CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General comments (Biology)

In the main, candidates coped well with the questions presented. Only two of the questions were correctly answered by fewer than half the candidates, and of those only one of them proved to offer any serious challenge to their ability.

Comments on specific questions (Biology)

Question 6

Perhaps candidates were confused by this question as it was phrased in the negative. There seems to have been some guesswork as all options proved popular. If candidates had asked themselves which of the options did not involve the liver, then perhaps many more would have realised that ‘movement’ was the correct answer.

Question 7

This was the easiest question in the biology section of the paper, with most candidates able to recognise a description of the term *homeostasis*.

Question 11

It may be that candidates find it easier to work out a genetics problem if the information is presented in the form of a genetic diagram. In this question, candidates may have struggled to solve the problem in their heads, and thus a significant number opted for the answer that seemed logical, that black parent mice produce black offspring, thus omitting the important fact that the parents were heterozygous.

Question 13

If trees are removed, then it is logical that the substances they release are reduced. Whilst this is correct, a significant number of candidates did not realise that the absorption of any substance by the trees would also be reduced.

General comments (Chemistry)

Three of the questions in this section were answered correctly by the majority of candidates. None of the questions may be considered as being very difficult and there was no evidence of guesswork.

Comments on specific questions (Chemistry)

Question 14

Although almost all of the candidates recognised that sand is insoluble, a few chose option **A**, indicating that they did not appreciate that barium chloride is soluble in water.

Question 19

This was an easy question which the majority answered correctly. Almost all correctly identified the hydrogen ion, and only a few confused hydrogen atoms with hydrogen molecules.

Question 21

The vast majority of candidates recognised this apparatus as involving gaseous components in the reaction mixture, and most realised that it would be used to measure gaseous product formation rather than gaseous reactant consumption.

General comments (Physics)

Almost all candidates found **Question 28** easy, but **Questions 31**, **32**, **35** and **36** were more demanding.

Comments on specific questions (Physics)

Question 31

The majority of candidates believed that evaporation of a liquid causes the temperature of the remaining liquid to increase.

Question 32

Most candidates failed to appreciate that the temperature of the liquid fell continually during the period shown, indicating that it had not reached its melting point, and therefore remained as a liquid.

Question 35

This question on dispersion of light was not answered well. A number of candidates, despite making the wrong choice, did know that dispersion starts to occur as the light enters the prism, and not just when it leaves.

Question 36

The topic here was electromagnetic waves. Only a minority of candidates answered correctly, and many appeared to have guessed the answer.

Question 37

Although this was a simple recall question about the range of human hearing, only just over half the candidates answered it correctly.

CO-ORDINATED SCIENCES

Paper 0654/12

Multiple Choice

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

General comments (Biology)

With only one exception, candidates handled the biology questions on this paper with considerable competence.

Comments on specific questions (Biology)

Question 7

Perhaps candidates were confused by this question as it was phrased in the negative. There seems to have been some guesswork as all options proved popular. If candidates had asked themselves which of the options did not involve the liver, then perhaps many more would have realised that 'movement' was the correct answer.

Question 8

This proved the easiest question on the paper, and although it demanded no more than simple knowledge, the nervous system is traditionally a topic in which candidates tend to experience problems.

Question 11

This again examined a topic (floral structure) that often causes confusion, but in this case was answered very well. Clearly, candidates had carefully learnt the names and functions of the parts involved in pollination.

Question 12

If trees are removed, then it is logical that the substances they release are reduced. Whilst this is correct, a significant number of candidates did not realise that the absorption of any substance by the trees would also be reduced.

General comments (Chemistry)

Four of the questions in this section were answered correctly by the majority of candidates. None of the questions may be considered as being very difficult and there was no evidence of guesswork.

Comments on specific questions (Chemistry)

Question 14

This item required simple recall and application to everyday experience relating to the properties of metals to use in cooking pans. The majority answered this correctly.

Question 16

Although almost all of the candidates recognised that sand is insoluble, a few chose option **A**, indicating that they did not appreciate that barium chloride is soluble in water.

Question 18

This was an easy question which the majority answered correctly. Almost all correctly identified the hydrogen ion, and only a few confused hydrogen atoms with hydrogen molecules.

Question 20

The vast majority of candidates recognised this apparatus as involving gaseous components in the reaction mixture, and most realised that it would be used to measure gaseous product formation rather than gaseous reactant consumption.

Question 21

A significant minority chose option **A** rather than the correct answer, **B**. This indicates that many candidates thought, incorrectly, that catalysts are consumed in a chemical reaction.

General comments (Physics)

Question 30 was the best-answered, but **Questions 31**, **34** and **37** proved to be more demanding.

Comments on specific questions (Physics)

Question 31

Most candidates failed to appreciate that the temperature of the liquid fell continually during the period shown, indicating that it had not reached its melting point, and therefore remained as a liquid.

Question 32

The majority of candidates believed that evaporation of a liquid causes the temperature of the remaining liquid to increase.

Question 34

This question on dispersion of light was not answered well. A number of candidates, despite making the wrong choice, did know that dispersion starts to occur as the light enters the prism, and not just when it leaves.

Question 37

The topic here was electromagnetic waves. Only a minority of candidates answered correctly, and many appeared to have guessed the answer.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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

General comments (Biology)

Only one question in the biology section was correctly answered by fewer than half the candidates. All other questions were competently handled.

Comments on specific questions (Biology)

Question 1

This question presented a scenario for candidates to read and understand. This was the easiest of the questions in this section.

Question 3

Candidates often find it difficult to remember the relative positions of the xylem and phloem in the stem and in the root. There was evidence of this problem here, with all options being chosen by all but the most able candidates.

Question 7

The key to this question was to realise that oxygen is taken up by the blood in the alveolus. A considerable number of candidates appeared to think the opposite. They may not have read the question properly before attempting to answer.

Question 9

A significant minority of candidates believed that it is the entire pollen grain that travels to an ovule when fertilisation occurs. They also misunderstood the term *pollination*, not appreciating that this process terminates as soon as the pollen grain reaches the stigma.

General comments (Chemistry)

Four of the questions in this section were answered correctly by the majority of candidates. None of the questions may be considered as being very difficult and there was no evidence of guesswork.

Comments on specific questions (Chemistry)

Question 14

Although almost all of the candidates recognised that sand is insoluble, a few chose option **A**, indicating that they did not appreciate that barium chloride is soluble in water.

Question 16

Those candidates who chose option **A** not only misinterpreted the energy level diagram but also thought that the most reactive halogen, correctly identified as fluorine, would produce the least energy change.

Question 18

It was well known that the measurement of time is essential for determining reaction rate.

Question 19

This question was a straightforward recall and presented no problems.

Question 20

A significant minority chose option **A** rather than the correct answer, **B**. This indicates that many candidates thought, incorrectly, that catalysts are consumed in a chemical reaction.

Question 22

This question relating the properties of copper to its uses was answered correctly by almost all of the candidates.

General comments (Physics)

Candidates found **Questions 28** and **40** the easiest, whereas **Questions 29** and **31** were more demanding.

Comments on specific questions (Physics)

Question 29

In this question about stretching a spring, almost as many candidates chose option **B** as chose the correct answer, having failed to notice that a graph of extension against load (not length against load) was required.

Question 31

The majority of candidates believed that evaporation of a liquid causes the temperature of the remaining liquid to increase.

Question 32

The topic in this question was thermal expansion and contraction. Although almost half of the responses were correct, a significant number of candidates believed that cooling a metal rod considerably would not alter its length, and therefore chose option **B**.

Question 34

Although quite well answered, this simple recall question about the nature of common types of wave caused many candidates to guess the answer.

Question 35

This question also involved simple recall, in this case about the nature of the image in a plane mirror. Although many responses were correct, a considerable number thought that the image was real.

Question 36

Slightly more candidates confused the relative frequencies and wavelengths of red and blue light than answered this question correctly.

CO-ORDINATED SCIENCES

Paper 0654/21

Core Theory

Key Message

Candidates should quote any formula used in a standard form and use recognisable symbols. Formulae consisting of only units or containing a mixture of words, symbols and units should be avoided. The idea of using the triangle consisting of three variables is a valuable tool to answering calculation questions but is not acceptable as a formula.

Candidates are reminded to use scientific language / words in their answers. Candidates should not answer questions using the word 'it', as it is often difficult to work out what the 'it' is referring to, and the Examiners' are therefore unable to award credit.

General Comments

Most candidates were able to attempt most questions, with parts of all questions accessible. There was a good range of marks on most questions. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depends not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

There was evidence of candidates running short of time to complete the examination, with the last few questions frequently rushed.

Comments on Specific Questions

Question 1

While parts of the question proved difficult most candidates gained partial credit for their responses.

(a) (i) Candidates needed to refer to the reactivity of the two elements, rather than discuss the full outer shells of the ions.

(ii) Many candidates were able to state one difference between a compound and an element. A few candidates described a difference between an element and a mixture or between a compound and a mixture.

(iii) Many candidates gained partial credit. Either they suggested that the solution needed to be heated / boiled or that the solution was left to evaporate.

(b) (i) Many candidates knew that the reason why atoms did not have an overall electrical charge was because the number of protons in an atom equalled the number of electrons in an atom. The reason why a potassium ion had a single positive charge was less well explained.

(ii) Candidates seemed to find it difficult to explain this part clearly. The idea that a formula showed the ratio of carbon to nitrogen particles in a molecule was not understood.

(c) (i) Electrolysis was well known.

(ii) This was not well answered. Only the most able candidates referred to bromine.

Question 2

(a) This was quite well answered, although some candidates drew an arrow which went both down and then up.

(b) This was very well answered by most candidates, showing good data handling skills.

(c) (i) Care should be taken when drawing particle diagrams. Most candidates gained credit for their drawing of the solid, but few gained credit for their drawing of the liquid. Correct particle diagrams of a solid showed particles drawn in a regular arrangement, of a similar size and touching. Correct particle diagrams of a liquid showed particles drawn in an irregular arrangement, of a similar size and with most of the particles touching.

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

Question 3

(a) (i) This was not well known. Few candidates were able to state that that a hormone was a substance produced by a gland or that a hormone was carried in the blood.

(ii) This was well answered with most candidates gaining credit, most often for stating that adrenaline increased the heart rate.

(b) (i) Most candidates were able to state that the blood glucose concentration increased and then decreased. Only the most able used the data in Fig. 3.1 to add further quantitative information to gain credit.

(ii) This was not well known. Many candidates attempted to give an answer about fibre rather than about the digestion of starch to sugar and the subsequent respiration.

(iii) Most candidates made a simple comparison, but few used the data in Fig. 3.1 to gain further credit.

(c) The idea that fibre reduced constipation was well known.

Question 4

This question was answered well throughout.

(a) (i) **Y** and **Z** were well known as the two elements that were poor conductors. Most candidates explained that this was because they were both non-metals gaining credit.

(ii) **Z** was frequently identified as the element which would not be expected to form a compound. Many candidates knew that this was because it was noble gas.

(b) (i) Most candidates determined that the elements were in Group I of the Periodic Table. Only the most able explained clearly how they worked this out.

(ii) Rubidium was well known as the element with the lowest boiling point. A few candidates suggested caesium or francium.

(c) (i) Many candidates knew that the oxide needed to be made into a solution and then mixed with indicator. Few candidates were able to give the correct colour changes for a metal oxide and for a non-metal oxide.

(ii) Most candidates gained credit for stating that an insoluble substance had dissolved or that a coloured substance had been produced.

