CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General comments

All questions fell well within the ability range of the candidates, and all questions were also effective at discriminating between the candidates of higher and lower abilities.

Comments on specific questions (Biology)

Question 2

This question had just the right balance of options to tempt those who were uncertain of their facts, but not to stand in the way of those who were secure in their knowledge. Thus the candidates who were successful were also largely those who managed to score well on other questions in the paper. It is a concern, however, that over a third of the candidates did not appear to know that water is needed for photosynthesis.

Question 3

Although only calling for an item of specific knowledge, this question differentiated well between candidates of differing abilities. The best candidates performed well, but the most popular incorrect answer indicated a misunderstanding between photosynthesis and respiration.

Question 7

The only real problem here for candidates was to decide on which neurone is involved in carrying impulses to the spinal cord. As a significant number of candidates opted for motor neurone, this is an area for improvement.

Question 11

This was the easiest question in this section, but as all incorrect answers were equally popular, this suggests that the minority of candidates who chose incorrectly may have attempted to guess the answer.

Comments on specific questions (Chemistry)

Questions 17 and **21** proved straightforward with the majority of candidates selecting the correct answer.

Question 14 was the most difficult with a significant number of the candidates selecting an incorrect answer.

Question 18 Many candidates incorrectly chose option **C**. Candidates realised that the reaction was an oxidation but did not understand that an explosion is, in fact, rapid combustion.

Question 20 Many candidates incorrectly chose option **C**. Candidates realised that tube one contained an acid but chose the first alternative including that answer without reading the other.

Question 23. Candidates did not read the question properly and incorrectly chose option **B**. They saw copper oxide and assumed, wrongly, that an oxidation reaction was taking place.

Question 27 Candidates realised that Z was the polymer but selected X as the monomer as its formula most closely matched the bonding in Z incorrectly choosing option **A**.

Comments on specific questions (Physics)

Question 28

Slightly more candidates opted for **C**, which did not include the 30 minute break in the overall journey time, than the correct option **B**.

Question 29

The most common error here was not to subtract the mass of the tank from that of the tank plus liquid. Had these candidates looked beyond option **A**, they might have realised their mistake.

Question 30

A significant number of candidates believed that work done could be calculated using only a metre rule and stopwatch. The word ‘only’ was written in bold, and should have made candidates think carefully about what could be measured.

Question 31

Although those candidates who chose distractor **C** might have believed that the internal volume of the tyre could have decreased significantly overnight, this would not have lead to a fall in air pressure.

Question 32

There was evidence of guessing in this question about heat transfer.

Question 34

The most common misconception was a belief that light could not travel in a vacuum.

Question 35

A significant number of candidates were unaware that all electromagnetic waves travel at the same speed in a vacuum.

Question 37

There was a widespread lack of understanding of the effect of fitting an incorrectly-rated fuse in an electrical circuit.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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

General comments

All questions fell well within the ability range of the candidates, and all questions were also effective at discriminating between the candidates of higher and lower abilities.

Comments on specific questions (Biology)

Question 2

Candidates answered this question very well thanks to the clear diagram provided.

Question 4

Although only calling for an item of specific knowledge, this question differentiated well between candidates of differing abilities. The best candidates performed well, but the most popular incorrect answer indicated a misunderstanding between photosynthesis and respiration.

Question 6

The part that has been exposed that was not exposed before is clearly the dentine. There may have been an element of insufficiently careful reading leading to incorrect responses by candidates.

Question 7

This question examined knowledge of the digestive system, this time, of features associated with the alimentary canal. Almost all candidates selected the correct response.

Question 8

The only real problem here for candidates was to decide on which neurone is involved in carrying impulses to the spinal cord. As a few candidates opted for motor neurone, this is an area for improvement.

Question 9

This question was answered correctly by few candidates. The majority appeared to believe that urea is made in the kidney, would indicate a serious misunderstanding. Candidates are reminded to carefully consider what the question as in this case the question was concerned with which organ makes urea and how is it then removed from that organ.

Question 10

There was a lack of accuracy surrounding knowledge of the functions of parts of the male reproductive system. Many candidates did not know the function of the prostate gland, or the function of the testes.

Comments on specific questions (Chemistry)

Question 14 A small number of candidates incorrectly chose option **C**. They had rejected the distractors **A** and **B** but chose the first 'likely' alternative without looking at option **D** which was a better solution.

Questions 16, 17, 21, 23 and **24** proved straightforward with most candidates selecting the correct answer.

Question 19 was the most difficult question with many candidates incorrectly choosing option **A**. Candidates had not fully read the question. They chose the first chloride available without taking into account that the solution was coloured. This answer was more popular than the correct answer.

Comments on specific questions (Physics)

Question 29

A common error was not to subtract the mass of the tank from that of the tank plus liquid. Had these candidates looked beyond option **A**, they might have realised their mistake.

Question 30

There was evidence of guessing in this question about energy resources and which of them received their energy originally from the Sun.

Question 32

Although this question about melting and boiling was reasonably well answered, a significant number of the candidates believed that both these processes involved an increase in temperature.

Question 34

There was a good deal of uncertainty over the image formed by a converging lens, with all three distractors proving popular.

Question 35

A significant number of candidates were unaware that all electromagnetic waves travel at the same speed in a vacuum.

Question 37

There was a lack of understanding of the effect of fitting an incorrectly-rated fuse in an electrical circuit.

Question 39

This question concerned the nature of alpha and beta radiation. Although the majority of candidates chose correctly, the rest were attracted almost equally by each distractor.

Question 40

Although a high number of candidates understood the meaning of the term isotope, there was some confusion for those who were not so well prepared.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**B**	22	**A**
3	**B**	23	**A**
4	**C**	24	**D**
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9	**B**	29	**B**
10	**A**	30	**A**
11	**B**	31	**D**
12	**A**	32	**D**
13	**D**	33	**C**
14	**D**	34	**A**
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Question 40

Although a high number of candidates understood the meaning of the term isotope, there was some confusion for those who were not so well prepared.

CO-ORDINATED SCIENCES

Paper 0654/21

Core Theory

Key Messages

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols and units should also be avoided. Candidates should be reminded that while using a 'triangle consisting of three variables' is a valuable tool when answering calculation questions, this is not acceptable as a formula.

Candidates need to use to specific terminology and/or appropriate scientific language when answering questions. Examiners can not be award credit if are unsure as to what candidates are referring to, for example answering questions using the word 'it' rather than specifying what they were writing about.

General comments

Parts of some questions were inaccessible to some candidates. However, most candidates were able to attempt most questions. There was a good range of credit on most questions. Candidates generally scored on all questions. Few gained no credit on any question and very few gained full credit on any question. Although it appeared that candidates often knew the answers to the questions, their answers were often imprecise.

There was evidence of candidates running short of time to complete the examination as the last one or two questions were frequently rushed or left unanswered.

Comments on specific questions

Question 1

(a) Many candidates gained full credit for supplying a correct formula and carrying out the calculation correctly.

(b) (i) Few candidates suggested chemical energy as the answer. Kinetic energy and heat energy were common wrong answers.

(ii) Candidates gained credit by referring to heat energy. Few candidates went further and suggested where the heat energy was lost.

(c) The idea of expansion was reasonably well known. Few candidates suggested the probable reason for the expansion – hot temperatures in the summer. A number of candidates suggested that the train's motion heated up the track. Few candidates suggested why expansion was a problem. There were two common incorrect ideas for why the gaps were left. One wrong idea was that the gaps were left so that it would be easier to replace pieces of track if they damaged. The second wrong idea was that the gaps were left to make it easier for the train to change direction.

(d) (i) Ethanol as a renewable fuel/resource was not well known. There were many imprecise answers suggesting less pollution or less carbon dioxide produced.

(ii) This was poorly answered by candidates. Many knew two correct elements rather than the three needed for credit to be awarded. Nitrogen was a common wrong answer as well as glucose and sugar.

(e) (i) The accepted answer was a number greater than 3 but not greater than 5.

(ii) Most candidates showed good data handling skills here gaining credit.

(iii) The idea that it would not work if there was no wind was well known. Common wrong answers were that it was noisy, was visually unattractive or cost a lot.

(iv) Kinetic to electrical was the commonest answer, but many candidates got one or other of the two answers wrong.

Question 2

(a) (i) Candidates who gave two correct values gained partial credit and very few gained full credit.

(ii) Carbon dioxide was well known as a gaseous compound in the atmosphere. Water vapour was less well known.

(b) (i) A basic definition of an element was not well known. Many candidates attempted to link a definition to the context of the question and explained that they reacted together to form a compound.

(ii) Many candidates gained partial credit in this part knowing either that the bonding involved was covalent or that the bonding was between two non-metals.

(iii) Many candidates attempted to describe the results in Table 2.1 but merely repeated the information. The answer needed to relate the pH values in the table with an idea of relative acidity.

Question 3

(a) Most candidates were able to identify a root hair cell.

(b) Water and mineral ions were well known.

(c) (i) Xylem was a popular answer, but there were a number of candidates who answered phloem.

(ii) Candidates who wrote an **A** in the correct position making it clearly visible, or who drew a label line gained credit.

(d) Most candidates gained some credit on this question. However a number of candidates did not follow the instructions to put ticks and crosses in the relevant boxes and were unable to gain full credit.

Question 4

(a) (i) The question asked for the approximate audible frequency range. Very few candidates gave a range of frequencies. Most gave either a maximum or minimum frequency but these were frequently wrong.

(ii) Many candidates knew the meaning of the term *frequency*. A common mistake was not to state that it was the number of waves in a second. Many candidates did not gain credit for the meaning of the term *wavelength*, because their description did not make it clear that the distance between the waves must be the distance between identical points on two successive waves.

(b) (i) About half the candidates gained full credit. A large number of candidates 'reversed' the two wave types.

(ii) The idea that a medium (or air) was needed, or that a vacuum does not contain any particles, was well known.

(iii) Few candidates realised that the sound would be quieter. Many suggested that the pitch would change.

(iv) Microwaves was not well known. There were many answers of either radio waves or infrared waves.

Question 5

(a) Most candidates knew that a herbivore eats plants, but a number did not mention that herbivores do not eat meat.

(b) (i) Partial credit was gained by most candidates who could explain that the marmots would need to eat a lot. Very few were able to explain what happened to this extra food.

(ii) Most candidates gained credit for correctly identifying the relationship between body mass and survival.

(iii) The terms insulator or insulation were not commonly used.

(c) Carbon dioxide and methane were common correct answers. Carbon monoxide was also mentioned frequently.

(d) (i) The question asked for a general trend. Many candidates described the graph on a year by year basis.

(ii) Many candidates managed to gain the credit available by correctly explaining why the marmots would become heavier. A common misconception was that an earlier spring would cause an earlier winter.

Question 6

(a) Many candidates correctly described adding magnesium to the acid and inserting the bung. A number did not explain carefully enough what measurements would need to be taken to gain full credit.

(b) Most candidates appreciated that increasing the concentration would increase the rate of reaction but few went on to explain how the readings taken in the previous experiment would change.

(c) (i) Loss of electrons was well known.

(ii) Few candidates were able to state the correct formula for magnesium chloride. There was no common wrong answer.

(d) (i) Many candidates explained that the powder had a larger surface area and that therefore there would be an increased rate of burning. Few suggested that this was necessary to get all the light at once. A few incorrectly thought that it would be safer using powder because the reaction would be slower.

(ii) Low density and strong were quite well known as properties but few candidates were able to describe why these properties were suitable.

Question 7

(a) Many candidates referred to X-rays. Some candidates correctly referred to cancer treatment but then went on to describe chemotherapy.

(b) Most candidates gained partial credit here for knowing at least two of the answers.

(c) Most candidates gained at least partial credit here for mentioning that ionising radiation can cause cancer.

Question 8

(a) (i) The nucleus was well known as the part of the atom that contains protons and neutrons.

