or rounded incorrectly, gaving the values as 1 and 1.6 or 1.66.

(iv) Most candidates calculated the values correctly.

(b) (i) The points were usually plotted correctly and stronger candidates gained credit for the line. However, some joined the points plotted, or had multiple lines.

(ii) Few candidates showed on their graph how the values were obtained to calculate the gradient, and those that did often used a very small part of their best-fit line. A significant number inverted the division.

(iii) Candidates found this challenging with many performing calculations on their gradient.

(c) Few candidates gained credit. Most discussed controlling the brightness of the lamp.

Question 4

(a) Most candidates gained at least partial credit, usually for water, but a large number thought that light or oxygen was required. A significant number discussed how the conditions of the five seedlings could be controlled.

(b) Many candidates gained full credit, but a significant number thought 25 °C was too hot for good growth.

(c) Benedict's test was well known with many candidates gaining full credit. A small number described the protein or starch tests.

(d) Most candidates gained at least partial credit with the stronger ones gaining full credit. It was common for only one seedling to be tested in each condition, and some only had the light from above. Some candidates described experiments comparing light intensity.

Question 5

(a) (i) Candidates found this challenging. Common incorrect responses included metal oxide, sodium hydroxide and iron oxide.

(ii) Candidates found this challenging. Many discussed rusting, and common responses included yellow, orange, rust or changes colour. Of those that responded correctly, many did not include the term precipitate.

(iii) Few dissolved the solid but stronger candidates gave the correct test. Incorrect responses included electrolysis and using a magnet.

(b) (i) Stronger candidates gained partial credit for oil, with the most common incorrect responses being bung, cap and lid. Few gained full credit.

(ii) Stronger candidates gained credit. Incorrect responses included same temperature, all sealed with bungs, all contain water and all contain desiccant.

(c) Few candidates gained credit. Many repeated the stem, and most thought that test-tube **H** contained no water and therefore air alone causes rusting.

Question 6

(a) (i) Most candidates read the meters correctly. Incorrect responses were usually 5.8 or 4.8.

(ii) The majority of candidates gained partial credit, with mention of the surfaces being omitted quite often.

(iii) Many candidates gained credit, however a significant number answered in terms of numbers.

(b) Many candidates gained credit. Anomalous results and accuracy were the most common responses.

(c) Many candidates gained credit, but common incorrect responses cited a cause rather than an effect.

(d) Well answered by many candidates. Some chose materials with high friction, but which would not be used on a road such as carpet.