(iii) Many candidates correctly completed the word chemical equation.

Question 5

(a) This was very well answered by most candidates, showing good data handling skills.

(b) (i) Accelerating was well known.

(ii) This was another calculation which was very well answered.

(c) (i) A significant number of candidates found this calculation difficult.

(ii) The useful energy change occurring in an electric motor was well known.

(d) (i) Examples of renewable energy sources were well known. A few candidates suggested 'solar energy' and were not awarded credit as this was stated in the question.

(ii) Many candidates were unable to describe one advantage to the environment of using solar energy.

(e) Most candidates gained partial credit. A commonly incorrect characteristic suggested was to describe the image as 'real'.

(f) Most candidates realised either that the parallel rays needed to brought to a focus or that the focus was at 5 cm from the lens, however only the most able gained full credit.

Question 6

(a) (i) The atrium and ventricle were well known, although a number of candidates muddled them up.

(ii) Many candidates knew that the muscle contracted. Few candidates were able to elaborate on this and describe what happened as a result of the contraction.

(iii) This question on heart muscle was not well known.

(b) (i) Many candidates gave at least one difference between the contents of a pulmonary artery and a pulmonary vein. Common errors were to muddle up the artery and vein or to describe differences in the structure of the artery and vein.

(ii) This was well known. A common mistake was to confuse the artery with the vein.

Question 7

(a) An alloy being a mixture of metals was well known.

(b) (i) Many candidates correctly completed the word chemical equation.

(ii) The ideas that zirconium and oxygen atoms were bonded together and that oxygen atoms had mass were not understood.

(iii) The idea that the powder has a greater surface area was well understood. Some candidates found it difficult to explain how this would affect the reaction rate.

(c) (i) Most candidates correctly used the Periodic Table to find the proton number of zirconium.

(ii) The number of protons in each isotope was well known. The number of neutrons in each isotope was less often correctly determined.

(iii) The term *isotope* was well known.

Question 8

(a) The symbol for a fuse was not well known.

(b) This question on electrical hazards was well answered.

(c) (i) This was well answered. Only a few candidates gave values for $\mathbf{A_1}$ and $\mathbf{A_2}$ which were different from each other.

(ii) This was well answered, however a significant number of candidates calculated the combined resistance for the lamps as if they were in a parallel circuit. .

(d) (i) The equation V = I x R was not well known.

(ii) Most candidates were able to use the graph to determine the resistance of the component at 30 °C.

(iii) This calculation was not well done.

Question 9

(a) (i) The term *phenotype* was not well known, with a variety of answers seen. Candidates should be reminded to use the correct scientific terminology in these types of question.

(ii) Many candidates showed a good understanding of what they needed to do on this question. Even when an error was made part way through, the candidates invariably managed to complete the diagram to show the genotypes of the offspring.

(iii) Few candidates determined that the ratio was 1:2. The idea that **AA** zygotes would not develop was not understood.

(b) (i) Some candidates understood the insulating properties of air and fur , but few candidates were able to explain that the fur traps air, or that heat transfer would be reduced due to the trapped air.

(ii) Many candidates understood the idea that white chinchillas would be less camouflaged. Few candidates were able to explain why this fact would lead to most chinchillas found in the wild having normal grey fur.

Question 10

(a) Only the most able candidates explained the meaning the term unsaturated hydrocarbon.

(b) The colour change from orange to colourless was not well known.

(c) (i) Few candidates were able to use the information in Fig. 10.2 to explain that as the temperature inside the kiln was high, an exothermic reaction must have occurred releasing heat.

(ii) Very few candidates were able to explain that carbon dioxide was produced by the complete combustion of propane.

(iii) Only the most able candidates explained that carbon monoxide was produced by the incomplete combustion of propane.

(iv) Few candidates understood the link with part **(iii)** and therefore did not state that carbon monoxide is poisonous (to humans) if the gas cannot disperse.

Question 11

(a) The term *ionising radiation* was not understood.

(b) Only the most able candidates knew that ultraviolet radiation is the radiation in the electromagnetic spectrum that is between X-rays and visible light.

(c) (i) Most candidates were able to draw a suitable wave. The amplitude was usually shown correctly, gaining credit. Candidates, to gain credit for the wavelength, had clearly indicated the distance between identical points on two successive waves.

(ii) Longitudinal was the most popular answer given.

Question 12

(a) (i) Palisade tissue was not well known. Chlorophyll and chloroplasts were often suggested.

(ii) Most candidates gained partial credit but few candidates were able to give a complete answer.

(b) A few candidates gained full credit, with many gaining partial credit. The ideas of removal of habitats, less carbon dioxide being removed from the atmosphere and soil erosion were all well known.

CO-ORDINATED SCIENCES

Paper 0654/22

Core Theory

Key Message

Candidates should quote any formula used in a standard form and use recognisable symbols. Formulae consisting of only units or containing a mixture of words, symbols and units should be avoided. The idea of using the triangle consisting of three variables is a valuable tool to answering calculation questions but is not acceptable as a formula.

Candidates are reminded to use scientific language / words in their answers. Candidates should not answer questions using the word 'it', as it is often difficult to work out what the 'it' is referring to, and the Examiners' are therefore unable to award credit.

General Comments

Most candidates were able to attempt most questions, with parts of all questions accessible. There was a good range of marks on most questions. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depends not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

There was evidence of candidates running short of time to complete the examination, with the last few questions frequently rushed.

Comments on Specific Questions

Question 1

(a) (i) Many candidates suggested putting the electrodes in the beaker, but did not explain that the electrodes needed to make contact with the contents, to gain credit. Only the most able candidates explained that there would be a reading on the ammeter if the material conducted electricity.

(ii) Most candidates identified **Q** as a conductor and **S** as an insulator, however only a few candidates went on to explain that iron was a conductor because it was a metal and that sulfur was an insulator because it was a non-metal to gain full credit.

(iii) Only a few candidates identified chlorine as the gas released, however many more identified copper as the orange layer that formed.

(iv) Electrolysis was well known.

(v) The chemical test for chlorine gas was not well known.

(b) (i) Most candidates were able to state that an electron was lost.

(ii) The idea that the ions had opposite charges and that these opposite charges would attract was well known with most candidates gaining credit.

Question 2

(a) This was generally well answered; however some candidates confused amplitude with frequency.

(b) Many candidates gained credit for stating that sound waves need a medium to travel through.

(c) Most candidates were able to describe reflection and many were able to describe total internal reflection. Many candidates did this by continuing the light ray in the optical fibre on the diagram.

Question 3

(a) (i) This part was well known with many candidates gaining full credit.

(ii) Many candidates knew that xylem transported water and mineral ions. Fewer candidates knew that phloem transported the nutrients made in the leaves.

(b) (i) This was well answered with many candidates gaining full credit.

(ii) Few candidates were able to handle the data in the question and give an answer comparing the two plants.

(iii) The idea of a reduced surface was well known but only the most able candidates were able to explain the effect that this would have on the growth of the plant.

(c) Few candidates knew why adding nitrate ions to the soil made plants grow faster and larger. There were few references to proteins or amino acids.

Question 4

(a) (i) Many candidates were able to state that the pH increased but few were able to explain why.

(ii) Few candidates were able to suggest both the correct colour change and that effervescence would stop.

(b) (i) Most candidates referred to the correct two tests, but a significant number did not state what substance each test identified and were unable to be awarded full credit.

(ii) This was quite well known.

(iii) Many candidates were able to state that sodium carbonate has a lower mass. However, many candidates thought that this was because the sodium hydrogencarbonate lost hydrogen turning into sodium carbonate.

(iv) Few candidates were able to identify all three products.

Question 5

(a) (i) This was not well known.

(ii) Most candidates were able to place the ammeter in the correct position. Only the more able candidates were able to place the voltmeter in the correct position. A few candidates used incorrect symbols for the ammeter and voltmeter, and were unable to gain credit.

(iii) This was very well answered.

(iv) This was quite well answered although many candidates were not awarded full credit because they had used an incorrect symbol, in their formula, for current. The accepted symbol is I **not** A.

(b) This was very well answered by most candidates, showing good data handling skills.

(c) Candidates found this question challenging and were unable to describe sweating and cooling in terms of particles.

Question 6

(a) The parts on the diagram were quite well known.

(b) Candidates found this question challenging, with very few references to the X and Y chromosomes.

(c) (i) *Human immunodeficiency virus* was well known.

(ii) This was well known.

Question 7

(a) (i) Very few candidates knew the physical states of both bromine and iodine.

(ii) Many candidates explained that an iodine atom was larger than a bromine atom because it contained more protons and neutrons. Only a few went on to explain that iodine atom had more electron shells than a bromine atom to gain full credit.

(iii) This was not well answered. Only the most able stated that the mixture would turn brown, with even fewer explaining that this was due to iodine being produced.

(b) Chlorine being used to kill bacteria was well known. However, few candidates were able to add to this and explain that chlorine treatment made the water safe to drink.

(c) Many candidates answered this well, gaining full credit.

Question 8

(a) (i) Most candidates correctly drew the two arrows but a small number forgot to label the arrows.

(ii) Air resistance, and friction between the tyres and road, were frequent correct answers.

(iii) Candidates need to explain that the forces must be equal and opposite to gain credit.

(iv) Constant speed was the description required. A number of candidates wrote down 'constant' only which is not creditworthy.

(v) Gravity and weight were well known.

(b) (i) This was very well answered by most candidates, showing good data handling skills.

(ii) 'Kinetic' was the most popular answer, but a common incorrect answer was 'gravitational potential energy'.

(iii) 'Gravitational potential energy' was the most popular answer but a common incorrect answer was 'kinetic'.

(c) Most candidates stated that the pressure would increase. Fewer candidates went on to explain that this is because the particles were moving faster and therefore there are more frequent collisions with the tyre wall.

Question 9

(a) (i) Few candidates were able to explain what was meant the term *dominant*.

(ii) This was quite well known.

(iii) Many candidates showed a good understanding of what they needed to do on this question. Even when an error was made part way through, the candidates invariably managed to complete the diagram to show the genotypes of the offspring. Some candidates were not awarded credit because it was impossible to tell the difference between an **F** and an **f**.

(iv) Many candidates determined the correct ratio based on their answer to part **(iii)**.

(b) (i) This was not well answered by many candidates, who were unable to state that oxygen would combine with glucose and that the chemical energy in glucose would be transformed into heat energy.

(ii) Some candidates understood the insulating properties of air and fur , but few candidates were able to explain that the fur traps air, or that heat transfer would be reduced due to the trapped air.

(iii) This was not understood by most candidates. Candidates need to explain that some parts of the rabbit were colder than other parts of the body, for example the ears and nose and that the black pigment was produced in the colder areas.

Question 10

(a) (i) The molecular structures of methane and ethane were well known. The molecular structures of ethanol and ethene were less well known.

(ii) Most candidates were able to state one use for ethanol.

(b) (i) Many candidates successfully worked out the chemical formula of the chlorofluorocarbon shown.

(ii) Many candidates correctly stated that the bonding involved was covalent. Fewer explained that this was because the bonding was between two non-metals.

Question 11

(a) (i) This was not well answered. Candidates needed to draw a few magnetic field lines around the magnet. The direction of the field should have been indicated using arrowheads on the field lines.

(ii) This part was also not well answered.

(iii) Only the most able candidates were able to state an advantage of using an electromagnetic.

(b) (i) This was well understood.