(ii) Although many candidates correctly stated that the number of neutrons in the chlorine atom was 18, many others gave the answer 17.

(iii) Only the more able candidates were able to explain the idea of isotopes.

(b) (i) The answer required was more than **X** is a metal, **Y** is a non-metal. A typical property of a metal and non-metal was needed. For example, **X** is a conductor and **Y** is an insulator.

(ii) While many candidates realised that **Y** would be more reactive than **Z**, only the most able gave a creditworthy explanation.

(c) (i) Many candidates described the formation of carbon dioxide from the combustion of carbon. Fewer could explain how carbon dioxide was released during the decomposition of calcium carbonate.

(ii) Many candidates were able to describe the idea of neutralisation of the soil, but many incorrectly thought that lime was acidic and neutralised the alkaline soil.

Question 9

(a) Many candidates were able to correctly write down four of the characteristics of living things using the scientific descriptions from the syllabus. Some candidates incorrectly wrote down their five senses.

(b) Many candidates tried to discuss the effects of various hormones on the body especially the sex hormones rather than defining the term *hormone* and were unable to gain credit. .

(c) The idea of more energy being released was well known but few candidates linked this with more respiration or that the muscles would be able to work harder.

(d) A few candidates knew the term phototropism. Many, however, were able to describe the plant growing towards the light. Candidates should avoid describing the plant 'bending towards the light'.

Question 10

(a) (i) Most candidates were able to use the correct symbols and place them into a circuit. Frequently the voltmeter was placed in series with the lamp. Sometimes the variable resistor was placed in parallel with the lamp.

(ii) The use of the variable resistor in this circuit was not well known. A number of candidates were using it to protect the lamp.

(iii) This was well answered. A number of candidates did not quote the formula in an acceptable format. The use of A or C for current was not accepted. It is acceptable to write the formula in words.

(b) About half the candidates could explain which of two wires for parts **(i)** and **(ii)** would have the greater resistance.

(c) (i) Positive and negative were well known. Many candidates mentioned static.

(ii) The electron was well known. A number of candidates wrote down negative.

Question 11

(a) Using the correct scientific terms, as stated in the syllabus, will gain credit .Candidates should be discouraged from giving 'colloquial terms'.

(b) Many candidates gained full credit. Answers such as 'inhaled air contains oxygen and exhaled air contains carbon dioxide' were not creditworthy. More water vapour in exhaled air was not well known.

(c) (i) Diffusion was not well known, but there was no common wrong answer.

(ii) Very few candidates answered this correctly with 'pulmonary vein'. Answers with either just 'pulmonary' or 'vein' were not creditworthy.

(d) (i) Less than half the candidates knew this. Candidates need to be aware that although 1 in 4 is one correct form of the answer, 1:4 is not. Many candidates wrote down **Ff**.

(ii) Many candidates gained some credit here. Very few gained full credit because they did not highlight on their genetic diagram evidence that the ratio was 1 in 4. Many candidates made their work very difficult to mark by writing their **F**s and **f**s as almost identical characters.

Question 12

(a) Many candidates knew that the raw material was petroleum.

(b) (i) Most candidates mentioned that the limewater went cloudy / milky, but only a few knew that it was carbon dioxide which was responsible.

(ii) The correct answer water was about as common as methane, hydrogen and oxygen.

(iii) Very few candidates knew this. The most common answer was that the observations would be different because ethanol and methane have different formulae.

(c) Water was not well known.

(d) (i) Polymerisation was known by some candidates, but most candidates wrote down any type of reaction they could think of.

(ii) Many candidates gained partial credit here for something they had written or more commonly something they had drawn. Candidates should be reminded that carefully drawn diagrams may be able to gain full credit.

CO-ORDINATED SCIENCES

Paper 0654/22

Core Theory

Key Messages

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols and units should also be avoided. Candidates should be reminded that while using a 'triangle consisting of three variables' is a valuable tool when answering calculation questions, this is not acceptable as a formula.

Candidates need to use to specific terminology and/or appropriate scientific language when answering questions. Examiners can not be award credit if are unsure as to what candidates are referring to, for example answering questions using the word 'it' rather than specifying what they were writing about.

General comments

Parts of some questions were inaccessible to some candidates. However, most candidates were able to attempt most questions. There was a good range of credit on most questions. Candidates generally scored on all questions. Few gained no credit on any question and very few gained full credit on any question. Although it appeared that candidates often knew the answers to the questions, their answers were often imprecise.

There was evidence of candidates running short of time to complete the examination as the last one or two questions were frequently rushed or left unanswered.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to identify one compound but two compounds were required to gain credit.

(ii) Few candidates were able to work out that the tungsten ore was scheelite.

(b) Most candidates were able to correctly identify the two particles from the information given.

(c) (i) Most candidates gained partial credit. Candidates gave a number of different correct answers which were creditworthy.

(ii) Many candidates got this wrong by suggesting that potassium was less reactive than sodium.

(iii) Hydrogen was well known as the gas, but most candidates selected potassium oxide as the other product of the reaction.

Question 2

(a) Most candidates gained partial credit with some very well drawn graphs.

(b) Many candidates gained full credit for giving a correct formula and carrying out the calculation correctly.

(c) (i) Most candidates found this very difficult They were asked to describe evaporation in terms of molecules. The most able candidates based their answers on what the particles were doing. Many candidates worte about homeostasis.

(ii) Few candidates managed to identify two factors which would increase evaporation.

Question 3

(a) The question required a definition of the term *enzyme*. Some candidates gained full credit by writing a concise definition. Other candidates explained what catalysts did without explaining that an enzyme was a biological catalyst.

(b) Some candidates managed to show good data handling skills when describing the effect of pH on the enzyme. Many correctly gave 6.5 as the optimum pH, although some estimated it to be 7.0. The maximum pH and minimum pH were also frequently estimated correctly. A number of candidates went further and discussed why the enzyme activity would stop at these pHs.

(c) (i) Many candidates found this difficult. A curve starting at the origin with a peak at or below 4 was needed.

(ii) Few candidates were able to answer this effectively. There was little understanding of sodium hydrogencarbonate being able to neutralise the acid. There was also little understanding of the idea that the enzyme was not working in alkaline conditions.

(iii) Protein was not well known as the substrate, but a number of candidates correctly identified amino acids as the product.

(iv) The idea that large molecules needed to be broken down into smaller ones was not well known, although there were many candidates who correctly described the molecules being absorbed into the blood.

Question 4

(a) Many candidates gained partial credit for explaining that the air molecules would collide with the tyre walls, but few could explain how the collisions exerted a force which caused the pressure.

(b) This part was poorly answered. Most candidates could only give one effect. This was usually changing the speed of the object. Changing the shape or the direction of motion were rarely described.

Many candidates attempted to answer the question by describing things that could happen to the car in the question.

(c) Many candidates selected force **B** but some were unable to explain why force **B** was greater.

(d) This was well answered. The only common error was to describe the petrol as being boiled in the engine rather than burned.

(e) Many candidates gained full credit here. Common mistakes were an incorrect symbol for a switch and the lamps being placed in series.

Question 5

(a) (i) Cracking was well known.

(ii) The term *catalyst* was well understood.

(iii) Using bromine to test for unsaturated hydrocarbons was not well known. There was no common wrong answer.

(b) (i) Many candidates gained credit here.

(ii) This was well known.

(iii) A number of candidates knew that carbon monoxide was poisonous. Fewer were able to explain that carbon monoxide was produced due to the incomplete combustion of gasoline and oxygen.

Question 6

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

(b) (i) Many candidates were able to explain that the sand would be cooler under the trees, but were unable to gain further credit as they did not refer to data from the graph.

(ii) Whilst many candidates gained full credit on the question, many were not able to read and interpret the data in the table correctly.

(iii) Many candidates suggested that more females would be produced and that the imbalance between male and female would make breeding difficult.

(c) Many candidates gained full credit by explaining that deforestation would mean less oxygen in the atmosphere and more carbon dioxide. The ideas of soil erosion and flooding were also fairly well known.

Question 7

(a) To gain full credit, candidates needed to explain how beta and gamma radiations could be distinguished from each other. Therefore an answer such as 'beta can pass through paper and gamma can pass through lead' was not sufficient. Whereas, 'beta can pass through paper but is stopped by thick aluminium but gamma can pass through thick aluminium' gained full credit.

(b) Many candidates were able to explain that the wavelength was the distance between two waves. Fewer were able to explain that it was the distance between identical points on two successive waves. Many candidates were able to answer the question with a simple, clear diagram. Care must be taken, however, to ensure that information in the diagram and other information written down are not contradictory.

(c) Many candidates were able to explain why radiation is dangerous to human beings. Few candidates mentioned that alpha radiation is ionising radiation.

Question 8

(a) The use of chlorine or boiling to remove harmful microorganisms was well known. Candidates who suggested filtration were usually unable to explain why filtration was a suitable process.

(b) The most able candidates were able to describe a difference between a mixture of two elements and a compound containing these two elements.

(c) (i) Many candidates gained partial credit by explaining that some of the water evaporates.

(ii) This was very difficult for the candidates. Few realised that hexane was a liquid at room temperature and would therefore pass through the filter paper.

(d) (i) A number of candidates were able to state that the element was a metal but few were able to go further and give an explanation.

(ii) Whilst there were many correct answers here, a number of candidates incorrectly suggested that the oxide would be acidic and that the indicator would turn red.

Question 9

(a) The photosynthesis word equation was well known. A few candidates placed carbon dioxide on the right hand side of the equation. A few candidates attempted to complete a balanced symbolic equation.

(b) **A** and **B** were correctly identified by many candidates.

(c) The idea of gases diffusing in or out through stomata was well known, but few candidates specified the correct gases.

(d) Transpiration was not well known. Evaporation was commonly given.

(e) The idea that fewer stomata leads to reduced water loss was well known. However, some candidates explained that desert plants needed less water to enter and therefore would have less stomata.

(f) Few candidates were able to explain that having stomata on their upper surface meant that the stomata were in contact with the air. Many candidates incorrectly thought that stomata on the lower surface would cause lots of water to enter the plant and drown it.

Question 10

(a) Many candidates gained full credit for showing a good understanding of waves. Candidates need to be aware that answers such as 'they have different frequencies' was not sufficient. Occasionally, many candidates referred to 'it' and in many cases it was unclear whether the 'it' referred to a radio wave or a sound wave.

(b) Some candidates gained full credit but most candidates gained partial credit on this question.

(c) Many candidates stated the correct formula and carried out the calculation correctly. A number doubled the distance, perhaps because they thought that this was a question involving echoes.

(d) Many candidates gained full credit for giving a correct formula and carrying out the calculation correctly. A number of candidates, who clearly did not know the formula, used the units given on the answer line as their formula. This gave the correct answer but no credit was given for the formula quoted.

Question 11

(a) (i) Few candidates correctly completed this part. Although a number chose experiment **2**, most simply rewrote the question.

(ii) Many candidates knew that this was experiment **1**. Some did not explain their answer sufficiently. A number of candidates suggested that it was experiment **1** because it was the coldest. This was not accepted. There needed to be a clear statement that the temperature had decreased.

(iii) The idea that the temperature did not change in experiment **4** because there was no reaction was well known.

(b) Most candidates correctly chose experiment **5** because there was a larger surface area and therefore the rate of reaction was greater.

(c)(i) Hydrogen was correctly identified as the gas by most candidates who also knew the correct chemical test to identify hydrogen.

(ii) Many candidates gained partial credit. This was usually gained for suggesting that the acid must be added to the mixed metals. Many candidates gave imprecise descriptions relating to the reactivity of the two metals, but few explained how the metals would be separated.

Question 12

(a) Many candidates knew that respiration released energy but few were able to describe the breakdown of nutrient molecules to release energy

(b) This was poorly answered. Few candidates could give a realistic percentage for oxygen in expired air. Few knew the percentage for nitrogen or the fact that it is approximately the same in both inspired and expired air. Some candidates were able to give a good figure for the percentage of carbon dioxide in inspired air.

(c) This was well answered. Most candidates knew the role of the red blood cells and many knew the role of haemoglobin. Candidates should avoid using 'RBC' as an abbreviated form of red blood cell.

CO-ORDINATED SCIENCES

Paper 0654/23

Core Theory

Key Messages

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols and units should also be avoided. Candidates should be reminded that while using a 'triangle consisting of three variables' is a valuable tool when answering calculation questions, this is not acceptable as a formula.

Candidates need to use to specific terminology and / or appropriate scientific language when answering questions. Examiners can not be award credit if are unsure as to what candidates are referring to, for example answering questions using the word 'it' rather than specifying what they were writing about.

General comments

Parts of some questions were inaccessible to some candidates. However, most candidates were able to attempt most questions. There was a good range of credit on most questions. Candidates generally scored on all questions. Few gained no credit on any question and very few gained full credit on any question. Although it appeared that candidates often knew the answers to the questions, their answers were often imprecise.

There was evidence of candidates running short of time to complete the examination as the last one or two questions were frequently rushed or left unanswered.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to identify one compound but two compounds were required to gain credit.

(ii) Few candidates were able to work out that the tungsten ore was scheelite.

(b) Most candidates were able to correctly identify the two particles from the information given.

(c) (i) Most candidates gained partial credit. Candidates gave a number of different correct answers which were creditworthy.

(ii) Many candidates got this wrong by suggesting that potassium was less reactive than sodium.

(iii) Hydrogen was well known as the gas, but most candidates selected potassium oxide as the other product of the reaction.

Question 2

(a) Most candidates gained partial credit with some very well drawn graphs.

(b) Many candidates gained full credit for giving a correct formula and carrying out the calculation correctly.

(c) (i) Most candidates found this very difficult They were asked to describe evaporation in terms of molecules. The most able candidates based their answers on what the particles were doing. Many candidates worte about homeostasis.

(ii) Few candidates managed to identify two factors which would increase evaporation.

Question 3

(a) The question required a definition of the term *enzyme*. Some candidates gained full credit by writing a concise definition. Other candidates explained what catalysts did without explaining that an enzyme was a biological catalyst.

(b) Some candidates managed to show good data handling skills when describing the effect of pH on the enzyme. Many correctly gave 6.5 as the optimum pH, although some estimated it to be 7.0. The maximum pH and minimum pH were also frequently estimated correctly. A number of candidates went further and discussed why the enzyme activity would stop at these pHs.

(c) (i) Many candidates found this difficult. A curve starting at the origin with a peak at or below 4 was needed.

(ii) Few candidates were able to answer this effectively. There was little understanding of sodium hydrogencarbonate being able to neutralise the acid. There was also little understanding of the idea that the enzyme was not working in alkaline conditions.

(iii) Protein was not well known as the substrate, but a number of candidates correctly identified amino acids as the product.

(iv) The idea that large molecules needed to be broken down into smaller ones was not well known, although there were many candidates who correctly described the molecules being absorbed into the blood.

Question 4

(a) Many candidates gained partial credit for explaining that the air molecules would collide with the tyre walls, but few could explain how the collisions exerted a force which caused the pressure.

(b) This part was poorly answered. Most candidates could only give one effect. This was usually changing the speed of the object. Changing the shape or the direction of motion were rarely described.

Many candidates attempted to answer the question by describing things that could happen to the car in the question.

(c) Many candidates selected force **B** but some were unable to explain why force **B** was greater.

(d) This was well answered. The only common error was to describe the petrol as being boiled in the engine rather than burned.

(e) Many candidates gained full credit here. Common mistakes were an incorrect symbol for a switch and the lamps being placed in series.

Question 5

(a) (i) Cracking was well known.

(ii) The term *catalyst* was well understood.

(iii) Using bromine to test for unsaturated hydrocarbons was not well known. There was no common wrong answer.

(b) (i) Many candidates gained credit here.

(ii) This was well known.

(iii) A number of candidates knew that carbon monoxide was poisonous. Fewer were able to explain that carbon monoxide was produced due to the incomplete combustion of gasoline and oxygen.

Question 6

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

(b) (i) Many candidates were able to explain that the sand would be cooler under the trees, but were unable to gain further credit as they did not refer to data from the graph.

(ii) Whilst many candidates gained full credit on the question, many were not able to read and interpret the data in the table correctly.

(iii) Many candidates suggested that more females would be produced and that the imbalance between male and female would make breeding difficult.

(c) Many candidates gained full credit by explaining that deforestation would mean less oxygen in the atmosphere and more carbon dioxide. The ideas of soil erosion and flooding were also fairly well known.

Question 7

(a) To gain full credit, candidates needed to explain how beta and gamma radiations could be distinguished from each other. Therefore an answer such as 'beta can pass through paper and gamma can pass through lead' was not sufficient. Whereas, 'beta can pass through paper but is stopped by thick aluminium but gamma can pass through thick aluminium' gained full credit.

(b) Many candidates were able to explain that the wavelength was the distance between two waves. Fewer were able to explain that it was the distance between identical points on two successive waves. Many candidates were able to answer the question with a simple, clear diagram. Care must be taken, however, to ensure that information in the diagram and other information written down are not contradictory.

(c) Many candidates were able to explain why radiation is dangerous to human beings. Few candidates mentioned that alpha radiation is ionising radiation.

Question 8

(a) The use of chlorine or boiling to remove harmful microorganisms was well known. Candidates who suggested filtration were usually unable to explain why filtration was a suitable process.

(b) The most able candidates were able to describe a difference between a mixture of two elements and a compound containing these two elements.

(c) (i) Many candidates gained partial credit by explaining that some of the water evaporates.

(ii) This was very difficult for the candidates. Few realised that hexane was a liquid at room temperature and would therefore pass through the filter paper.

(d) (i) A number of candidates were able to state that the element was a metal but few were able to go further and give an explanation.

(ii) Whilst there were many correct answers here, a number of candidates incorrectly suggested that the oxide would be acidic and that the indicator would turn red.

Question 9

(a) The photosynthesis word equation was well known. A few candidates placed carbon dioxide on the right hand side of the equation. A few candidates attempted to complete a balanced symbolic equation.

(b) **A** and **B** were correctly identified by many candidates.

(c) The idea of gases diffusing in or out through stomata was well known, but few candidates specified the correct gases.

(d) Transpiration was not well known. Evaporation was commonly given.

(e) The idea that fewer stomata leads to reduced water loss was well known. However, some candidates explained that desert plants needed less water to enter and therefore would have less stomata.

(f) Few candidates were able to explain that having stomata on their upper surface meant that the stomata were in contact with the air. Many candidates incorrectly thought that stomata on the lower surface would cause lots of water to enter the plant and drown it.

Question 10

(a) Many candidates gained full credit for showing a good understanding of waves. Candidates need to be aware that answers such as 'they have different frequencies' was not sufficient. Occasionally, many candidates referred to 'it' and in many cases it was unclear whether the 'it' referred to a radio wave or a sound wave.

(b) Some candidates gained full credit but most candidates gained partial credit on this question.

(c) Many candidates stated the correct formula and carried out the calculation correctly. A number doubled the distance, perhaps because they thought that this was a question involving echoes.

(d) Many candidates gained full credit for giving a correct formula and carrying out the calculation correctly. A number of candidates, who clearly did not know the formula, used the units given on the answer line as their formula. This gave the correct answer but no credit was given for the formula quoted.

Question 11

(a) (i) Few candidates correctly completed this part. Although a number chose experiment **2**, most simply rewrote the question.

(ii) Many candidates knew that this was experiment **1**. Some did not explain their answer sufficiently. A number of candidates suggested that it was experiment **1** because it was the coldest. This was not accepted. There needed to be a clear statement that the temperature had decreased.

(iii) The idea that the temperature did not change in experiment **4** because there was no reaction was well known.

(b) Most candidates correctly chose experiment **5** because there was a larger surface area and therefore the rate of reaction was greater.

(c)(i) Hydrogen was correctly identified as the gas by most candidates who also knew the correct chemical test to identify hydrogen.

(ii) Many candidates gained partial credit. This was usually gained for suggesting that the acid must be added to the mixed metals. Many candidates gave imprecise descriptions relating to the reactivity of the two metals, but few explained how the metals would be separated.

Question 12

(a) Many candidates knew that respiration released energy but few were able to describe the breakdown of nutrient molecules to release energy

(b) This was poorly answered. Few candidates could give a realistic percentage for oxygen in expired air. Few knew the percentage for nitrogen or the fact that it is approximately the same in both inspired and expired air. Some candidates were able to give a good figure for the percentage of carbon dioxide in inspired air.

(c) This was well answered. Most candidates knew the role of the red blood cells and many knew the role of haemoglobin. Candidates should avoid using 'RBC' as an abbreviated form of red blood cell.

CO-ORDINATED SCIENCES

Paper 0654/31

Extended Theory

Key messages

When answering questions, candidates should be guided by the amount of credit allocated to each question and use appropriate scientific language and terms. It is beneficial for candidates to check that they are answering the question that has been asked and that their meaning is clear.

Candidates are reminded that version of the Periodic Table as printed on the question paper should be the one used.

General comments

There were many accurate, concise answers to the questions requiring extended explanations. Those candidates were awarded credit for their use of correct scientific language and terminology. Candidates did not appear to have difficulty in completing the paper in the time allowed.

Generally, in calculations, formulae were written using standard symbols, mathematical operations were carried out accurately and working was well presented. A few candidates used too few significant figures and credit could not be awarded where units were omitted or confused.

Comments on specific questions

Question 1

(a) (i) Most candidates knew the formula for kinetic energy, and gained full credit if they used the total mass of the train in their calculation.

(ii) The formula for work done was well known. A few candidates converted the distance from kilometres to metres in the calculation to obtain the correct answer.

(iii) Many of those who knew the formula for power did not convert the time into seconds. The work done in gaining the kinetic energy was sometimes used in the calculation, rather than the work done in applying the driving force to maintain a constant speed.

(b) (i) In general, candidates appreciated that the maximum kinetic energy of water at the foot of the waterfall was equal to the gravitational potential energy at the top. To gain credit, they needed to explain that energy was conserved during conversion from potential to kinetic energy.

(ii) Many candidates knew the relationship between heat energy transfer and temperature change. Difficulty was experienced in rearranging the formula, to make temperature change the subject.

Question 2

(a) (i) A correct bonding diagram was drawn when it was appreciated that a nitrogen molecule contained a triple bond.

(ii) Most knew that the nitride ion had an octet of electrons in the outer shell, but some failed to notice that they were required to show the arrangement of *all* the electrons.

(iii) Many answers simply restated the question, rather than showing that they knew the charges on electrons and protons, and that the charge on the ion was due to there being three more electrons than protons. Those who stated that three more electrons had been *added* also needed to show that the neutral atom initially contained the same number of electrons as protons.

(iv) The correct formula for magnesium nitride was usually given. The explanation had to be shown as a comparison of the total charges provided by the magnesium ions and by the nitride ions in the formula, or a statement of the need for charge balance. A diagram showing crossed arrows from the ionic charges, though a useful tool, was not an adequate explanation.

(b) (i) Chlorine was usually correctly identified as the gaseous element formed at the anode. Hydrogen and carbon dioxide were other suggestions.

(ii) Hydrogen was usually suggested as the gas forming at the cathode with aqueous magnesium chloride as the electrolyte. simply stating 'pop test' was not sufficient to gain credit; a description of the hydrogen test was required.

Question 3

(a) The root cell was usually labelled correctly.

(b) (i) Most candidates explained that root hair cells absorbed water by osmosis and some mentioned the partially permeable membrane. Answers involving movement from a region with high concentration to one with low concentration were ambiguous if they did not specify *water* concentration.