(ii) Most candidates were able to state one way by which the direction of motion of the wire could be reversed; usually by reversing the current.

Question 12

(a) (i) only the most able candidates knew the correct term, *producer*, for the microscopic green plants. Many candidates suggested algae, which was given in the question.

(ii) Few candidates suggested carbohydrates.

(iii) Few candidates suggested that the arrows in the food web show the energy flow or transfer. Most candidates thought that the arrow showed what organism ate what organism.

(b) A number of candidates correctly identified carbon dioxide as a gas that contributed to global warming. Methane was rarely seen.

CO-ORDINATED SCIENCES

Paper 0654/23

Core Theory

Key Message

Candidates should quote any formula used in a standard form and use recognisable symbols. Formulae consisting of only units or containing a mixture of words, symbols and units should be avoided. The idea of using the triangle consisting of three variables is a valuable tool to answering calculation questions but is not acceptable as a formula.

Candidates are reminded to use scientific language / words in their answers. Candidates should not answer questions using the word 'it', as it is often difficult to work out what the 'it' is referring to, and the Examiners' are unable to awarded credit.

General Comments

Most candidates were able to attempt most questions, with parts of all questions accessible. There was a good range of marks on most questions. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depends not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

There was evidence of candidates running short of time to complete the examination, with the last few questions frequently rushed.

Comments on specific questions

Question 1

(a) All three answers were well known.

(b) Water was well known as one of the substances absorbed by root hair cells. Mineral salts was less well known.

(c) (i) Few candidates were able to state what is transported in the phloem. Many candidates suggested 'nutrients', which was too vague to be creditworthy.

(ii) Many candidates gave answers referring to the nutrients and water not being able to move up the plant.

Question 2

(a) (i) Argon was well known, however a common incorrect answer was oxygen.

(ii) Most candidates selected a metal and non-metal. Most explanations given were in terms of electron gain and loss. What was required was that one of the elements needed to be a metal and the other a non-metal. Oxygen and sulfur was a common incorrectly suggested pair of elements, possibly because they are in the same group of the Periodic Table.

(b) (i) The nucleus was well known, although a significant number of candidates thought that structure **A** was the whole phosphorus atom.

(ii) Most candidates worked out that the proton number was 15 and went on to explain that this was because the atom had 15 electrons.

(c) (i) Very few candidates suggested magnesium sulfate as the original magnesium compound. Magnesium chloride was a common incorrect answer.

(c) (ii) Most candidates gained some credit for their response. Filtration was usually seen, although a number of candidates simply suggested separating the precipitate from the solution. Very few candidates mentioned drying the solid. A number of candidates attempted to calculate the volume of the precipitate and then carry out a calculation to determine the mass using the density of the precipitate.

Question 3

(a) (i) The use of a variable resistor was not well known.

(ii) Approximately half the candidates chose meter **X** for reading the current, although very few could explain that meter **X** was the ammeter as it was in series in the circuit given.

(iii) This was quite well answered although many candidates were not awarded full credit because they used an incorrect symbol, in their formula, for current. The accepted symbol is I **not** A.

(b) Most candidates gained partial credit for selecting two correct responses.

(c) Most candidates correctly identified the length of the wire and the cross sectional area of the wire as the two factors. A number of candidates repeated factors given in the question and were unable to be awarded credit.

Question 4

(a) The role of alcohol in the test was well known as was the milky appearance after adding the mixture to water. Only the most able candidates suggested that the beans would need to be chopped or crushed.

(b) The role of protein for growth and repair was well known.

(c) Most candidates explained that chewing would increase the surface area of the beans. Few candidates were able to describe clearly that the larger surface area made it easier for the enzymes to make contact with beans.

(d) Only the most able candidates mentioned protein or amino acids. Many candidates stated that enzymes are denatured by heating, however, while being correct was not creditworthy in this context.

(e) Most candidates gained partial credit with a number gaining full credit. The ideas of removal of habitats, less carbon dioxide being removed from the atmosphere and soil erosion were all well known.

Question 5

(a) (i) Test-tube **Q** was correctly identified as the one containing iron, although few candidates could explain why. Only the most able candidates referred to the orange layer being ‘rust’.

(ii) Calcium, magnesium and zinc were the only metals that gained credit, hydrogen (gas) was well known.

(iii) Either zinc or iron were awarded credit.

(b) This was quite well answered. Candidates were able to connect the key and copper electrode to the power supply using wires. Many showed the key and the copper electrode dipping into the solution and some gave the correct polarity for the key and copper electrode.

Question 6

(a) Many candidates gained some credit.

(b) Most candidates drew a suitable wave. The amplitude was usually correctly shown gaining credit. However, when labelling the wavelength candidates were unable to be awarded credit because they had not clearly shown the distance between identical points on two successive waves.

Question 7

(a) Most candidates gave 'normal' (for colour) and '**aa**' (for genotype) gaining full credit.

(b) The term *phenotype* was well known.

(c) (i) Many candidates showed a good understanding of what they needed to do on this question. Even when an error was made part way through, the candidates invariably managed to complete the diagram to show the genotypes of the offspring.

(ii) Many candidates determined the correct ratio based on their answer to part **(i)**.

(d) This was not well known. Very few candidates suggested crossing the snake with an albino snake. Most candidates suggested that you would have to investigate the parents and grandparents of the snake.

Question 8

(a) (i) Carbon dioxide was well known.

(ii) Using limewater to test for carbon dioxide was also well known.

(iii) Few candidates knew this. No common incorrect answer was seen.

(iv) Most candidates correctly determined that there were three different elements in calcium nitrate, but were unable to work out the total number of atoms present.

(b) (i) Most candidates confused higher pH with greater acidity and consequently gave an incorrect explanation.

(ii) Two variables were usually correctly identified gaining full credit.

Question 9

(a) (i) Most candidates were able to interpret the distance / time graph and determine the total distance covered.

(ii) 5 m / s was the most popular response.

(iii) While 'not moving' was the most popular correct response, a number of candidates confused the distance / time graph with a speed / time graph and suggested that the cart was moving at a constant speed.

(iv) Many candidates knew that the forces were unbalanced but only the most able explained that as the cart was accelerating the speed must be changing.

(b) Almost all the candidates correctly answered this question.

(c) (i) 'Kinetic' was the most popular answer, but a common incorrect answer was 'gravitational potential energy'.

(ii) 'Gravitational potential energy' was the most popular answer but a common incorrect answer was 'kinetic'

(d) Most candidates were able to do this. The commonest error was to choose an incorrect formula.

(e) (i) Most candidates were able to show that the particle arrangement in a gas was random.

(ii) Candidates needed to describe two ideas to gain credit. Not only did they need to describe that the particles would move faster, if the temperature increased, but also that this increased movement meant more collisions with the tyre wall.

(iii) Many candidates did not describe sweating and cooling in terms of particles and were unable to be awarded credit.

Question 10

(a) The trachea and lung were well known.

(b) (i) Many candidates correctly defined diffusion as the movement of molecules from a region of high concentration to a region of low concentration gaining full credit.

(ii) Plasma was not well known. Haemoglobin and red blood cells were commonly seen incorrect responses.

(iii) Many candidates gained full credit, however, a significant number of candidates referred to anaerobic respiration.

(iv) Many candidates were able to explain that the rate of diffusion of carbon dioxide would increase but few could explain why.

Question 11

(a) Coal was the most common correct answer given, but a number of candidates chose either a liquid or gaseous fossil fuel.

(b) (i) Fractional distillation was well known. Very few responses of just 'distillation' were seen.

(ii) Most candidates knew that gasoline was used as a vehicle **fuel**. A response such as 'for cars' were not creditworthy as this is too vague.

(c) (i) Many candidates gained full credit for their structure of ethane, a significant number drew the structure of methane.

(ii) This was poorly answered. A few candidates completed the left hand side of the equation with oxygen, and very few knew both carbon dioxide and water to complete the right hand side of the equation.

(d) (i) Cracking was well known.

(ii) This was not well answered. Few candidates were able to explain that air contained oxygen and fewer were able to suggest that oxygen would probably cause the reactant to burn rather than crack.

Question 12

(a) Most candidates were able to describe reflection and many were able to describe total internal reflection. Many candidates did this by continuing the light ray in the optical fibre on the diagram.

(b) (i) Red and violet were not well known. Green and yellow were common incorrect colours responses.

(ii) A number of candidates managed to work this out and suggest raindrops.

(c) (i) Most candidates knew that the image would be at the same horizontal level as the nose. Few realised that the image would be the same distance behind the mirror that the nose was in front. A number of candidates located the image either in front of the mirror or on the surface of the mirror.

(ii) Many candidates gained credit. A number of candidates wrote down contradictory descriptions, for example real and virtual.

CO-ORDINATED SCIENCES

Paper 0654/31

Extended Theory

Key Message

Candidates should quote any formula used in a standard form and use recognisable symbols. Formulae consisting of only units or containing a mixture of words, symbols and units should be avoided. Candidates are expected to give correct units with their answers and give an appropriate number of significant figures. Working should be shown, as some credit can be awarded even if errors have been made in the arithmetic.

When drawing diagrams or graphs, candidates should be reminded to take care to draw clearly and to use the correct labels and labelling lines.

General Comments

The majority of candidates showed a wide range of knowledge and understanding across the syllabus. Almost all candidates attempted to answer all the questions, and the majority communicated their responses clearly. Extended answers were well structured and ideas generally clearly expressed.

Candidates should check that they have answered the question that has been asked. The most successful candidates differentiated between instructions like state, describe and explain. They also checked their work to ensure that they were not simply rearranging or repeating information given in the question.

Candidates are reminded to use correct scientific terminology, and to know their definitions. Calculations were usually carried out systematically but a number of candidates had difficulty converting units.

Comments on Specific Questions

Question 1

(a) (i) Many candidates correctly referred to the reactivity of the elements and gained credit. Stating that the elements had reacted was not enough to credit.

(ii) Many candidates were knowledgeable about the differences between a compound and a mixture and gained credit. Many stated that compounds were hard to separate or mixtures were easy to separate, a creditworthy response would have been: *'Compounds can be separated by chemical means and mixtures can be separated by physical means'*.

(iii) The most able candidates identified using the melting points as a suitable test by referring to the numerical data in the question stem. Some candidates stated 'heating' but did not go on to identify the reasons for this approach.

(b) (i) Many candidates correctly identified both calcium and potassium to be awarded credit.

(ii) Many candidates gave the correct chemical formula of the compound calcium nitride. To be awarded full credit candidates had to demonstrate how the formula of the compound could be identified by the balancing of charges.

(c) This question was answered well, with many candidates gaining full credit. A few candidates muddled oxidation and reduction by stating that reduction was the loss of electrons.

Question 2

(a) (i) Nearly all candidates drew a correct arrow pointing downwards to indicate the flow of air. A few drew a convection current or an arrow outside the fridge.

(ii) This was well answered with most candidates. Where candidates were not awarded full credit, their response had not made it clear that it was the <u>air</u> that was more dense rather than the particles.

(b) Some candidates knew the correct formula and how to apply it. Candidates should, when writing out an equation, use words or recognised symbols not a mixture of both. Some candidates used the correct formula but did not round their figures correctly and / or used the incorrect units, resulting in only partial credit.

(c) (i) Many candidates gained credit. A small minority did not identify that it was the <u>intermolecular</u> bonds that required force to be broken. A few gained credit for correctly referring to the latent heat of fusion.

(ii) Care should be taken when drawing particle diagrams. Most candidates gained credit for their drawing of the solid, but few gained credit for their drawing of the liquid. Correct particle diagrams of a solid showed particles drawn in a regular arrangement, of a similar size and touching. Correct particle diagrams of a liquid showed particles drawn in an irregular arrangement, of a similar size and with most of the particles touching.

(d) Many candidates stated that refrigerator **D** (white and shiny) would be the most effective at keeping its contents cool, but only the most able could fully explain why.

Question 3

(a) Candidates who correctly identified the effect on the cells gained full credit. Many candidates did not appreciate that it was the effect of concentration on the cells and suggested possible general negative health impacts of increased concentration of blood glucose.

(b) (i) Many candidates were able to correctly describe the changes in blood glucose concentration. Some candidates described results of cornflakes with <u>and</u> without added fibre, which was unnecessary. Candidates are reminded to refer specifically to the numerical data when answering these types of questions.

(ii) Some candidates gave detailed explanations for the changes seen on the graph gaining credit. Only a very few candidates did not differentiate between 'describe' in **(b) (i)** and 'explain' in **(b) (ii)**.

(iii) Many candidates gained credit by referring to fibre reducing constipation. A number of candidates stated that blood glucose would stay lower but did not suggest a specific health benefit.

Question 4

(a) Most gained credit for this question. Care needs be taken when writing specific elements which could be confused with other similarly spelt substances. Very few candidates gave an incorrect group IV element.

(b) (i) Most candidates gave the correct group, with a suitable explanation. Some candidates were vague in their explanation. Candidates needed to show a link between group I and the proton number on the graph. This could be done by referring to a specific proton number or a more general comment on proton numbers of group I.

(ii) Most candidates were able to plot a point on the graph for a proton number of 55, however, many gave a temperature that was too low.

(c) (i) Many wrote the correct name 'carbon monoxide'. Candidates are reminded that if the question asks to name the gas then a name should be given rather than formula. Common incorrect responses included carbon dioxide and oxygen.

(ii) Most candidates gave at least one correct word equation. A small minority gave formulae equations instead of word equations. Candidates are reminded that an arrow symbol should be used and not an equals sign to indicate the formation of products.

(iii) Some candidates gave a very detailed explanation of how carbon monoxide was formed gaining credit.

Question 5

(a) (i) Many candidates used the correct formula to give 105 km. Nearly all candidates used the correct units.

(ii) Most candidates found this part of the question challenging. Candidates were often unable to be awarded full credit as they had not converted the units to m/s^2. Credit was awarded where candidates used a valid, alternative method.

(b) (i) Most candidates gave the correct answer of '10%'.

(ii) The candidates who did not correctly calculate the kinetic energy for this part, usually had not appreciated that 90% of the energy was initially reflected.

(c) (i) Many candidates correctly drew the mirror as a straight line. The majority of these were able to draw the mirror in the correct position at the correct angle.

(ii) Candidates who drew a mirror attempted this part and many of these were able to draw and identify the angle of incidence. Some candidates drew the angle of incidence in the wrong position. Fewer confused the angle of incidence with the angle of reflection.

(d) Many candidates brought the rays to focus at 5 cm on the principal axis, gaining full credit.

Question 6

(a) (i) Many candidates identified that blood pressure increased. Many also stated that the blood was pushed out into the aorta. Some candidates identified the wrong blood vessel.

(ii) Most candidates gave the correct effect of the valve closing gaining credit.

(b) (i) Many candidates linked the need for oxygen with respiration to release energy. Only a few candidates recognised the heart is a muscle that is constantly contracting. Some candidates incorrectly referred to the need for oxygen so the heart could pump the oxygen around the body. Candidates should be reminded that respiration releases energy and does not create or produce energy.

(ii) Many candidates shaded the correct area of the heart. Some candidates incorrectly shaded only the coronary artery or an area above the site of the blockage.

(iii) Most candidates stated at least one correct lifestyle factor, with many gaining full credit. A few candidates needed to be more specific and refer to too much fat in the diet rather than just stating the term '*fatty foods'*.

(c) (i) Candidates should be reminded to use comparative statements when describing differences. Many candidates correctly identified one difference in blood contents, the majority stating the difference in concentration of oxygen between the pulmonary artery and the pulmonary vein. Some candidates incorrectly referred to the structure of the blood vessels.

(ii) Most candidates compared the wall thickness gaining credit. Candidates who did not refer to the artery / vein *wall* or stated that the 'artery was thicker', were unable to be awarded credit.

Question 7

(a) (i) Many candidates correctly calculated the number of protons, neutrons and electrons. Some candidates confused the nucleon number with the proton or neutron number.

(ii) Most candidates stated the meaning of the term *atomic mass* and only the most able correctly defining the meaning of the term ***relative atomic mass***.

(b) (i) Most candidates gained credit for calculating the relative atomic mass of 91. Many correctly calculated the value of 200 moles, however some candidates did not covert kg into g and therefore gave an incorrect value of 2 moles.

(ii) Many candidates correctly calculated 380 kg, gaining full credit.

(c) (i) This question was answered well with most candidates identifying that the surface area had increased. Many explained the effect of increased surface area using collision theory.

(ii) Only some candidates identified that the reactants contained a greater amount of energy. Some gained partial credit for identifying the reaction as exothermic, however only a few were explained that chemical potential energy had been transferred to the surroundings.

Question 8

(a) Some candidates calculated the correct answers of 2.0 A and 14 A. The most common incorrect answers were 0.5 A and 6 A.

(b) Most candidates were able to rearrange the equation and correctly calculate current, gaining full credit.

(c) (i) Some candidates correctly drew sine waves. They almost always had a regular amplitude and wavelength gaining full credit.

(ii) This question was answered well. Most candidates gave at least one factor that would affect the voltage. Candidates should take care to make clear whether it is the number of turns on a coil they are referring to, or the speed of rotation. There were several ambiguous answers such as '*number of turns',* which were not creditworthy.

Question 9

(a) (i) Most candidates were able to state that a *mutation* was a change in the gene. Some candidates were confused with genetic engineering and incorrectly referred to modification of genes. A variety of responses were seen referring to genetic makeup or genetic material.

(ii) Although most candidates attempted this question, many were not specific enough, citing *radiation* rather than ***ionising radiation***.

(b) (i) The term *phenotype* was not well known, with a variety of answers seen. Candidates should be reminded to use the correct scientific terminology in these types of question.

(ii) Most candidates attempted this question, with the majority gaining at least partial credit. Very few candidates drew out a genetic diagram in full, labelling parental phenotype, parental genotype, gamete, offspring genotype, offspring phenotype and ratios. To gain full credit candidates should complete genetic diagrams in full, label them accurately and include a ratio.

(iii) Many candidates identified that **AA** zygotes would not develop. Not all were then able to give the correct ratio of two white: one normal. The most common incorrect answer was to give the expected ratio of a heterozygous cross of 3:1.

(c) Many candidates identified that trapped air acted as an insulator rather than the fur itself. Those who identified air as an insulator generally gained full credit.

Question 10

(a) Most candidates gave butane for compound **X**, and that the homologous series is alk**a**nes gaining full credit. Some candidates gave the homologous series of alk**e**nes.

(b) (i) Many candidates gave the correct colour change. Candidates should use the correct term of '*colourless'*. A range of alternative incorrect answers were seen.

(ii) Many candidates did not know the name of this type of reaction.

(iii) Most candidates drew a correct structural molecular diagram. The most common incorrect response was to give a double bond between the two carbons rather than a single bond. Some candidates also incorrectly included an additional chlorine atom.

(iv) Candidates answered this well. Candidates should take care when writing chemical names to spell them accurately.

(c) Many candidates correctly constructed the symbol equation and balanced it correctly. However a common mistake was candidates not realising that hydrogen is a diatomic molecule.

Question 11

(a) Some candidates gave the correct meaning of the term *ionising radiation*. A number of candidates needed to give a more detailed meaning as it is not enough to state that 'ionising radiation produces ions'.

(b) The candidates who gave the correct radiation generally were able to give a correct use.

(c) A numerical value given with the correct units was the required answer. Many candidates gave the statement '*the speed of light*' rather than its value. Candidates should always use the correct units when giving a numerical answer.

(d) (i) Many candidates had some knowledge about half-life but answers were sometimes vague. Candidates should be specific in their answers. Many candidates referred to radioactive substances or materials decaying. Candidates should refer to radioactive <u>atoms</u> or <u>nuclei</u> decaying.

(ii) Most candidates were correctly able to show half-life using graphical means.

Question 12

(a) Many candidates gave a detailed description of photosynthesis gaining full credit. Some candidates were not clear on the role of chlorophyll in the process and there was some confusion between the role of the chloroplasts and chlorophyll.

(b) This question was answered well. Many candidates were able to link deforestation with the decrease in photosynthesis resulting in an increase in carbon dioxide in the atmosphere. Many candidates also gained credit for identifying carbon dioxide as a greenhouse gas. Some candidates incorrectly referred to carbon dioxide having an effect on the ozone layer.

CO-ORDINATED SCIENCES

Paper 0654/32

Extended Theory

Key Message

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When drawing diagrams or graphs, candidates should be reminded to take care to draw clearly and to use the correct labels and labelling lines.

General Comments

The majority of candidates showed a wide range of knowledge and understanding across the syllabus. Almost all candidates attempted to answer all the questions, and the majority communicated their responses clearly. Extended answers were well structured and ideas generally clearly expressed.

Candidates should check that they have answered the question that has been asked. The most successful candidates differentiated between instructions like state, describe and explain. They also checked their work to ensure that they were not simply rearranging or repeating information given in the question.

Candidates are reminded to use correct scientific terminology, and to know their definitions. Calculations were usually carried out systematically but a number of candidates had difficulty converting units.

Comments on Specific Questions

Question 1

(a) (i) Most candidates stated that the 'sodium ion had lost an electron' which was insufficient to be awarded credit. For credit it was necessary to state that the 'sodium atom had an equal number of protons and electrons'. Further credit was given for stating the charges on the protons and electrons and the relative numbers (of protons and electrons) in the ion.

(ii) Most candidates knew that aqueous sodium chloride had ions which were free to move. The majority did not distinguish between sodium chloride crystals which have ions that are immobile and decane having no ions. Despite the question asking for an explanation it terms of **ions**, many answered only in terms of **electrons.**

(iii) Many candidates were unable to identify the gases produced, or placing them at the wrong electrodes. A number of the responses were not gases, e.g. sodium or sodium hydroxide. Most identified that formation of an alkali / base caused the pH to rise although some thought it became more acidic.

(b) (i) The majority of candidates knew that strong bonds required high energy to break leading to a high melting point. Candidates who referred to 'covalent bonding' and / or 'molecules' in their response were unable to gain full credit.

Question 2

(a) (i) Most candidates relied on completion of the diagram to show total internal reflection. Some diagrams were accurate and drawn with care. Only the most able candidates appreciated that total internal reflection only occurs when the angle of incidence exceeds the critical angle.

(ii) Most candidates correctly stated the formula and calculated the time, using the correct units.

(iii) Only the more able candidates realised that the distance via satellite was greater leading to a longer time. Many answered in terms of wavelength or frequency, or higher speed in the fibre despite being told in the question that it was lower.

(b) Most candidates were aware that sound waves needed a medium, however only the most able referred to transmission of sound by vibration of particles or compression and rarefaction of the medium.

Question 3

(a) (i) Some candidates answered this in terms changing acidity / alkalinity rather than how pH changed.