(ii) There was misunderstanding between the functions of roots and of root hairs. 'To anchor the plant' was a common response, rather than to absorb ions or minerals. The absorption of nutrients was not sufficient to gain credit.

(iii) Many candidates described the adaptation of root hair cells by noting their large surface area but some did not go on to explain that this maximised absorption.

(c) (i) The xylem was usually identified as the tissue which transported the coloured water.

(ii) The central region of the root was not always labelled as the xylem.

(iii) Most candidates attempted to answer this question in terms of biological processes rather than recognising it as a particle model question. Some did state that the water evaporated but the dye did not, while few recognised that molecules of each behaved independently as separate molecules and were not combined.

Question 4

(a) (i) Relatively few candidates knew concise, useful definitions of both frequency and wavelength. Candidates who labelled the distance from peak to peak or trough to trough generally gained credit. Candidates are reminded that carefully drawn (and labelled) diagrams can gain all of the available credit.

(ii) Most candidates knew the formula for the speed of a wave.

Those who could not recall the standard symbol for wavelength, λ, sometimes wrote the formula in words: speed = frequency × wavelength; rather than choosing a symbol that could have an ambiguous meaning. The question tested whether the candidate knew that the system of units requires the conversion of kilohertz to hertz.

(iii) Successful candidates interpreted this question as requiring a description of the meaning of the terms compression and rarefaction as regions of particles packed close together under higher pressure and of particles further apart under lower pressure. Others described the propagation of sound waves or simply the nature of air particles.

(b) (i)(ii) Candidates gaining credit in these parts appreciated the need to measure the angle between each ray and the normal to the surface.

(iii) Many candidates gained partial credit by suggesting a device such as an optical fibre. Full credit required a description of its use, such as data transfer or seeing inside the body, rather than, say, just being connected to a telephone. There was some confusion with simple reflection in mirrors, and devices which may or may not use total internal reflection, such a periscope. In this case ambiguity could have been avoided by identifying the optics performing the total internal reflection.

Question 5

(a) The explanation of how mammals use food to keep body temperature constant needed to include the statement that glucose combines with oxygen in the respiration process, releasing energy as heat. Some answers used ideas from the rest of the question, for example, suggesting that fat in food supplies insulation. Others showed a misunderstanding of the respiration process by stating that energy was used in order to respire.

(b) (i) Many candidates suggested that marmots need to eat a lot in order to build up fat stores. Most went on to state incorrectly, that they should eat fat which is then stored, rather than excess carbohydrate being converted to fat. The fact that marmots were herbivorous was sometimes ignored and some answers suggested that they had control over the amount of exercise they took.

(ii) Most candidates correctly described the relationship between a marmot's body mass and its chances of survival. The use of the term 'proportional' was not appropriate for this non-linear relationship. Some compared two sets of data selected from the graph to support their description and a minority observed that the rise in survival rate reached a limit at higher mass.

(iii) Candidates awarded credit recognised that fat was an insulator or a poor conductor of heat.

(c) Most candidates could suggest deforestation as a human activity that contributed to global warming and many explained this as being due to the reduction in the removal of carbon dioxide through photosynthesis. Those who had first stated that global warming was caused by the *addition* of carbon dioxide to the atmosphere avoided subsequently making the contradiction that deforestation caused this increase in carbon dioxide. Some knew that methane was a greenhouse gas and that cattle rearing was an important source of this gas. Those who successfully attempted an explanation of the greenhouse effect often used arguments based on trapping heat, rather than radiation. A considerable number of candidates confused depletion of the ozone layer with the greenhouse effect.

(d) (i) The majority of candidates correctly described the trend as that of increasing body mass rather than commenting on the fluctuations.

(ii) Rather than merely stating that the earlier arrival of spring caused the increase in mass, successful candidates suggested that this occurred because marmots had more time to feed on plants that were more easily available, or used less of their fat store during winter.

Question 6

(a) To gain credit, candidates needed to identify both surface area of magnesium and temperature as variables that should be kept constant for a fair test. Ambiguous statements about the 'amounts' of materials to be used, or inclusion of factors related to the choice of equipment were not creditworthy

(b) (i) Most candidates correctly identified experiment **B** as using acid with the higher concentration.

(ii) Many candidates gained credit by reading the maximum volume of gas and time taken from the graph and substituting their values into the formula. To gain full credit, they needed to state the units of these measurements and the consistent derived unit of the calculated rate of reaction.

(c) (i) The (aq) symbol was usually interpreted as standing for aqueous or in water solution.

(ii) The majority of candidates could find the relative atomic mass of magnesium or could show how to calculate the number of moles present to gain credit.

Question 7

(a) Candidates who stated that nuclei *split* during fission gained credit.

(b) (i) The nature of a beta particle as an electron was not well known.

(ii) Only those who knew that an electron was emitted from the Strontium-90 atom could predict the composition of the Yttrium nucleus. A common misconception was that the nucleus was split in half during the decay.

(iii) Very few candidates realised that beta was ionising radiation and so changed the neutral atom into an ion by causing the loss of an electron. Some described the capture of the beta particle while others suggested a nuclear process.

(c) (i) The majority of candidates interpreted the scale accurately and read off the correct count rate after 10 hours.

(ii) Most understood the effect of half-life on the shape of the decay curve and chose the correct source.

Question 8

(a) (i) Many candidates knew that they could identify the Periodic Table group number from the number of electrons in the outer shell. Candidates should be reminded that the Group Number for the noble gases is '0' rather than '8'.

(ii) Most identified **Q** as least reactive because it had a full outer shell.

(iii) Most identified **P** as a good conductor of electricity because it was a metal.

(b) (i) The use of limestone in the modern blast furnace was not well known.

(ii) Only some candidates could name a gaseous oxide of carbon other than carbon dioxide, and could identify iron oxide as the constituent of iron ore from the information given in the question. Rather more could name the products of the reaction in a word equation. Others attempted a symbol equation instead of the word equation required.

(c) (ii) There were few scientific explanations of sacrificial protection. Successful candidates avoided the pitfalls of referring to the reaction of steel rather than iron, and to the rusting of zinc rather than its corrosion, by explaining the action of a more reactive metal coating a less reactive metal in general terms.

Question 9

(a) A minority of candidates could recall the full syllabus definition of a hormone. Some responses often described the action of specific hormones using non-scientific terminology, or showed confusion with enzymes.

(b) (i) About half of candidates knew that insulin was formed by the pancreas, with the liver often being suggested by others.

(ii) There were some succinct answers stating that insulin causes the liver to remove glucose from the blood and to store it as glycogen. These candidates wrote or implied that glucose was removed from the blood rather than restating the information that the concentration was lowered, or making similar statements about lowering the glucose *level*.

(c) Some candidates could state at least one effect of adrenaline on the body. The primary effects could have been 'increased blood glucose concentration causing increased respiration and energy provision in the muscles' and 'increased pulse rate causing more glucose and oxygen to be delivered to the muscles'. Answers often stated secondary effects such as sweating, or less scientific descriptions such as 'the body getting more energy' or 'the brain working faster'.

Question 10

(a) (i) Most candidates could draw a suitable circuit diagram including an ammeter and voltmeter, correctly connected. The symbol for a variable resistance was often drawn incorrectly or the means of varying the potential difference was omitted.

(ii) The resistance of the lamp was usually calculated correctly from the Ohm's Law formula.

(b) (i) Most chose **D** as having a greater resistance than **B** because of its greater length.

(ii) Fewer chose **A** as having a greater resistance than **E** because of its smaller cross-section.

(iii) A quantitative explanation was required for the values of the resistances of **C** and **E**. The resistance of **C** was 20 Ω, twice the resistance of **A**, because the wire had twice the length. The resistance of **E** was 5 Ω, half the resistance of **A**, because the wire had twice the cross-sectional area. Some candidates seemed unaware that this was not the same as twice the thickness.

Question 11

(a) Some candidates could recall that meiosis produced four cells rather than two, halved the chromosome number and produced genetic variation. Credit was awarded to candidates specifying *genetic* variation. Others described mitosis without implying the differences between mitosis and meiosis.

(b) (i)(ii) Most candidates could draw a genetic diagram to find the probability that the first child would have cystic fibrosis. Where candidates had omitted the parents' genotypes or did not highlight the offspring genotype responsible for appearance of the disease, credit could not be awarded. Ambiguity can be avoided if candidates write the upper and lower case 'f' in such a way as to emphasise the difference.

(c) It was quite well known that diffusion was the mechanism for the exchange of gases in and out of the alveoli. Relatively few candidates used the idea of the mucus increasing the distance between the alveoli and the blood. They tended not to mention the greater time taken to diffuse over this distance. Many responses mentioned the reduction in surface area for absorption, or the blockage of air passages, which did not answer the question referring to mucus collecting on the inner surface of the alveoli.

Question 12

(a) (i) Most candidates could match the molecules to their families of carbon compounds.

(ii) Many candidates correctly draw the structure of a butene molecule gaining full credit. Others drew butane or assigned incorrect valencies to carbon atoms.

(b) It was common to suggest that the introduction of electric vehicles would not achieve the predicted reduction in carbon dioxide because carbon dioxide would still be produced by other sources. Better answers recognised that electricity for charging the vehicle battery would come from a power station that was likely to burn a fuel that would produce carbon dioxide.

(c) (i) Some candidates knew that ethanol was made by a reaction between ethene and water at elevated temperature in the presence of a catalyst. Several candidates incorrectly mentioned processes such as cracking and fractional distillation, while others attempted to explain a mechanism of addition of individual atoms to the ethene molecule.

(ii) Some candidates were able to give a use for ethanol (other than fuel).

CO-ORDINATED SCIENCES

Paper 0654/32

Extended Theory

Key messages

When answering questions, candidates should be guided by the amount of credit allocated to each question and use appropriate scientific language and terms. It is beneficial for candidates to check that they are answering the question that has been asked and that their meaning is clear.

Candidates are reminded that version of the Periodic Table as printed on the question paper should be the one used.

General comments

There were many accurate, concise answers to the questions requiring extended explanations. Those candidates were awarded credit for their use of correct scientific language and terminology. There was no evidence that candidates were short of time.

Generally, in calculations, formulae were written using standard symbols, mathematical operations were carried out accurately and working was well presented. A few candidates used too few significant figures and credit could not be awarded where units were omitted or confused.

Comments on specific questions

Question 1

(a) (i) Nearly all candidates were able to identify binary compounds but many did not realise that there were two correct answers and only gave galena.

(ii) Most candidates were able to pick out a tungsten ore but there were some who gave responses which were not from the list given. Iron was a common error of this type.

(b) (i) Many candidates were able to make the logical deduction that the element was germanium following the idea that the number of shells gave the period and the number in the outer shell the group in the Periodic Table. However, a large number tried to work out the total electrons and hence the atomic number to identify the element on the assumption that all shells in this case, with the exception of the inner and outermost shell, had a maximum of 8 electrons. They thus concluded wrongly that the element was titanium.

(ii) Nearly all candidates were able to answer this successfully with almost all showing at least one shared pair of electrons.

(iii) Many candidates were able to produce a fully balanced equation for the reaction and most had correct formulae. Incorrect formulae often came from attempts to balance the equation by changing them rather than the coefficients.

Question 2

(a) Many candidates confused electromagnetic induction with the motor effect and did not realise that the turning of the coil was due to the efforts of the cyclist. Some thought that the magnetism was induced by the movement of the coil. Some who did understand induction referred to the axle rather than the coil. Most candidates understood that the brushes and slip rings provided a complete circuit with the moving coil.

(b) Many candidates did not take into account that the question specified that the explanation should be in terms of movement of molecules and concentrated their answers on the production of sweat. Those who answered in terms of molecular movement scored well.

Question 3

(a) (i) Many candidates were able to describe the optimum pH level but often did not describe the upper and lower limits of activity.