(ii) Some candidates did not distinguish between observations and inferences, e.g. that becoming acidic is an inference from the observation of change in the colour of the indicator.

(b) (i) Most candidates correctly linked the observations to the presence of water and carbon dioxide.

(ii) Many candidates wrote a correctly balanced equation, however a few candidates included oxygen as a reactant, and some did not use the information in the question (stating the products).

(iii) Only the more able candidates realised that the layer of solid sodium hydrogen carbonate on the paper would restrict the access to oxygen in the air. Most knew that carbon dioxide and water produced would inhibit burning.

(iv) Of the candidates who stated that the reaction was endothermic, many related this to decomposition or bond breaking gaining credit.

Question 4

(a) (i) Many candidates were aware that this was a change in the genes but some referred to changes in 'genetic information' or 'genetic material' which was not awarded credit as it is not precise enough.

(ii) The majority of candidates used the term 'radiation' rather than '*ionising radiation*'.

(b) (i) Most candidates gained full credit for their response.

(ii) Most candidates realised that there was a much greater effect of phosphate ions on the length of root hairs of mutant plants than normal plants. Many did not comment on the similarity of the effects on number of root hairs for both types of plant. Full credit was awarded by giving comparative statements (to normal plants), not just describing the effects on mutant plants.

(iii) Most candidates recognised that shorter root hairs would decrease the surface area of the roots and hence the uptake of water and / or mineral ions. Some candidates referred to nutrients or minerals rather than mineral ions. Only the more able expanded this to give a reason why growth would be affected as a result of shortage of water or one of the ions.

(c) (i) Many candidates knew that nitrogen intake was important in the synthesis of proteins by plants. Only the more able candidates went on to say why this would improve growth, e.g. building new cells to gain credit.

(ii) Many candidates were familiar with run off and eutrophication and describe the initial stages in the process. Some attributed oxygen deficiency to less photosynthesis rather than the respiration of bacteria which were decomposing dead plants.

Question 5

(a) Most candidates used the correct formula (for a parallel circuit) to calculate the resistance. Only a few used the formula for series circuit.

(b) The majority of the candidates used the correct formula but many incorrectly used the combined resistance they had calculated in part **(a)** rather than the resistance of light **A** (10 Ω).

Question 6

(a) Most candidates correctly identified the placenta and amniotic fluid. Many labelled the cervix at the top of the fetus's head or the opening, rather than the appropriate section of the uterine wall.

(b) Most candidates were aware that oxygen was supplied to the fetus from the mother's blood but many did not make it clear that there was no transfer of blood. Some candidates stated that the oxygen was diffused from the placenta to the umbilical cord rather than from the mother's blood to the fetus's blood through the placenta. Many did not make it clear that the oxygen was transferred by the umbilical cord in oxygenated blood rather than as a gas.

Question 7

(a) Many candidates were not aware that fluorine was a gas at room temperature. Those who had the correct state usually went on to give a correct statement about relative size of molecules. Only the more able candidates referred to low intermolecular forces.

(b) The majority of the candidates gained full credit, correctly identifying the noble gas group and its unreactive nature due to a having eight electrons in the outer shell. Candidates are reminded to use the group numbering as in the given Periodic Table, i.e. Group 0 for the noble gases rather than Group VII / 8.

(c) (i) The more able candidates realised that the fluoride ion had eight electrons in its outer shell and was therefore unreactive gaining full credit.

(ii) Many candidates either did not work out the number of moles in 10 000 dm^3 or did not multiply this by the molar mass of sodium fluoride and were unable to be awarded full credit.

Question 8

(a) (i) Almost all candidates knew the correct formula for work done, but many did not convert the distance from kilometres to metres. When the unit is required, the newton-metre (Nm) is not creditworthy; the correct unit for work is joules (J).

(ii) The majority of candidates knew the correct formula for power and used it correctly. The creditworthy unit for power is watts (W); joules per second (J/s) was not accepted.

(b) Many candidates knew the correct formula linking pressure, force and area. Many candidates completed the multi-stage calculation correctly, however the most common mistake was forgetting to allow for four tyres. Converting the area from cm^2 to m^2 correctly was found difficult by many candidates.

(c) (i) Most candidates realised the folded copper foil would provide increased surface area for cooling and some also stated that copper was a good conductor of heat. Those who referred to the increased surface area leading to increased evaporation or to increased rate of reaction were not awarded credit.

(ii) Most candidates knew the appropriate formula but quite a number used temperature rather than temperature change.

Question 9

(a) (i) Most candidates knew that the dominant allele produced white fur but some used two different letters as symbols, rather than upper and lower case of the same letter.

(ii) Most candidates drew an acceptable genetic diagram but many did not identify the genotypes of the parents and / or did not link the phenotypes of the offspring to their genotypes.

(b) (i) Many candidates did not take into account that the question asked how heat was generated and referred to homeostasis, vasodilatation and vasoconstriction, shivering and moving about. Those who mentioned respiration often did not explain how this *released* heat energy.

(ii) Many candidates did not appreciate that it was the **air** trapped by the fur that provides insulation and reduces convection. Statements such as 'fur trapping heat' are not creditworthy. Candidates should be aware that insulation does not prevent heat loss but only reduces it.

(**iii)** Many candidates realised that the parts of the body where the fur turned black were cooler than the rest of the body because they were at the extremities. Only the more able candidates related this to the enzyme being active in these areas. Quite a number referred to the temperatures in the Himalayas being below 25 °C. Some tried to explain the advantage of black fur in terms of absorption of heat.

Question 10

(a)(i) Almost all candidates knew that chlorine and fluorine have seven outer shell electrons.

(i) The majority of candidates ascribed eight electrons to the outer shell of fluorine and chlorine in the CFC but some did not make it clear that the additional electron was shared with carbon rather than donated by carbon.

(b) (i) Some candidates were aware of the kinetic theory and explained the force on the paint in terms of particle collisions with the surface. A significant number attributed the force to pressure created when the cap was pushed down.

(ii) Most candidates were able to explain that ozone had three oxygen atoms per molecule and gaseous oxygen only two.

(c)(i) Almost all candidates drew a correct diagram for an 'alkane' but a few did not draw 'propane', i.e. they used an incorrect number of carbon atoms.

(ii) Most candidates knew that hydrocarbons were flammable but some suggested that they were less effective.

Question 11

(a) Most candidates were able to identify the components from their descriptions. A few confused the microphone with the speaker.

(b) (i) The vast majority of candidates had the correct answer to this question but some did not give a formula as requested.

(ii) Hardly any candidates knew the function of the core in a transformer. Many thought it was to conduct the electricity from one coil to another. A number described it as creating a magnetic field rather than enhancing the field produced by the coil.

(iii) Whilst many candidates knew that high voltage led to a low current which reduced energy lost, few identified this as being mainly in the form of heat. Some did not realise that the power would remain the same and suggested that the power was higher and the loss was a smaller proportion of the total.

(c) (i) Most candidates had some idea of the shape of the magnetic field although many bent all the lines form one pole to the other. Some did not place arrows on the lines which went from north to south. Credit was not awarded where there were distinctly crossing lines of force.

(ii) Only the most able drew the lines of force through the middle of the coil.

Question 12

(a) Most candidates gained partial credit, by writing 'nicotine, tar and carbon monoxide'. The term carcinogen was not sufficiently precise to gain credit and many included tobacco.

(b) Some candidates did not make it clear that it was mucus which trapped bacteria rather than the cilia themselves. Many referred to the action of cilia but did not include build up of mucus and bacteria in the lungs and that mucus was a breeding ground for bacteria.

(c) Many candidates named phagocytes and lymphocytes and described their roles in defending the body against bacteria. Some referred to bacteria being engulfed and antibodies being produced but did not relate these to particular cells.

CO-ORDINATED SCIENCES

Paper 0654/33
Extended Theory

Key Message

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Candidates should check that they have answered the question that has been asked. The most successful candidates differentiated between instructions like state, describe and explain. They also checked their work to ensure that they were not simply rearranging or repeating information given in the question.

Candidates are reminded to use correct scientific terminology, and to know their definitions. Calculations were usually carried out systematically but a number of candidates had difficulty converting units.

Comments on Specific Questions

Question 1

(a) Most candidates labelled the root hair cell correctly, however many were unable to locate stucture **A** 'a partially permeable membrane'.

(b) The relationship between the structure of the cell and its function was appreciated by most. The uptake of water and the large surface area were often quoted. The effect of surface area on rate of uptake and the role of the partially permeable membrane in osmosis were less well known.

(c) Those candidates who gained full credit in this question appreciated that it was the removal of the phloem, rather than the xylem or outer layer, which prevented movement of material to the roots. They stated that the phloem transported sucrose from the leaves to the root, rather than in the reverse direction.

Question 2

(a) Many candidates selected two non-metals as having atoms which formed covalent bonds. Others demonstrated a misconception by selecting a non-metal and a metal. A few were given credit for going beyond the requirements of the syllabus, explaining in terms of the difference in electronegativity.

(b) PH_3 was usually given as the formula of phosphine. Credit was awarded for a well drawn 'dot and cross' diagram of the electronic structure. A few candidates attemptied to describe ionic bonding.

(c) (i) Only the most able candidates appreciated that the use of excess barium chloride would remove all sulfate ions from the solution. Names or (symbols with the correct charge) gained credit, however candidates had to use the term *chlori**d**e.*

(ii) Most candidates knew how to calculate a mass from concentration and volume, but a significant number had difficulty in converting units.

(iii) The equation was used by many to establish the relationship between numbers of moles of reactant and of product.

(iv) Many candidates found the relative formula mass from data in the Periodic Table, but only the most able correctly calculated a mass in grams from the number of moles.

Question 3

(a) A minority of candidates knew the relationships between variables in the circuit.

(b) The majority of candidates knew the factors affecting resistance and gained full credit.

(c) (i) The power input was usually calculated correctly, with the working shown.

(ii) Candidates were most likely to succeed in obtaining the power output when they carried out the process in two stages. Those most successful stated both of the formulae required and used the correct units.

(iii) The reason for the difference between power input and output was not always appreciated, with the question often being repeated in a different form, rather than describing the loss of useful energy from the system.

(iv) Those that understood the meaning of efficiency could usually show how they calculated its value. A few candidates obtained an answer in excess of 100% without attempting to correct an earlier error.

(d) (i) Most candidates named the sign of the charge on an electron gaining credit.

(ii) The behaviour of α- and β-radiation in an electric field could often be explained in terms of differing charges. The lack of charged particles in γ-radiation was not always included in the answer.

Question 4

(a) (i) Bacteria or an appropriate named bacterium was required for the type of microorganism added to milk to make yoghurt. Yeast was a popular incorrect response.

(ii) Some candidates appreciated that the milk was kept warm to speed the process because the bacteria worked better above normal room temperature or at the optimum temperature for the enzyme. Others misunderstood *warm* and suggested that a high temperature would kill unwanted bacteria.

(b) (i) Most could describe the change in lactic acid concentration shown on the graph and used data as evidence gaining credit.

(ii) Most noticed that added sugar caused an increase in lactic acid concentration or an increase in rate of production. Only a few explained this in terms of sugar being converted to lactic acid to gaining credit. A common misconception was that ‘sugar helped’ or ‘catalysed the bacterial process’.

(c) There were many creditworthy suggestions for harmful effects on the environment caused by deforestation. To gain full credit candidates needed to give an explanation for the effect, e.g. erosion caused by the lack of tree roots holding the soil.

Question 5

(a) This question proved to be a good discriminator for those with a sound understanding of redox processes. Some candidates explained the displacement process in terms of the relative reactivity of metals, which was not required. Others made correct general statements of the relationship between oxidation and reduction and electron transfer, gaining partial credit. Very few were able to apply this principle to the specific atoms and ions involved in this reaction.

(b) Some candidates understood that the metal was combining with oxygen whereas others suggested the name of a metal. Most candidates realised that hydrogen was displaced and could write the correct order of reactivity. Very few candidates explained the order in terms of relative ability to combine with oxygen, most simply stating that **Q** reacted and **P** did not.

(c) Some candidates were awarded credit stating that zinc acted as a barrier between the steel and the air, but only the most able went on to gain any further credit. A common misconception was that zinc was less reactive than iron so formed this protective oxide coating more slowly than the iron would rust.

Question 6

(a) (i) The majority of candidates correctly linked the types of electromagnetic radiation with their uses and effects gaining full credit.

(ii) The property most often given was speed.

(b) (i) Many candidates used the graph to give a reason for identifying the flask that cooled most rapidly, by comparing the final temperatures. Some repeated the question and were unable to be awarded credit.

(ii) Few candidates demonstrated an understanding of heat transfer by comparing the emission of heat radiation by the different surfaces. Many gave incorrect explanations in terms of the absorption or attraction of radiation.

(iii) Most candidates gave at least one of the two variables required to be kept constant. The use of the same measuring instrument or constant temperature of the water was not creditworthy.

Question 7

(a) Most candidates showed understanding of dominant and recessive alleles, gaining credit.

(b) Most knew that *phenotype* was the term used for the visible appearance produced by a genotype gaining credit.

(c) There were many genetic diagrams drawn that gained full credit. A number of candidates were not awarded full credit due to the omission of the parents' genotypes.

(d) Many candidates showed good understanding of the subject by being able to apply their knowledge to this genetic problem and explained their solution very clearly gaining credit.

Question 8

(a) Many candidates correctly deduced the answer knowing that the symbol for a calcium ion was Ca^{2+}. To gain full credit candidates had to use an argument or show working based on the need for charge balance.

(b) (i) Most candidates gained credit for stating that the rate of reaction increased with concentration, only the most able referred to direct proportionality to gain full credit.

(ii) The most able candidates described the increased probability or rate of collision, but many gave explanations that were too vague to be creditworthy.

(iii) Many candidates stated that temperature would have an effect on the rate of reaction so needs to be kept constant, to make it a fair test gained credit.

Question 9

(a) (i) Candidates had to indicate how data from the distance / time graph was used to be awarded credit.

(ii) Candidates who gave the correct formula for kinetic energy usually calculated the correct answer, however, some candidates did not use the correct unit.

(iii) Most candidates interpreted the graph correctly and stated that the cart was stationary over that period gaining credit.

(iv) Candidates who gave the formula for acceleration usually calculated the correct answer. A minority made a mistake with the unit using m / s or m/s^{-2}. Credit was only given for formulae that made it clear that the **change in** speed was used.

(b) (i) Candidates who described the increased rate of collision (or more forceful collisions) with the tyre wall gained credit. There were a number of imprecise attempts to apply the gas laws or to describe a tendency towards expansion.

(ii) Only the most able candidates were able to apply kinetic theory to give an explanation of evaporation.

(iii) Care should be taken when drawing particle diagrams. Most candidates gained credit for their drawing of the gas, but few gained credit for their drawing of the liquid. Correct particle diagrams of a gas showed particles drawn in a random arrangement, of a similar size and not touching. Correct particle diagrams of a liquid showed particles drawn in an irregular arrangement, of a similar size and with most of the particles touching.

Question 10

(a) Most candidates gained some credit showing knowledge of the mechanism of accommodation by the eye.

(b) Many candidates correctly located the image on the retina of the eye, but some placed it on the lens.

(c) (i) Only the most able candidates gave a definition that gained credit, many just gave an example which was not sufficiently detailed to be creditworthy.

(ii) The role of the structures should have been applied to the specific reflex action described in the stem of the question. Candidates needed to use the term *nerve impulse* rather than vague terms such as *information*, and describe the specific transmission between retina to brain and brain to muscle to be awarded credit.

(d) (i) The best explanations for the lack of blood capillaries in the cornea and lens were based on their absorption of light. Imprecise reasons such as 'loss of vision' were not sufficient to be awarded credit.

(ii) The requirement for oxygen for respiration by cells was understood by a few candidates. The best answers described the release of energy rather than its production.

Question 11

(a) (i) The correct formula for the alkane in Fig. 11.1 was usually given gaining credit.

(ii) The explanation for the structure being that of an alkane molecule usually included the observation that the C-C bonds are single bonds. The fact that the compound was a hydrocarbon was often omitted. Several candidates showed knowledge beyond the syllabus by referring to the general formula for alkanes.

(b)(i) The most able candidates stated that gasoline had smaller molecules and hence weaker intermolecular forces leading to lower boiling point, gaining credit.

(ii) Only a small number of candidates could explain why gasoline boiled over a range of temperature.

(c)(i) Some knew the bromine test for unsaturated hydrocarbons, but many candidates described the resulting mixture as *clear* rather than **colourless**.

(ii) The best candidates deduced the balanced equation for the combustion of ethene.

Question 12

(a) Most candidates relied on completion of the diagram to show total internal reflection. Some diagrams were accurate and drawn with care. Only the most able candidates appreciated that total internal reflection only occurs when the angle of incidence exceeds the critical angle.

(b) Most diagrams showed rays reflected from the mirror into the eye at reasonable angles. The best responses anticipated what was required in part **(ii)** by locating the image and drawing construction lines back to rays drawn accurately to the eye.

CO-ORDINATED SCIENCES

Paper 0654/04

Coursework

(a) Nature of tasks set by Centres.

All the assessments set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates work was comparable with previous years with candidates covering the whole mark range.

(b) Teacher's application of assessment criteria.

The assessment criteria were understood and applied well.

(c) Recording of marks and teacher's annotation.

Tick lists are generally used for skill C1.

Many scripts had teacher's comments aimed to help the candidate improve in future occasions. There were some comments justifying marks awarded.

(d) Good practice.

Tick lists used were appropriate.

Centres are reminded when annotating scripts, to annotate the script at the place where the marks are awarded.

CO-ORDINATED SCIENCES

Paper 0654/51

Practical Test

Key message

When instructed to indicate on the graph the values used to calculate the gradient, it is important to show these values on the graph, rather than in the space provided for the calculation.

General comments

Candidates were able to attempt all questions on this paper and only a very small number of candidates left parts unanswered.

Candidates are reminded to use the appropriate scientific language when recording their observations, e.g. the word 'precipitate' or its abbreviation 'ppt'.

Comments on specific questions

Question 1

Some Centres appeared to use very large volumes of water to contain the visking tubing.

The correct observations were usually seen in **(a)(i)** but these were not always linked to correct conclusions. There was evidence that some candidates confused the test for starch with the test for reducing sugars. Other candidates reported the absence of sugar because they had observed a green or yellow colour rather than a red precipitate. The Benedict's test can give a range of colours and candidates should be made aware of this.

For part **(a)(ii)** while many candidates correctly stated that amylase broke down, only a few went on to complete the conclusion stating that sugar had been formed in the process.

The results in part **(b)(i)** may have been dependant on the amount of liquid in the container containing the visking tubing. However, many candidates recorded the expected observations and went on to state that sugar molecules can pass through the tubing. Again, some candidates muddled their food tests in terms of what the results indicated.

Part **(c)** was all to do with starch, as stated in the question, but this was not always appreciated. Those who obtained the expected results usually went on to answer part **(c)(ii)** correctly, gaining full credit.

Part **(d)(i)** was answered correctly by about half of the candidates, with the most commonly seen incorrect responses being '*large intestine*' and '*intestine*'. Answers to **(d)(ii)** were often unclear and many candidates did not know (or did not use their results to conclude) that starch is a large molecule.

Question 2

Following instructions, making measurements and recording observations are skills required for this paper. A number of Centres used lenses where the focal length was not the specified 15 cm. However this was allowed for in the mark scheme and candidates were not penalised.

The table in part **(a)** was always completed. Common errors were not recording distances to the nearest mm and using too few significant figures for the values of *v* and *u*.

Although a large range of responses were accepted for part **(b)**, this part was not answered well.

For part **(c)(i)**, the graph axes were usually labelled correctly; however the scales chosen did not always make the best use of the grid. Where the scales were sensible, the plotting was usually carried out accurately. A small number of candidates plotted points as unacceptably large blobs. Some candidates plotted *u* wrongly. A significant number of candidates drew curves despite the instruction to draw the best fit straight line. Odd scales should be avoided wherever possible as this makes plotting difficult and time-consuming for the candidates.

For part **(c)(ii)** candidates were asked to indicate on their graphs the values chosen for calculating the gradient. Candidates were unable to be awarded full credit if this was not seen. Gradients calculated directly from table values only gained credit if the best straight line passed through these points.

The calculation in **(c)(iii)** did not present any problems and the accuracy mark was related to the $u = 30\,\text{cm}$ reading. This accuracy mark was generally awarded to candidates who had carried out the experiment well (even if they used a lens with a different focal length).

The last part was well answered.

Question 3

In part **(a)**, most candidates reported a black colour, but some thought it was a liquid because of the way the powder was moved by the evolved gas.

The colour change on adding the hydrochloric acid to **X** in **(b)(i)** was often not recorded but most candidates reported a change in the limewater. For the limewater test candidates should be reminded that 'cloudy' is not an acceptable alternative to 'milky' or 'white precipitate'. Most candidates stated that the gas was carbon dioxide but this answer was only credited when evidence of a gas or a change in the limewater had been recorded. Identification of the anion as a carbonate was not dependant on any other responses.

Parts **(b)(ii)** and **(c)(i)** were well answered. For part **(c)(ii)** many candidates recorded only '*blue ppt*' **or** '*dark blue solution*' rather than both answers, and could not be awarded full credit. Many candidates needed to use the word 'precipitate' or its abbreviation '*ppt*' where appropriate. Alternative descriptions were generally not accepted. The misuse of '*soluble in excess*' or '*insoluble in excess*' was commonly seen, for example, '*blue ppt insoluble in excess to give a dark blue solution*'.

The displacement reaction in **(c)(iii)** worked well and the full range of observations was seen. The most common responses were '*bubbles*' and '*magnesium goes black*'. A relatively small number of candidates were able to identify the type of reaction.

X was often identified correctly as copper carbonate. Those candidates just giving '*copper*' as their answer did not gain credit.

CO-ORDINATED SCIENCES

Paper 0654/52

Practical Test

Key message

When instructed to indicate on the graph the values used to calculate the gradient, it is important to show these values on the graph, rather than in the space provided for the calculation.

General comments

Candidates were able to attempt all questions on this paper and only a very small number of candidates left parts unanswered.

Comments on specific questions

Question 1

There may have been an issue with some Centres finding that 'dead' grains still produced starch digesting enzymes. Some allowance was made for this so that candidates could still access the majority of the marks.