(ii) Most candidates were familiar with the term 'denatured' but were unable to describe what was meant in terms of active site and substrate.

(iii) Most candidates correctly sketched a curve covering a suitable pH range.

(iv) Many candidates realised that sodium hydrogencarbonate would neutralise the acid from the stomach but did not relate this to taking the pH out of the range in which the protease enzyme would operate. Many thought it stopped working because all the food was digested.

(b) Many answers demonstrated a good knowledge of the process of digestion as breakdown of large nutrient molecules to smaller soluble ones.

(c) (i) Most candidates could name capillaries but lacteal proved more elusive with 'vein' being a common incorrect alternative.

(ii) Most answers demonstrated good knowledge of absorption of nutrients in the alimentary canal. Some answers suggested that the villi were being confused with the 'alveoli'.

Question 4

(a) Most candidates demonstrated good knowledge of kinetic theory but were not always able to direct this knowledge to answering the questions.

(i) Many failed to refer to impact of particles on the tyre <u>wall</u> as the cause of the pressure and few referred to this exerting a force.

(ii) Most candidates answered this well with clear reference to increased speed.

(iii) Most understood this in terms of increased collisions but did not always refer to rate of collision or to the tyre wall.

(b) The majority of candidates were able to draw circuit diagrams with correct symbols with connections appropriate to the specification.

(c) Most candidates were able to quote the correct formula and make an appropriate calculation of the mass. There were occasionally incorrect or missing units.

(d) Most candidates recognised that the extra passengers and luggage would make the car heavier although some referred to weight rather than mass. Many linked this to increased energy or momentum but it was also common to refer to increased inertia. Many candidates realised that this would lead to a longer breaking time or distance or the need for more force to be applied. It was a common misconception that the increased mass would increase friction and pressure on the road and therefore slow the car down quicker.

(e) The majority of candidates were able to quote and use the correct formula but there were some who used units derived from the formula rather than standard units of acceleration.

Question 5

(a) (i) Most candidates correctly distinguished between single and multiple bonding although a few mixed up saturated and unsaturated.

(ii) Most candidates knew that bromine was used for this test but in describing a positive result often did not state the initial colour and were unable to gain full credit.

(b) (i) Many candidates understood that there was a trend in the boiling points but many had difficulty in linking this to increasing length of the carbon chain, often using terms such as more bonds or more molecules. When comparing boiling points of alkenes and alkanes, few candidates referred to similar length of carbon chain. Many candidates gave a second answer that was a repeat of the first but referring to alkanes in one and alkenes in the other; some used a reverse argument of the first answer as the second answer.

(ii) Candidates commonly referred to bonds rather than forces and many did not make it clear that these were not bonds between atoms. Many candidates referred to more forces or bonds rather than stronger forces or bonds and most understood that an increase in intermolecular forces led to more energy being required to separate the molecules and hence a higher boiling point. Quite a number of candidates misunderstood the question and attempted to answer in terms of differences between alkanes and alkenes.

Question 6

(a) Most candidates were familiar with the idea of X and Y chromosomes being responsible for sex determination in mammals, correctly linking XX to female and XY to male. However it was common to refer to gametes as having two chromosomes rather than one.

(b) Most candidates could identify the trend shown in the table but many attempted to explain rather than describe the effect and did not illustrate their answers with data from the graph.

(c) The majority of candidates were able to identify the link between hotter sand and more females or *vice versa* and many linked this to the critical temperature. However some candidates repeated data from the table with no explanation and were inclined to concentrate on the numbers of nests rather than the sex ratio of hatchlings.

(d) Most candidates correctly deduced that the female / male balance would be altered and that significant changes would lead to difficulties in breeding.

(e) Many candidates showed a good awareness of the role that trees play in maintaining our environment either through photosynthesis or take up and release of water through transpiration. Candidates who explained the effect of increasing carbon dioxide in the atmosphere gained further credit than those who just referred to the 'greenhouse effect or global warming'.

Question 7

(a) (i) Most candidates drew appropriate lines on the graph and made a correct deduction of the half-life. Some candidates did not simply use half the initial count rate and made their calculation more difficult, whilst others misread the scale as 51 s rather than 55 s.

(ii) Most candidates knew that an alpha particle was a helium nucleus and correctly stated the loss of two neutrons and two protons. A much smaller number were also able to link the loss of protons to the change into a different element.

(iii) Most candidates knew that an alpha particle was positively charged but few explained why this was the case. Some candidates tried to answer in terms of its low penetrating power.

(b) (i) Some candidates realised that the best way to distinguish between the different types of radiation was to state something the radiation would pass through and something that would absorb it. However many candidates referred to only one or the other and gave answers that would have applied to both beta and gamma radiation.

(ii) The majority of candidates linked ionisation correctly to removal of an electron.

(c) Most candidates were able to satisfactorily explain the meaning of wavelength and illustrate this successfully with a diagram. Candidates should be reminded to draw their diagrams carefully and that a good diagram may be awarded full credit.

Question 8

(a) Most candidates understood that, in a compound, atoms of different elements were chemically combined but few realised that, in a mixture of hydrogen and oxygen, the atoms of the same element were combined. Many candidates simply stated that a mixture could be easily separated.

(b) (i)(ii) Most candidates realised that an insoluble solid could be separated from water by filtration and those who correctly identified silicon dioxide in part **(i)** could usually explain the reasons why hexane and sodium chloride could not be separated by this method.

(iii) Many candidates thought this question was about ionic bonding rather than the crystal lattice. Diagrams were often drawn representing a close-packed structure rather than cubic and in many cases the charges on the ions were omitted.

(c) In this question, candidates were asked to describe the main steps that should be taken to obtain copper sulfate crystals from sulfuric acid and copper carbonate given that the latter was insoluble. Many candidates did not realise that an insoluble compound was not suitable for titration and those who added copper carbonate in excess did not say how they would recognise this. Most candidates tended to concentrate on the crystallisation process, often without reacting the two substances.

Question 9

(a) Some candidates did not draw the required label line to the diagram but of those who did, most were able to correctly identify a palisade cell.

(b) Most candidates understood the overall role of stomata but did not always relate this to photosynthesis as asked in the question.

(c) (i) Some candidates did not use a label line but wrote the letter **A** on the diagram. A common error was to label cells in the upper or lower epidermis.

(ii) Only the more able candidates linked magnesium to the production of chlorophyll. Many candidates tried to explain how they had made their choice of cell rather than why the cell would lose the green colour. Many confused chlorophyll with chloroplasts and tended to interchange the terms.

Question 10

(a) The majority of candidates were unable to state three distinct differences between sound waves and radio waves. Often the reverse argument was used as a second point making a statement about radio waves and then a corresponding statement about sound waves.

(b) Most candidates were able to complete this calculation successfully with few using an incorrect formula.

(c) Most candidates were able to draw correctly angled lines through the rectangular block but some showed the lines bending too far and therefore along the normal. Most candidates were able to draw the line entering the triangular block correctly but often it was bent in the wrong direction on exit. Those candidates who attempted to show dispersion in the triangular block often made the mistake of spreading the rays too far and therefore bending some in the wrong direction.

(d) Most candidates were able to successfully complete this calculation. Some candidates seemed to be recalling experiments where they had used an echo method and therefore doubled the distance.

Question 11

(a) (i) Many candidates correctly identified experiment **2** as the reaction involving an alkali with a valid reason but some thought sodium hydrogencarbonate was an alkali.

(ii) Most candidates correctly identified experiment **1** as endothermic with a valid reason but there was a tendency to state that it was the lowest temperature rather than a temperature decrease.

(iii) The majority of candidates recognised that there was no reaction and gave a valid reason.

(b) Most candidates knew that the rate of reaction would increase with an increase of surface area and many realised that the temperature would also rise faster. Some mistakenly stated that there would be a bigger temperature rise.

(c) Most candidates knew that oxidation and reduction were related to loss and gain of electrons but many stated the loss (or gain) of the electrons the wrong way round. It was common to state that zinc was reduced and copper oxidised.

(d) (i) The majority of candidates were able to carry out the calculation although some inverted the formula.

(ii) Most candidates realised that there were more moles of copper involved than zinc although there was some confusion over whether this was sufficient to react with the zinc. Several candidates gave the correct reasoning but thought that it was necessary to have equal amounts of copper and zinc. Many recognised that the equation showed a 1:1 ratio of copper to zinc.

Question 12

(a) Few candidates could define the term *respiration*, often confusing this with breathing or photosynthesis. Many referred to the creation or production of energy and of those who referred to the release of energy few related this to glucose being involved in a chemical change.

(b) (i) The majority of candidates confused anaerobic respiration of yeast with that in muscles and gave lactic acid as a product. Often water was given as a reactant.

(ii) The majority of candidates knew that yeast caused the bread to rise and that this was due to production of carbon dioxide.

CO-ORDINATED SCIENCES

Paper 0654/33
Extended Theory

Key messages

When answering questions, candidates should be guided by the amount of credit allocated to each question and use appropriate scientific language and terms. It is beneficial for candidates to check that they are answering the question that has been asked and that their meaning is clear.

Candidates are reminded that version of the Periodic Table as printed on the question paper should be the one used.

General comments

There were many accurate, concise answers to the questions requiring extended explanations. Those candidates were awarded credit for their use of correct scientific language and terminology. There was no evidence that candidates were short of time.

Generally, in calculations, formulae were written using standard symbols, mathematical operations were carried out accurately and working was well presented. A few candidates used too few significant figures and credit could not be awarded where units were omitted or confused.

Comments on specific questions

Question 1

(a) (i) Nearly all candidates were able to identify binary compounds but many did not realise that there were two correct answers and only gave galena.

(ii) Most candidates were able to pick out a tungsten ore but there were some who gave responses which were not from the list given. Iron was a common error of this type.

(b) (i) Many candidates were able to make the logical deduction that the element was germanium following the idea that the number of shells gave the period and the number in the outer shell the group in the Periodic Table. However, a large number tried to work out the total electrons and hence the atomic number to identify the element on the assumption that all shells in this case, with the exception of the inner and outermost shell, had a maximum of 8 electrons. They thus concluded wrongly that the element was titanium.

(ii) Nearly all candidates were able to answer this successfully with almost all showing at least one shared pair of electrons.

(iii) Many candidates were able to produce a fully balanced equation for the reaction and most had correct formulae. Incorrect formulae often came from attempts to balance the equation by changing them rather than the coefficients.

Question 2

(a) Many candidates confused electromagnetic induction with the motor effect and did not realise that the turning of the coil was due to the efforts of the cyclist. Some thought that the magnetism was induced by the movement of the coil. Some who did understand induction referred to the axle rather than the coil. Most candidates understood that the brushes and slip rings provided a complete circuit with the moving coil.

(b) Many candidates did not take into account that the question specified that the explanation should be in terms of movement of molecules and concentrated their answers on the production of sweat. Those who answered in terms of molecular movement scored well.

Question 3

(a) (i) Many candidates were able to describe the optimum pH level but often did not describe the upper and lower limits of activity.

(ii) Most candidates were familiar with the term 'denatured' but were unable to describe what was meant in terms of active site and substrate.

(iii) Most candidates correctly sketched a curve covering a suitable pH range.

(iv) Many candidates realised that sodium hydrogencarbonate would neutralise the acid from the stomach but did not relate this to taking the pH out of the range in which the protease enzyme would operate. Many thought it stopped working because all the food was digested.

(b) Many answers demonstrated a good knowledge of the process of digestion as breakdown of large nutrient molecules to smaller soluble ones.

(c) (i) Most candidates could name capillaries but lacteal proved more elusive with 'vein' being a common incorrect alternative.

(ii) Most answers demonstrated good knowledge of absorption of nutrients in the alimentary canal. Some answers suggested that the villi were being confused with the 'alveoli'.

Question 4

(a) Most candidates demonstrated good knowledge of kinetic theory but were not always able to direct this knowledge to answering the questions.