All candidates scored in **(a)(i)** and generally this was well drawn. Again the drawing mark in **(a)(ii)** was deservedly awarded but not all drawings were labelled to show the colours. Although most candidates drew yellow or brown areas where the grains had been, few made this connection in **(a)(iii)**. Consequently **(a)(iv)** was often answered in a rather muddled way. Only the best candidates discussed the breakdown of starch, sometimes mentioning starch digesting enzymes. Some candidates erroneously believed that the grains had produced the starch. In **(a)(v)** only a few candidates identified the use of dead grains as a control however credit was given for clear answers discussing the comparison of dead and living grains for breaking down starch.

Part **(b)(i)** was carried out well, usually producing expected results. The mark scheme allowed for unusual results after heating **B** and allowance was made for an unusual result after heating **D** if the Supervisor reported such an anomaly. Most candidates then related the colour changes to the presence or absence of (reducing) sugar. Some candidates are still confused about which food tests which nutrient and discussed starch in **(b)(ii)**.

For part **(c)**, there were many responses which referred to accuracy or fair testing and so did not access this mark. A significant number correctly discussed the need for repetition to improve reliability or the chance of a grain failing.

As the two parts of **(d)** were related, candidates who thought that the seeds produced starch tended to score no marks. Many correct answers were seen, even by candidates who had not included 'starch digestion' in answers to previous parts.

Question 2

For the first mark, candidates were expected to record the value of *x* to the nearest mm because all data had been provided to the nearest mm. For **(a)(ii)** most candidates described the method for finding the balance point which was not required. Correct descriptions were marked generously providing the intent was clear. Tables were always completed and nearly all showed the expected trend.

For the graph, axes were usually labelled correctly. The scales chosen did not always make the best use of the grid, despite candidates being prompted that there was no need to start the axes at the origin. Plotting was carried out accurately if the scales were sensible. Odd scales should be avoided wherever possible,

particularly for the independent variable. A small number of candidates plotted points as unacceptably large blobs.

Candidates were asked to indicate on their graphs the values chosen for calculating the gradient. This was rarely seen and was marked strictly according to the mark scheme. For the second mark, gradients calculated from table values were only accepted if the best straight line passed through these points.

Part **(c)** was well answered. Some candidates lost the mark due to a poor choice of significant figures and incorrect rounding, despite being able to carry out the calculation.

Most candidates recorded *t* and *w* correctly while a few muddled thickness and width. The last calculation did not prove difficult for candidates. The second mark for **(d)(ii)** was an accuracy mark and related to the Supervisor's value. Examiners used a corrected candidate value if errors had been made in earlier parts. Consequently a good number of candidates scored this accuracy mark which was pleasing.

Question 3

In **(a)(i)** reasonable alternatives to '*no reaction*' were allowed. It was surprising how few candidates realised that a result of no reaction with an acid indicated the absence of the carbonate ion.

There was still a problem with candidates not using the word '*precipitate*' or its abbreviation '*ppt*' where appropriate. Alternative descriptions were not always accepted. It should be noted that '*chlorine ions*' were not an acceptable alternative for chloride.

In parts **(b)(i)** and **(b)(ii)** the candidate had to filter the mixtures. In these cases it is important to describe the mixtures, the residues and the filtrates. Many candidates did not describe the filtrates and consequently copper ions were not identified.

For part **(c)** many candidates just listed the ions they had identified previously, rather than pairing up cations and anions to give compounds as required.

CO-ORDINATED SCIENCES

Paper 0654/53

Practical Test

Key message

When instructed to indicate on the graph the values used to calculate the gradient, it is important to show these values on the graph, rather than in the space provided for the calculation.

General comments

Candidates were able to attempt all questions on this paper and only a very small number of candidates left parts unanswered.

Comments on specific questions

Question 1

There may have been an issue with some Centres finding that 'dead' grains still produced starch digesting enzymes. Some allowance was made for this so that candidates could still access the majority of the marks.

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Part **(b)(i)** was carried out well, usually producing expected results. The mark scheme allowed for unusual results after heating **B** and allowance was made for an unusual result after heating **D** if the Supervisor reported such an anomaly. Most candidates then related the colour changes to the presence or absence of (reducing) sugar. Some candidates are still confused about which food tests which nutrient and discussed starch in **(b)(ii)**.

For part **(c)**, there were many responses which referred to accuracy or fair testing and so did not access this mark. A significant number correctly discussed the need for repetition to improve reliability or the chance of a grain failing.

As the two parts of **(d)** were related, candidates who thought that the seeds produced starch tended to score no marks. Many correct answers were seen, even by candidates who had not included 'starch digestion' in answers to previous parts.

Question 2

For the first mark, candidates were expected to record the value of *x* to the nearest mm because all data had been provided to the nearest mm. For **(a)(ii)** most candidates described the method for finding the balance point which was not required. Correct descriptions were marked generously providing the intent was clear. Tables were always completed and nearly all showed the expected trend.

For the graph, axes were usually labelled correctly. The scales chosen did not always make the best use of the grid, despite candidates being prompted that there was no need to start the axes at the origin. Plotting was carried out accurately if the scales were sensible. Odd scales should be avoided wherever possible,

particularly for the independent variable. A small number of candidates plotted points as unacceptably large blobs.

Candidates were asked to indicate on their graphs the values chosen for calculating the gradient. This was rarely seen and was marked strictly according to the mark scheme. For the second mark, gradients calculated from table values were only accepted if the best straight line passed through these points.

Part **(c)** was well answered. Some candidates lost the mark due to a poor choice of significant figures and incorrect rounding, despite being able to carry out the calculation.

Most candidates recorded *t* and *w* correctly while a few muddled thickness and width. The last calculation did not prove difficult for candidates. The second mark for **(d)(ii)** was an accuracy mark and related to the Supervisor's value. Examiners used a corrected candidate value if errors had been made in earlier parts. Consequently a good number of candidates scored this accuracy mark which was pleasing.

Question 3

In **(a)(i)** reasonable alternatives to '*no reaction*' were allowed. It was surprising how few candidates realised that a result of no reaction with an acid indicated the absence of the carbonate ion.

There was still a problem with candidates not using the word '*precipitate*' or its abbreviation '*ppt*' where appropriate. Alternative descriptions were not always accepted. It should be noted that '*chlorine ions*' were not an acceptable alternative for chloride.

In parts **(b)(i)** and **(b)(ii)** the candidate had to filter the mixtures. In these cases it is important to describe the mixtures, the residues and the filtrates. Many candidates did not describe the filtrates and consequently copper ions were not identified.

For part **(c)** many candidates just listed the ions they had identified previously, rather than pairing up cations and anions to give compounds as required.

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. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters, etc.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on Specific Questions

Question 1

(a) A knowledge of the iodine test for starch and the Benedict's test for reducing sugar was required to answer this question. The colours of the tests were given and candidates were expected to state whether starch or sugar was present or absent. A number of candidates could not match the colours with the results and others failed to state if the substance was present or absent.

(b) Most candidates realised that the sugar molecules were now small enough to pass through the visking tubing but a number failed to say that the amylase was responsible for the breakdown of starch into sugar.

(c) Most candidates realised that the visking tubing represented part of the intestine, however, to gain credit the answer had to specify "small intestine". Some of the better candidates named a part of the small intestine, e.g. ilium, which also gained credit. The water, representing blood or capillaries was much less known.

(d) Most candidates realised that starch molecules are too big to pass through into the alimentary canal and therefore need to be digested before they can be absorbed.

Question 2

(a) Most candidates could read a metre rule correctly, but a few did not realise that results must be tabulated to the same degree of accuracy as results already given in the table.

(b) Results were generally plotted correctly, although a few candidates confused the scales or did not notice the very different scales on each axis. Most drew a line of best fit correctly, and a number showed how they found the gradient, ideally by drawing a triangle on the graph as instructed; a few used values from their table. Again some candidates failed to take the different scales into account, and no credit was given for lines that were non-linear at the point of the gradient determination.

Question 3

(a) Almost all of the candidates knew that carbon dioxide turns limewater milky, and most interpreted this test to imply that a carbonate was present, although many suggested carbon instead.

(b) Most candidates scored full credit for a labelled diagram illustrating filtration, but quite a few omitted either the funnel or the filter paper.

(c) Very few candidates identified copper hydroxide as the precipitate on adding dilute ammonia to an aqueous copper salt, and even fewer referred to the blue solution formed in excess ammonia.

(d) Few candidates correctly described the changes in appearance of the solution or iron filings when displacing copper from copper nitrate solution, suggesting unfamiliarity with this experiment.

(e) Several sulfates and iron compounds were deduced through incorrect observations; only the best candidates gave the correct name and formula of copper carbonate.

Question 4

(a) A number of candidates were unable to measure the lengths correctly, with some giving a magnification of less than 1, even though their drawing was larger than the photograph.

(b) Candidates had to add to their drawing in **(a)** a line to represent a transverse cut through the root and to label the xylem tissue on Fig. 4.2. Some candidates appeared to have missed this part and moved on to the next. It is very important to read the question fully and carefully.

(c) Candidates were asked to outline an experiment to find where the xylem tissue is distributed in the stem, a common experiment that few candidates described well. Many failed throughout their explanation to mention the stem, and only considered the root. Other candidates failed to take notice of the credit allocation and gave simple one line answers.

Question 5

(a) Almost all candidates identified magnesium and many identified silicon rather than silica.

(b) A number of candidates thought that P was potassium.

(c) The colour of chlorine was well known. It is important that candidates avoid making ambiguous statements such as “one is coloured” or “by colour”. Descriptions of how to test for chlorine were unacceptable as the question asked about appearance.

(d) Some candidates realised that electrical conductivity was a suitable test for all metals, but several chose to react aluminium with an acid, and others gave non-general metal tests.

(e) Most candidates knew that sulfur burns with a blue flame, but there were some interesting ideas with regard to the addition of water including “cooling it” and “to put out the flame”. Many scored well on the colours of Universal Indicator.

Question 6

(a) Many candidates made errors when reading the meters, but overall most scored some credit. Some credit was lost by candidates who did not give their readings to the same degree of accuracy as the figures already in the table.

(b) The most commonly suggested reason made reference to the variation in the variable resistance or the current and voltage. Many candidates realised that the results should be averaged.

(c) Electrons were often identified as the particles involved in conductivity, but not many gave the correct direction of travel in the circuit.

CO-ORDINATED SCIENCES

Paper 0654/62

Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters, etc.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on Specific Questions

Question 1

This question tested candidates' knowledge of the tests for starch and reducing sugars and that starch can be converted to reducing sugar. Many candidates thought that it was the grains that were being tested, rather than the gel.

(a) (i) Candidates were asked to describe the results in dish **A**. Many candidates offered an explanation, which was not required at this stage.

(ii) A number of candidates failed to realise that the gel in the Petri dish was a starch-agar mixture and that the colour change of the iodine solution was brought about by an enzyme in the living barley grains. Some incorrectly stated that the grains produced the starch.

(iii) The use of a control, in this case using dead grains, was well known.

(b) The use of Benedict's solution to test for the presence of reducing sugars was not well known and therefore few candidates realised that the enzyme in the barley grains had converted the starch in the gel to sugar.

(c) The use of more than one grain was well known, although a number thought that it was to increase accuracy.

(d) The results would be a greater or smaller area of brown. Some candidates tried to explain why the areas would be different in size which did not answer the question.

(e) When asked to outline an experiment candidates will usually be expected to explain how they would adapt the experiment in the question. The question stated they should use starch-agar gel, and therefore candidates were expected to place different varieties of seeds on the gel, keeping all other conditions constant, and then compare the sizes of the brown areas.