(i) Many failed to refer to impact of particles on the tyre <u>wall</u> as the cause of the pressure and few referred to this exerting a force.

(ii) Most candidates answered this well with clear reference to increased speed.

(iii) Most understood this in terms of increased collisions but did not always refer to rate of collision or to the tyre wall.

(b) The majority of candidates were able to draw circuit diagrams with correct symbols with connections appropriate to the specification.

(c) Most candidates were able to quote the correct formula and make an appropriate calculation of the mass. There were occasionally incorrect or missing units.

(d) Most candidates recognised that the extra passengers and luggage would make the car heavier although some referred to weight rather than mass. Many linked this to increased energy or momentum but it was also common to refer to increased inertia. Many candidates realised that this would lead to a longer breaking time or distance or the need for more force to be applied. It was a common misconception that the increased mass would increase friction and pressure on the road and therefore slow the car down quicker.

(e) The majority of candidates were able to quote and use the correct formula but there were some who used units derived from the formula rather than standard units of acceleration.

Question 5

(a) (i) Most candidates correctly distinguished between single and multiple bonding although a few mixed up saturated and unsaturated.

(ii) Most candidates knew that bromine was used for this test but in describing a positive result often did not state the initial colour and were unable to gain full credit.

(b) (i) Many candidates understood that there was a trend in the boiling points but many had difficulty in linking this to increasing length of the carbon chain, often using terms such as more bonds or more molecules. When comparing boiling points of alkenes and alkanes, few candidates referred to similar length of carbon chain. Many candidates gave a second answer that was a repeat of the first but referring to alkanes in one and alkenes in the other; some used a reverse argument of the first answer as the second answer.

(ii) Candidates commonly referred to bonds rather than forces and many did not make it clear that these were not bonds between atoms. Many candidates referred to more forces or bonds rather than stronger forces or bonds and most understood that an increase in intermolecular forces led to more energy being required to separate the molecules and hence a higher boiling point. Quite a number of candidates misunderstood the question and attempted to answer in terms of differences between alkanes and alkenes.

Question 6

(a) Most candidates were familiar with the idea of X and Y chromosomes being responsible for sex determination in mammals, correctly linking XX to female and XY to male. However it was common to refer to gametes as having two chromosomes rather than one.

(b) Most candidates could identify the trend shown in the table but many attempted to explain rather than describe the effect and did not illustrate their answers with data from the graph.

(c) The majority of candidates were able to identify the link between hotter sand and more females or *vice versa* and many linked this to the critical temperature. However some candidates repeated data from the table with no explanation and were inclined to concentrate on the numbers of nests rather than the sex ratio of hatchlings.

(d) Most candidates correctly deduced that the female / male balance would be altered and that significant changes would lead to difficulties in breeding.

(e) Many candidates showed a good awareness of the role that trees play in maintaining our environment either through photosynthesis or take up and release of water through transpiration. Candidates who explained the effect of increasing carbon dioxide in the atmosphere gained further credit than those who just referred to the 'greenhouse effect or global warming'.

Question 7

(a) (i) Most candidates drew appropriate lines on the graph and made a correct deduction of the half-life. Some candidates did not simply use half the initial count rate and made their calculation more difficult, whilst others misread the scale as 51 s rather than 55 s.

(ii) Most candidates knew that an alpha particle was a helium nucleus and correctly stated the loss of two neutrons and two protons. A much smaller number were also able to link the loss of protons to the change into a different element.

(iii) Most candidates knew that an alpha particle was positively charged but few explained why this was the case. Some candidates tried to answer in terms of its low penetrating power.

(b) (i) Some candidates realised that the best way to distinguish between the different types of radiation was to state something the radiation would pass through and something that would absorb it. However many candidates referred to only one or the other and gave answers that would have applied to both beta and gamma radiation.

(ii) The majority of candidates linked ionisation correctly to removal of an electron.

(c) Most candidates were able to satisfactorily explain the meaning of wavelength and illustrate this successfully with a diagram. Candidates should be reminded to draw their diagrams carefully and that a good diagram may be awarded full credit.

Question 8

(a) Most candidates understood that, in a compound, atoms of different elements were chemically combined but few realised that, in a mixture of hydrogen and oxygen, the atoms of the same element were combined. Many candidates simply stated that a mixture could be easily separated.

(b) (i)(ii) Most candidates realised that an insoluble solid could be separated from water by filtration and those who correctly identified silicon dioxide in part **(i)** could usually explain the reasons why hexane and sodium chloride could not be separated by this method.

(iii) Many candidates thought this question was about ionic bonding rather than the crystal lattice. Diagrams were often drawn representing a close-packed structure rather than cubic and in many cases the charges on the ions were omitted.

(c) In this question, candidates were asked to describe the main steps that should be taken to obtain copper sulfate crystals from sulfuric acid and copper carbonate given that the latter was insoluble. Many candidates did not realise that an insoluble compound was not suitable for titration and those who added copper carbonate in excess did not say how they would recognise this. Most candidates tended to concentrate on the crystallisation process, often without reacting the two substances.

Question 9

(a) Some candidates did not draw the required label line to the diagram but of those who did, most were able to correctly identify a palisade cell.

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(c) Most candidates were able to draw correctly angled lines through the rectangular block but some showed the lines bending too far and therefore along the normal. Most candidates were able to draw the line entering the triangular block correctly but often it was bent in the wrong direction on exit. Those candidates who attempted to show dispersion in the triangular block often made the mistake of spreading the rays too far and therefore bending some in the wrong direction.

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(a) (i) Many candidates correctly identified experiment **2** as the reaction involving an alkali with a valid reason but some thought sodium hydrogencarbonate was an alkali.

(ii) Most candidates correctly identified experiment **1** as endothermic with a valid reason but there was a tendency to state that it was the lowest temperature rather than a temperature decrease.

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(b) Most candidates knew that the rate of reaction would increase with an increase of surface area and many realised that the temperature would also rise faster. Some mistakenly stated that there would be a bigger temperature rise.

(c) Most candidates knew that oxidation and reduction were related to loss and gain of electrons but many stated the loss (or gain) of the electrons the wrong way round. It was common to state that zinc was reduced and copper oxidised.

(d) (i) The majority of candidates were able to carry out the calculation although some inverted the formula.

(ii) Most candidates realised that there were more moles of copper involved than zinc although there was some confusion over whether this was sufficient to react with the zinc. Several candidates gave the correct reasoning but thought that it was necessary to have equal amounts of copper and zinc. Many recognised that the equation showed a 1:1 ratio of copper to zinc.

Question 12

(a) Few candidates could define the term *respiration*, often confusing this with breathing or photosynthesis. Many referred to the creation or production of energy and of those who referred to the release of energy few related this to glucose being involved in a chemical change.

(b) (i) The majority of candidates confused anaerobic respiration of yeast with that in muscles and gave lactic acid as a product. Often water was given as a reactant.

(ii) The majority of candidates knew that yeast caused the bread to rise and that this was due to production of carbon dioxide.

CO-ORDINATED SCIENCES

Paper 0654/04

Coursework

(a) Nature of the tasks set by Centres.

Most Centres have provided coursework in previous years and have acted on advice given.

Several Centres, including new ones, provided a very comprehensive portfolio of practical exercises. In most Centres, all the tasks set were appropriate to the requirements of the syllabus and to the competence of the candidates. Candidates' work was of a similar standard to previous years.

(b) Teacher's application of assessment criteria.

In the majority of Centres, the assessment criteria were understood and applied well for all of their activities. There has been a steady improvement in the Centres' application of assessment criteria.

(c) Recording of credit and Teacher's annotation.

Following suggestions made encouraging the use of annotation on candidates' scripts, many more Centres are using this technique to indicate or justify credit awarded. There is still scope for further improvement with some Centres writing comprehensive summaries, but not indicating the point at which the credit was awarded. Tick lists remain popular, particularly with skill C1.

(d) Good practice.

Some Centres make very useful comments about individual candidate's performance on a summary sheet. Many Centres have developed a booklet of tasks and dedicated assessment criteria.

CO-ORDINATED SCIENCES

Paper 0654/51

Practical Test

Key Messages

Candidates need to pay close attention to instructions regarding the accuracy of readings, calculations and should use the same number of decimal places for each set of readings.

Centres should always document any difficulties encountered during the practical test.

General comments

There was a good spread of awarded credit on this paper and all credit was accessible.

Judging from some results, it would appear that a small number of Centres had issues in preparing solutions. Centres should always document any difficulties encountered during the practical test. Supervisors are reminded of the importance of their role in providing a good set of results and observations as well as reporting difficulties with apparatus and chemicals.

Comments on specific questions

Question 1

Most candidates started strongly by gaining full credit in part **(a)**.

Around half could give a reason why the leaves were placed in boiling water. In part **(b)(ii)**, the most common omission was 'photosynthesis' and the most common error was to repeat the conclusions from Table 1.1 rather than to state that 'starch had been produced' as a result of photosynthesis. There were a significant number of imprecise discussions.

In part **(c)**, most appreciated the reason for the bung in the test-tube but fewer could suggest a reason for the experiment in test-tube **E**. Generally the colours of the indicator in test-tubes **C** and **D** in **(c)(iii)** were not well explained and many candidates simply repeated the stem of the question. Very few chose to use 'respiration' in the answer to explain the colour of the indicator in test-tube **D**.

Question 2

Generally candidates did well with reading I and V and calculating R. Some candidates need practice in reading meters since some impossibly high and low values were recorded. Some candidates used different numbers of decimal places within a column. If 2 decimal places have been chosen then 0.2 should be written as 0.20 although this was not necessarily penalised in this paper.

For the graph, most candidates plotted points accurately, included the origin and had sensible scales. There were a small number of candidates who did not draw the best fit line and this is an area for improvement. Most candidates were familiar with gradients and most showed their working. Too many candidates worked from a very small triangle and they should be made aware that errors in reading the scales will have a smaller effect on the value of the gradient if a large triangle is used.

The cross-sectional area was usually calculated correctly. However, most candidates did not convert their answer to square metres, often using a factor of 100 instead of 10 000 and then often multiplying by 100 rather than dividing.

The last part of the question was answered correctly by about half of the candidates.

Question 3

Most candidates observed and recorded a green residue. Candidates who describe a colourless solution as clear, cannot be awarded credit; a coloured solution will probably be clear (transparent) also. For part **(a)(ii)**, most candidates described seeing bubbles and correctly concluded the presence of the carbonate ion, however the green solution was rarely recorded. The copper hydroxide precipitate in part **(a)(iii)** was usually observed and identified; though many did not use the word 'precipitate' so could only gain partial credit.

In part **(b)(i)**, the responses 'milky' and 'cloudy white' were not accepted as alternatives for 'precipitate'; nevertheless many candidates scored full credit.

The following two parts had negative results which many candidates were not expecting and consequently gave positive observations when this was not the case. A number of candidates did recognise that there was no sulfate present, however very few concluded that there was no ammonium present. As well as not expecting negative results, some candidates must have placed the litmus paper either in the liquid or at the very least in the spray from an overheated test-tube which would have caused the litmus to turn blue. Candidates must expect some tests to have negative results thereby indicating the absence of a particular ion.

CO-ORDINATED SCIENCES

Paper 0654/52

Practical Test

Key Messages

Candidates need to pay close attention to instructions regarding the accuracy of readings, calculations and should use the same number of decimal places for each set of readings.

Centres should always document any difficulties encountered during the practical test.

General comments

There was a good spread of awarded credit and all credit proved to be accessible.

Judging from some results, it would appear that a small number of Centres had issues in preparing solutions. Supervisors are reminded of the importance of their role in providing a good set of results and observations as well as reporting difficulties with apparatus and chemicals.

Comments on specific questions

Question 1

Many candidates did not record the times in seconds as instructed in part **(a)**.