Question 2

(a) Some candidates did not follow the instruction to read the position on the rule of the centre of **M**, and so were not awarded credit. The results already given in the table gave an indication of the level of accuracy required and candidates should, therefore, have recorded their results to one decimal place, i.e. 68.0 rather than 68.

(b) (i) Plotting of points was mostly very accurate and few candidates had problems. The calculated points should lie on or very close to the best straight line. Candidates whose plotted points did not lie on or near to the line of best fit should have realised that either their calculations or plotting were incorrect and should have carefully checked their working.

(ii) Calculation of gradients caused problems for some candidates, and the instruction to show on the graph the values used was often ignored.

(c) The gradient was used to calculate the mass of the rule using the equation given. Whatever value the candidate calculated for the gradient could be used with no further loss of credit provided the answer was correctly calculated. Some candidates, however, incorrectly rounded their answers, giving, for example, 123 when the calculated value was 123.67 and therefore should have been rounded to 123.7 or 124.

(d) Candidates whose formulae did not use the symbols given could not gain credit for this part of the question.

Question 3

This question consisted of a series of tests, observations and conclusions a candidate made to identify the ions present in an unknown solution. Candidates from many Centres were aware of the tests and results involved in analytical chemistry, although it appeared that candidates from some Centres had little practical experience of these tests.

(a) (i) When dilute nitric acid is added to solid **X**, a gas is given off and a green solution formed; the student would have observed bubbles rising in the solution. The green colour suggests the presence of a transition metal.

(ii) Candidates were told that the unknown solid contained carbonate ions, and so the limewater would turn cloudy.

(iii) The formation of a white precipitate when aqueous silver nitrate was added would show that the unknown also contained chloride ions.

(b) The cations were identified, by the addition of ammonia solution and sulfuric acid, as copper(II) and iron(III).

(c) Finally candidates had to name the salts that could have been used to make the solution **X**. Either iron(III) chloride and copper(II) carbonate or copper(II) chloride and iron(III) carbonate were acceptable.

Question 4

(a) After reading the scales and completing a table candidates had to plot a graph and draw a smooth curve. Candidates should always use as much of the graph paper as possible, and many realised that with all the points lying in the range 10.0 to 14.1 it was sensible not to start the axis at 0. The vertical axis had already been labelled, but many failed to label the horizontal axis with a name and unit. When asked to calculate the average extension between two points, many candidates struggled and their answers suggested that they did not understand what they were doing, as the extensions given were longer than any of the figures in the table.

(b) It is important that candidates read the questions properly and answer the questions rather than what they think has been asked. Often the answer to part **(ii)** was given in part **(i)**, or was simply a repeat of the question.

(c) Again, some candidates did not read the question carefully. When asked for one other factor that should be kept the same when investigating a piece of vein of the same length, some gave the answer "same length".

Question 5

(a) The scales were read correctly by many candidates. Some, however, confused 28.2 with 27.8. Most candidates were able to identify the most and least concentrated sample.

(b) It was rare to see a correct equation even though the salt, sodium ethanoate, was given in the question. Few gave the correct colour for a weak acid, many giving red or a shade of red.

(c) A number of candidates did not attempt to answer this question part. As indicated by the credit allocation, a detailed answer was required. Some thought that it was enough to give 'crystallise' with no further experimental detail. Many believed that the solution could just be evaporated to dryness to leave crystals in the dish.

Question 6

(a) (i) A large number of candidates appeared not to be familiar with the term *amplitude*.

(ii) A number of candidates ignored the instruction "to the nearest 0.1 cm".

(iii) Many were able to rearrange the equation to calculate a frequency.

(b) Although some candidates tried to put figures in the space for units, many scored well here.

(c) Candidates were required to calculate the speed of the trolley at a different point.

(d) The question stated that the trolley accelerates, so a simple answer such as "it gets faster" was not credited unless reference was made to the calculations in **(b)** and **(c)** as instructed in the question.

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. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, thermometers, stopwatches, etc.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on specific questions

Question 1

(a) Most candidates correctly assigned a scale to the vertical axis and then correctly plotted the points. A significant number did not label the axes or indicate the units used. Despite the instruction to draw a best-fit curve many candidates simply joined the points, and in some cases used a ruler.

(b) Many candidates identified a possible anomalous result but did not suggest a reason for the result and so were unable to gain credit for their choice. Many candidates incorrectly chose **A**, because it was so much larger than the others. They should instead have looked at the trend in the results and realised that two results were almost identical and therefore one was likely to be anomalous. A significant number misinterpreted what was being asked and described the trend in the results.

(c) The majority of candidates used their graphs to predict a value beyond the scope of the line they had drawn.

(d) (i) The majority of candidates suggested modifying the experiment by changing the temperature. The more able candidates identified the control of concentration and the most able included the necessary experimental details.

(ii) Many candidates labelled the axes correctly, but a significant number inverted the axes, plotting temperature against concentration or temperature against activity of enzyme. Only the most able candidates were able to correctly sketch the shape of the expected graph; most sketched either an ascending curve or a descending curve.

Question 2

This followed an investigation into the resistances of lamps in series and in parallel.

(a) (i) The majority of candidates read dial $\mathbf{A_1}$ correctly; a significant number read dial $\mathbf{A_2}$ as 2.25 A and/or dial $\mathbf{A_3}$ as 5.3 A.

(ii) and **(iii)**
The majority of candidates correctly calculated the resistances, although incorrect rounding was frequently seen.

(b) Many candidates calculated the combined resistance correctly, but a number went on to double their answer. A significant number of candidates attempted to use $1/R = 1/R_1 + 1/R_2 + 1/R_3$.

(c) The vast majority of candidates did not refer to the numerical quantities involved and most did not refer to a reason for either the closeness of the values or the difference in the values.

(d) (i) The more able candidates could correctly identify **Y** as the brighter lamp. Many candidates discussed the amperes in the circuit rather than the observation asked for in the question.

(ii) Only the more able could correctly identify the parallel circuit in Fig. 2.1 as having the brighter bulbs. Many candidates discussed the relevant brightness of the two bulbs within each circuit separately, rather than comparing the two circuits. A significant number of candidates discussed the resistances or the meter readings rather than the observation requested in the question.

Question 3

(a) The majority of candidates were able to correctly read the values on the thermometers, although a significant number gave 26.45 °C for **A** and 27.45 °C for **B**.

(b) In part **(i)** most candidates were able to calculate the temperature change correctly and in part **(ii)** both the term *exothermic* and the reason were well known by many of the candidates.

(c) The most able candidates appreciated that identical temperature changes would be caused by identical volumes or concentrations of sodium hydroxide. Many candidates focused on the fact that the amounts of acid were the same, although the question did not specify whether the acids were mono-, di- or tri-basic or on the fact that it was the same reaction of hydrogen ions and hydroxide ions, without considering that the amounts of these present is also important.

(d) Only the most able candidates gained credit here, usually for suggesting either higher temperature change or faster reaction, but often with no explanation as to why this would lead to smaller percentage errors. The vast majority of candidates thought that doubling the concentration would either ensure that all of the acid would react or that it would take a longer time to react or discussed collisions and their need for a longer reaction time. A significant number of candidates omitted this question.

(e) Few candidates knew the test for chloride ions but those who did also knew the observation. A significant number of candidates omitted this question. Universal Indicator and litmus were frequent responses.

Question 4

(a) (i) Many candidates were able to interpret the graph and so correctly describe an increase and then a decrease in pH over the 24 hour period. Many candidates discussed the peak or trough at sunrise and sunset without considering the changes over the time, or only described the increase in the first part of the graph or the decrease in the second part of the graph.

(ii) More able candidates understood the connection between pH and concentration of carbon dioxide and so realised that the answer here was the inverse of the trend in part **(i)**. As in part **(i)** many candidates either discussed the peak or trough at sunset and sunrise without considering the changes over the time, or only described the increase from sunrise to sunset or the decrease from sunset to sunrise.

(iii) Many candidates correctly explained why photosynthesis affects carbon dioxide levels; fewer discussed the role of respiration on levels of carbon dioxide and fewer still discussed both. A significant number reversed photosynthesis, thus producing carbon dioxide and, some also reversed respiration. Weaker candidates did not refer to photosynthesis and respiration at all. A significant number of candidates answered in terms of oxygen rather than carbon dioxide.

(b) (i) Many candidates correctly placed the **X** in the middle of the ascending left-hand part of the graph. A number placed the **X** at the peak at sunset and others placed the **X** at either or both of the sunrises.

(ii) The more able candidates recognised the role of respiration. The majority of candidates answered in terms of a lack of photosynthesis.

(iii) Many candidates realised that there would be less oxygen produced during a cloudy day and so drew the whole of the line beneath the existing line. However, there were many carelessly drawn lines, mostly drawn below the existing line but crossing above it in places. A significant number drew the line above the existing line, suggesting that more photosynthesis would occur on a cloudy day.

(c) Only the most able candidates gained any credit in this question. Many candidates rewrote part of the question stem or answered in general terms without outlining a method for the investigation. A significant number of candidates did not attempt this question. The more able candidates either described how to vary the light intensity, or stated that the amount of oxygen and the time needed to be measured, but few made both points. A small number of the most able candidates gave three creditworthy points.

Question 5

In this experiment candidates were following a reaction to make a salt and its subsequent crystallisation.

(a) (i) Many candidates appreciated that the pieces of apparatus needed included those for measuring the volume of acid, such as a measuring cylinder, for adding the powder to the acid, such as a spatula, and for stirring the solution, such as a stirring rod. A significant number of candidates included goggles, beakers, filter funnels and evaporating basins.

(ii) Many candidates did not read the question carefully and so gave the observations showing that the reaction was occurring, rather than the observations which would be made to show that the reaction was complete, such as the bubbles stopping or the magnesium carbonate no longer dissolving.

(b) It was appreciated by many that the mixture needed to be filtered, but a significant number of candidates either did not include both filter paper and a filter funnel in their diagram, or did not include any labels. A significant number of candidates thought the mixture should be decanted, evaporated or distilled.

(c) (i) Few candidates could describe how to obtain crystals from a solution. Many suggested heating the solution until all of the water had been evaporated, rather than just saturating the solution by reducing the volume and then leaving to cool for the crystals to form.

(ii) Very few candidates knew a method for growing one large crystal, e.g. by tying a seed crystal onto a piece of string and suspending it in a saturated solution of the salt. Many candidates suggested heating the crystals, perhaps believing that they would melt into one large crystal. A significant number of candidates did not attempt to answer this question.

Question 6

This experiment involved the reflection and refraction of light rays.

(a) (i) Many candidates drew the reflected beams parallel to each other, at an angle of 30° to the mirror. A significant number of candidates transposed the rays to the right so that they were not actually reflected at the point of incidence.

(ii) More able candidates quoted the law of reflection. A significant number discussed the angle of refraction or just stated the term *law of reflection*. Boyle's Law and Hooke's Law were also named by some candidates.

(b) More able candidates constructed the lines passing through **F** in order to obtain a correct value of around 2.0 cm. Many candidates constructed the correct lines but then measured the distance from the lens to the screen and so gave the value as around 7.0 cm.

(c) (i) Many candidates constructed the diagram carefully, keeping the rays in each medium parallel, with the beams bending towards the normal on entry to the block and away from the normal on leaving the block. A significant number of candidates drew the beams refracted beyond the normal. Many did not draw the emergent beam parallel to the incident beam.

(ii) Some candidates drew a normal as the beam entered the block, and only the more able candidates correctly labelled the angle of incidence and the angle of refraction. A significant number of candidates omitted this question.