In part **(b)**, stronger candidates gained full credit whilst most usually appreciated that the pH fell below 8.

A significant number knew the action of bile and gained full credit in part **(c)**. Some answered wrongly in terms of a catalyst increasing the rate of digestion.

In part **(d)**, the majority referred to temperature as a source of error but did not qualify this; the reason for performing the experiment within certain limits of temperature was well known.

The large majority were familiar with the tests in part **(e)** and it was not unusual for full credit to be awarded. Please note that the response 'no change' should not be used when a colour has been requested.

Question 2

Most candidates scored well in this question. A significant number of candidates did not record their results to the number of decimal places specified or to the appropriate accuracy. A small number thought that density = mass × volume. The majority appreciated when method 1 would not be suitable for finding density in part **(a)(vi)**.

Although the credit in parts **(b)(i)**, **(ii)** and **(iii)** could be easily obtained, often the volumes were read poorly; candidates who took care over readings often went on to gain credit in part **(b)(iv)**.

For part **(c)**, few candidates appeared to appreciate that the rule was more accurate and of those who made any comment, very few contrasted it with reading a measuring cylinder.

Question 3

The majority appeared to have no difficulty in performing the experiment although a few seemed to find that the temperatures just reduced. A small number had unexpected starting temperatures, e.g. zero, and many did not enter the readings to the nearest half degree as instructed (meaning that temperature readings should end with .0 or .5). In **part (a)(iii)**, most candidates gained at least partial credit as a relatively large range of colours was accepted.

Graph plotting was generally very good; however the phrase 'smooth curve through the points' was often overlooked or misinterpreted. It was expected that a best fit smooth curve with one maximum would be drawn, not necessarily passing though every point.

Parts **(b)(ii)** and **(iii)** were well answered although some candidates used Table 3.1 rather than the graph to find the maximum temperature rise.

Part **(c)** was generally well answered with most candidates opting for a lid.

CO-ORDINATED SCIENCES

Paper 0654/53

Practical Test

Key Messages

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General comments

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Judging from some results, it would appear that a small number of Centres had issues in preparing solutions. Centres should always document any difficulties encountered during the practical test. Supervisors are reminded of the importance of their role in providing a good set of results and observations as well as reporting difficulties with apparatus and chemicals.

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Most candidates started strongly by gaining full credit in part **(a)**.

Around half could give a reason why the leaves were placed in boiling water. In part **(b)(ii)**, the most common omission was 'photosynthesis' and the most common error was to repeat the conclusions from Table 1.1 rather than to state that 'starch had been produced' as a result of photosynthesis. There were a significant number of imprecise discussions.

In part **(c)**, most appreciated the reason for the bung in the test-tube but fewer could suggest a reason for the experiment in test-tube **E**. Generally the colours of the indicator in test-tubes **C** and **D** in **(c)(iii)** were not well explained and many candidates simply repeated the stem of the question. Very few chose to use 'respiration' in the answer to explain the colour of the indicator in test-tube **D**.

Question 2

Generally candidates did well with reading I and V and calculating R. Some candidates need practice in reading meters since some impossibly high and low values were recorded. Some candidates used different numbers of decimal places within a column. If 2 decimal places have been chosen then 0.2 should be written as 0.20 although this was not necessarily penalised in this paper.

For the graph, most candidates plotted points accurately, included the origin and had sensible scales. There were a small number of candidates who did not draw the best fit line and this is an area for improvement. Most candidates were familiar with gradients and most showed their working. Too many candidates worked from a very small triangle and they should be made aware that errors in reading the scales will have a smaller effect on the value of the gradient if a large triangle is used.

The cross-sectional area was usually calculated correctly. However, most candidates did not convert their answer to square metres, often using a factor of 100 instead of 10 000 and then often multiplying by 100 rather than dividing.

The last part of the question was answered correctly by about half of the candidates.

Question 3

Most candidates observed and recorded a green residue. Candidates who describe a colourless solution as clear, cannot be awarded credit; a coloured solution will probably be clear (transparent) also. For part **(a)(ii)**, most candidates described seeing bubbles and correctly concluded the presence of the carbonate ion, however the green solution was rarely recorded. The copper hydroxide precipitate in part **(a)(iii)** was usually observed and identified; though many did not use the word 'precipitate' so could only gain partial credit.

In part **(b)(i)**, the responses 'milky' and 'cloudy white' were not accepted as alternatives for 'precipitate'; nevertheless many candidates scored full credit.

The following two parts had negative results which many candidates were not expecting and consequently gave positive observations when this was not the case. A number of candidates did recognise that there was no sulfate present, however very few concluded that there was no ammonium present. As well as not expecting negative results, some candidates must have placed the litmus paper either in the liquid or at the very least in the spray from an overheated test-tube which would have caused the litmus to turn blue. Candidates must expect some tests to have negative results thereby indicating the absence of a particular ion.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key Messages

Candidates need to have a good knowledge of chemical analysis and the practical aspects of all three sciences in order to do well in this paper.

Candidates should be reminded to use the same of significant figures as that of the question unless they are instructed otherwise.

General comments

There were many scripts from good candidates who have thoroughly grasped the practical aspects of the three sciences that make up the syllabus. These candidates are a credit to the Centres who entered them for this examination.

Some candidates from some Centres need to demonstrate a better understanding of chemical analysis.

A common problem is the incorrect rounding of numerical answers and answers given to the incorrect number of significant figures. In general, Examiners expect candidates to give answers to the same number of significant figures as appear in the question, rounded correctly if required. A calculator answer of, for example, 2.606 should be written as 2.61 and not 2.60 if three significant figures are required.

An alternative to practical paper will have a number of diagrams with scales on, and candidates who are unable to interpret them correctly are at a disadvantage.

Comments on specific questions

Question 1

This question concerned two leaves, with one de-starched by being stored in the dark for 24 hours.

(a) (i) Most candidates realised the green substance dissolved in the alcohol was chlorophyll.

(ii) Many candidates were unaware of the colours of iodine and others thought that iodine tested for glucose. A number tried to write a sentence in the conclusion box referring to photosynthesis; this was not required as the conclusion required only reference to the test in question, i.e. starch being present or absent.

(b) (i) Almost all candidates were able to read the measuring cylinders correctly, although a few were still reading them in the wrong direction, e.g. 28 cm^3 rather than 12 cm^3.

(ii) Again, almost all candidates identified oxygen as the gas that relit a glowing splint.

(ii) Tube **F** had been kept in the dark for 48 hours, and the gas did not relight a glowing splint. Many candidates realised that the gas must be carbon dioxide, produced by respiration. However a minority thought it was hydrogen, and others thought the process was still photosynthesis.

Question 2

Candidates were expected to find the cross-sectional area of a resistance wire, with a diagram showing how the apparatus was set up.

(a) (i)(ii) Candidates were asked to read voltmeter and ammeter dials and record the values in a table. All other values in the table were given to two decimal places and candidates were expected to follow the example. Some gave the voltmeter reading as 2.225, suggesting accuracy above the tolerance of the meter. Values of 2.22 or 2.23 were expected and credited. Candidates were given the formula to calculate the resistance of the lengths of wires, and again answers to two decimal places, correctly rounded, were credited.

(b) (i) Candidates had to plot a graph of their values for resistance against length of wire. In this case, a grid was provided with the axes already printed. Almost every candidate plotted their points accurately and drew in a line of best fit, although some failed to follow the instruction that the line should pass through the origin, and others failed to use a ruler. Candidates should be reminded to follow the instructions given.

(ii) While many candidates correctly calculated a gradient, a significant number did not indicate on the graph the values they used or how they did this. The clearest way of doing this is with a 'triangle' under the line, but any *clear* and unambiguous method is acceptable and creditworthy.

(iii) The cross-sectional area could be worked out using the formula provided. A value in the region of 0.0004 was expected, depending on the gradient. Some candidates gave an incorrect number of zeroes in their answer.

(iv) Candidates had to predict that the resistance would decrease if the wire had a greater cross-sectional area.

Question 3

The candidates worked through a series of tests in order to identify a mixture containing two cations and two anions.

The question demanded a working knowledge of practical chemistry rather than the reproduction of facts and there were some good answers given by candidates.

Candidates should be reminded that unless the formula is asked for, a name will gain credit; however an incorrect formula, even if the name is correct, will not be credited.

(a) (i) Following the addition of hydrochloric acid, carbon dioxide is evolved. Candidates were asked to give the test and result to prove the gases identity. Many candidates were able to correctly state that limewater turns milky. However, fewer candidates were able to give the anion that must be present. Some, correctly stated carbonate, but were not credited as they had given an incorrect formula, usually CO_3^-.

(ii) Candidates then had to identify the cation responsible for the blue precipitate produced when aqueous sodium hydroxide was added to the residue left from the above test. Only a small minority correctly identified the copper ion, many giving either zinc or iron.

(b) (i) The filtrate from previous tests was now tested, with the candidates being asked for a sulfate test. Few candidates knew the reagent barium chloride (or nitrate) as the test for sulfate ions, and that the result would have been no precipitate formed. Some candidates stated that a white precipitate *would* be produced, indicating that they had not read the question fully.

(ii) A second sample of the filtrate was tested with acidified silver nitrate. A number of candidates correctly identified the chloride ion, but a number suggested it was chlori**ne** or gave an incorrect formula.

(iii) Aqueous sodium hydroxide was added to the final sample of the filtrate produced above, no precipitate was formed. After warming gently, a piece of damp red litmus paper showed no change when held over the mouth of the test-tube. This should have led candidates to the conclusion that

the ammonium ion was not present. Common incorrect answers were 'ammonia' and / or an incorrect formula.

(c) Candidates had to suggest a possible second cation using the information above. They should have noted that only ammonium, potassium or sodium ions fail to give a precipitate with aqueous sodium hydroxide. The ammonium ion has already been discounted, so either of the other two was an acceptable answer.

Question 4

Oscilloscope traces were used to investigate how exercise affects breathing rates.

(a) The three sections of this part required candidates to use a diagram of an oscilloscope trace to find out the volume of air inhaled in one breath (0.5 dm^3), the number of breaths in one minute (12) and therefore the total volume inhaled in one minute (6 dm^3). This was successfully achieved by most candidates, but a common answer in part **(a) (i)** was 0.45 dm^3 suggesting that the graph scales had been misinterpreted.

(b) (i) A second trace was provided showing the readings of a candidates breathing pattern after exercise. Candidates were required to describe two differences between this trace and the original. Some candidates, however, only described this second trace without reference to the first trace.

(ii) Most candidates were able to give the volume of the first breath as 1.6 dm^3.

(iii) Candidates were asked to explain why this volume was different to the resting value. Many candidates answered that 'more air' was required; this answer was insufficient as oxygen had to be named. Few candidates mentioned the need to remove the increased volume of carbon dioxide, although a number referred to 'oxygen debt' and gained credit.

(c) Candidates had to give reasons why it would be undesirable to breathe in the exhaled air. Many candidates answered that the exhaled air would *only* contain carbon dioxide and no oxygen; these answers were not creditworthy. Candidates who stated that the exhaled air had 'an increased proportion of carbon dioxide and a reduced amount of oxygen' gained full credit. Candidates who said that there would be 'too much carbon dioxide and not enough oxygen' were given credit.

Question 5

This question was based on the expansions of different metals.

While many candidates scored well on this question, a significant number did not gain credit because they had not read the information carefully enough.

(a) Candidates had three different figures to study and complete a table using them. Almost all candidates correctly completed the first column giving the original lengths of the metals, but there were many errors in the second column, where candidates had to read the increase in length from the scales in the three figures. Some candidates gave the new, expanded length of the metal, but as they were clearly asked for the increase in length, these answers were not awarded credit.

(b)(i) Candidates were given the formula to calculate the coefficient of thermal expansion. Many calculated correctly, but some, having not read all the information provided, failed to use the correct temperature rise of 100 °C.

(ii) Candidates were asked to state the unit for the coefficient ($°C^{-1}$). A significant number of more able candidates were able to work this out.

(iii) Using their calculated values, candidates had to select which of the metals would expand the least. Some candidates misunderstood the number of zeros after the decimal point and gave an incorrect answer.

(c) Candidates were then required to suggest where, in everyday life, expansion of metals is useful and where it is a problem, Examiners were expecting to see real-life cases. The use of expansion in thermostats, fire alarms and thermometers were some of the expected answers for the former

and the buckling of railway tracks or the need to leave expansion gaps in bridges for the latter. General responses such as 'railways' were not creditworthy.

Question 6

In this question candidates had to determine which of two household cleaners would be the best for removing fat.

(a) (i) Universal Indicator was used to follow the neutralisation of the alkali and candidates were asked for the colour change. Therefore two colours were required; the colour changes from blue / purple to green. A number of candidates gave a single colour and many gave wrong colours.

(ii) Candidates were supplied with titration figures for the first cleaner and were required to calculate the volume of acid added in two titrations and then the average. Although this caused few problems to the majority of candidates, a significant minority did not correctly complete this section.

(iii) To calculate the concentration of the first cleaner, candidates had to divide their average (whether it was a correct figure or a reasonable answer if an error had been made) by 25. Most were able to do this.

(b) (i)(ii) Candidates had to do a similar exercise with the second cleaner. This gave similar results as in the previous section.

(c) The second cleaner candidates had to consider a dilution factor. Many candidates were able to calculate this using their answer to part **(b) (ii)**. Some however, used an incorrect figure in their calculation (usually 25).

(d) Candidates had to select the cleaner that would be more effective at removing fat and explain why. The best answers selected the first cleaner, stating that 'it was the most concentrated'.

(e) Finally, candidates had to provide a balanced symbol equation for the reaction, having been given a word equation. A large number of candidates gave the symbol for sodium as S and did not correctly write H_2O for water.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key Messages

Candidates need to have a good knowledge of chemical analysis and the practical aspects of all three sciences in order to do well in this paper.
Candidates should be reminded to use the same of significant figures as that of the question unless they are instructed otherwise.

General comments

There were many scripts from good candidates who have thoroughly grasped the practical aspects of the three sciences that make up the syllabus. These candidates are a credit to the Centres who entered them for this examination.

Some candidates from some Centres showed poor knowledge of chemical analysis.

A common problem is the incorrect rounding of numerical answers and answers given to the incorrect number of significant figures. In general, Examiners expect candidates to give answers to the same number of significant figures as appear in the question, rounded correctly if required. A calculator answer of, for example, 2.606 should be written as 2.61 and not 2.60 if three significant figures are required.

An alternative to practical paper will have a number of diagrams with scales on, and candidates who are unable to interpret them correctly are at a disadvantage.

Comments on specific questions

Question 1

This question concerned the digestion of fat in milk by the enzyme lipase.

(a) (i) Almost all correctly stated 37 °C and most gave the correct reason for this temperature, i.e. body temperature. Other descriptions such as 'optimum temperature' were credited, but not 'normal or room temperature'.

(ii) A number of candidates wrote the times as 3:25, 3:37 and 3:05 rather than 205, 217 and 185. Candidates should be reminded that credit is not awarded for simply copying data from one place to another.

(iii) Almost all candidates were able to calculate a correct average of 202 seconds, even some of those that had incorrectly given the answer in minutes in part **(a) (i)** converted their answer to seconds.

(b) A lot of information was given about what was happening in the reaction. Candidates had to use this information to 'Explain why the mixture in the tubes turned from pink to colourless.' The answer could be extracted from the information given. Some answers suggested that candidates had not read this and did not gain credit.

(c) Some candidates incorrectly stated it was for the lipase to warm up. Answers referring to it being body temperature did not gain credit. Examiners were looking for the need for the contents reaching the temperature (reaching body temperature was credited) or that all the tubes were the same temperature.

(d) Candidates could have approached this in two ways, proving lipase is an enzyme, or proving it breaks down fat. Both approaches however are small refinements on the experiment in the question, for the former, the lipase should be boiled or denatured in some way and the pink colour would not change. For the latter the experiment should be repeated with another type of fat and then the indicator would change as before.

Question 2

Candidates had to find the density of a piece of plastic pipe.

(a) Candidates had to read a balance window and record the mass to the nearest 0.1 g. A number of candidates did not follow instructions and gave an answer of 13.69 g rather than 13.7 g.

(b) (i) The pipe was drawn 'life size' and candidates were instructed to use a ruler to measure and record their values of the length, external diameter and internal diameter. These dimensions were indicated on the diagrams and most candidates were able to do this accurately.

(ii) Candidates had to use their answers above to work out a value for **k**. The formula was given and candidates had to square their values of the external and internal diameters. Most correctly calculated this value gaining credit.

(iii) Another formula was given to candidates to calculate the volume of the pipe, again most candidates were successful.

(c) Candidates were asked to calculate the density of the pipe. They had already read the mass of the pipe in part **(a)** and had just calculated the volume. This time no formula was given and candidates had to show that they correctly used $\frac{\text{mass}}{\text{volume}}$.

Question 3

This question was about the production of heat produced when two chemicals reacted together.

(a) A table of results was provided with three gaps to be filled in by the candidate from three diagrams of thermometers. The first thermometer showed 20 °C exactly and in keeping with every other result in the table should have been shown to one decimal place, i.e. 20.0 °C.

(b) (i) A grid was provided and candidates were asked to plot the values. A total of 15 plots had to made, most of them were only 1 or 1.5 °C less than the one before, therefore any incorrect plots should have stood out and been corrected. Most candidates plotted correctly but failed to label the axes with the variable or the unit. Candidates were instructed to draw a smooth curve between the points. Examiners are aware that this can be challenging, however straight lines or right angle turns were penalised and a maximum between the second and third points was also expected.

(ii) Candidates had to find the maximum temperature rise in the reaction. This was not the highest point of the graph, as the temperature at the start was 20.0 °C. Many candidates missed this. Candidates who failed to show a maximum in part **(i)** were not penalised a second time.

(iii) The energy given out by the reaction could now be calculated using the formula provided. This required candidates reading the information given at the start of the question to find the volume of solution **B**. Those that entered an incorrect volume were awarded no credit.

Question 4

This question was testing the theory that caffeine speeds up heart rate and candidates were given a set of results to evaluate.

(a) (i) Candidates were required to complete the table by converting the figures into beats per minute; that is, multiplying the values by 2.

(ii) A grid was provided for candidates to draw a graph. A maximum should have been drawn here as well, but to ensure that candidates were not penalised twice for the same error, Examiners accepted a curve that did not significantly rise above 90 beats per minute.

(iii) Most candidates were able to give a maximum time, but some gave a range.

(b) (i) Almost all candidates realised that exercise would cause the heart rate to increase and so it should be avoided during this experiment.

(ii) Two quantities that should be kept constant if the experiment is to be reliably repeated are the volume and concentration of coffee. Many gave the inexact term "amount"; this was given partial credit if neither of the expected answers were present.

(iii) Candidates were asked to describe a way in which a more accurate value for the maximum rate of heart beat could be obtained. The available data told the candidates the value was somewhere above 90 beats per minute at sometime between 15 and 20 minutes. Therefore more readings are required between these times, readings being taken every minute or two minutes rather than the present every five minutes. Many candidates thought that using some sort of "machine" should be used, this may gave a more accurate value for beats per minute, but unless the readings are taken closer together it does not help.

Question 5

This question found the speed of sound, using an echo, and compared an empirical value with the actual value obtained.

(a) (i) Candidates had to use their rulers to measure a distance marked on the paper representing the distance from the girl to a wall, this value was exactly 9 cm.

(ii) Many candidates gave the answer 270 m rather than the expected 540 m as they forgot the return journey.

(iii) A table of five times was shown for five different experiments. The last time was much longer than the others, candidates were asked to suggest a reason for this. Simple answers such as 'timing error' or 'experimental error' were not awarded credit. Examiners were looking for a possible reason such as 'she was not paying attention' or 'she was distracted'.

(iv) A number of candidates used all five values and were not given credit.

(v) An answer of 307 m/s was expected from candidates if their previous calculations were correct.

(vi) Candidates were told that the actual speed of sound in air is 343 m/s and were asked to comment on the accuracy of their value. Simple answers such as 'My answer is not very accurate' with no reason did not gain credit.

(b) Answers referring to molecules or particles being closer together were expected and most candidates realised this.

Question 6

(a) Most candidates correctly gave the test for hydrogen. It pops with a lighted splint. Candidates gained no credit for the use of a glowing splint or an unlit splint.

(b) (i) Many candidates correctly suggested that the hydrogen produced by the reaction floated the magnesium to the surface. Despite being told that magnesium is more dense than the acid, some suggested it wore away and became lighter.

(ii) The answer expected from candidates was that copper was chosen because it does not react with the acid.

(c) Examiners were expecting candidates to note that hydrogen was produced more rapidly in graph **A**. Many candidates were correct, but some stated that more hydrogen was given off, yet the volume of hydrogen given off was the same in both experiments. Many more able candidates were able to suggest that the copper acts as a catalyst for the reaction.

(d) An observation to show that magnesium was in excess would be some solid left in the beaker at the end of the reaction. This is not, however, a precipitate.

(e) Candidates were asked to draw a third line on the graph to show how the reaction between magnesium and ethanoic acid would proceed. A line drawn below the previous curves, but finishing at the same level was expected.

(f) Candidates had to complete a diagram to show a method of collection and measuring the gas evolved that did not involve the displacement of water. A delivery tube to a syringe was expected. Few diagrams given by candidates were air tight and some showed the use of incorrect apparatus.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key Messages

Candidates need to have a good knowledge of chemical analysis and the practical aspects of all three sciences in order to do well in this paper.

Candidates should be reminded to use the same of significant figures as that of the question unless they are instructed otherwise.

General comments

There were many scripts from good candidates who have thoroughly grasped the practical aspects of the three sciences that make up the syllabus. These candidates are a credit to the Centres who entered them for this examination.

Some candidates from some Centres need to demonstrate a better understanding of chemical analysis.

A common problem is the incorrect rounding of numerical answers and answers given to the incorrect number of significant figures. In general, Examiners expect candidates to give answers to the same number of significant figures as appear in the question, rounded correctly if required. A calculator answer of, for example, 2.606 should be written as 2.61 and not 2.60 if three significant figures are required.

An alternative to practical paper will have a number of diagrams with scales on, and candidates who are unable to interpret them correctly are at a disadvantage.

Comments on specific questions

Question 1

This question concerned two leaves, with one de-starched by being stored in the dark for 24 hours.

(a) (i) Most candidates realised the green substance dissolved in the alcohol was chlorophyll.

(ii) Many candidates were unaware of the colours of iodine and others thought that iodine tested for glucose. A number tried to write a sentence in the conclusion box referring to photosynthesis; this was not required as the conclusion required only reference to the test in question, i.e. starch being present or absent.

(b) (i) Almost all candidates were able to read the measuring cylinders correctly, although a few were still reading them in the wrong direction, e.g. 28 cm^3 rather than 12 cm^3.

(ii) Again, almost all candidates identified oxygen as the gas that relit a glowing splint.

(ii) Tube **F** had been kept in the dark for 48 hours, and the gas did not relight a glowing splint. Many candidates realised that the gas must be carbon dioxide, produced by respiration. However a minority thought it was hydrogen, and others thought the process was still photosynthesis.

Question 2

Candidates were expected to find the cross-sectional area of a resistance wire, with a diagram showing how the apparatus was set up.

(a) (i)(ii) Candidates were asked to read voltmeter and ammeter dials and record the values in a table. All other values in the table were given to two decimal places and candidates were expected to follow the example. Some gave the voltmeter reading as 2.225, suggesting accuracy above the tolerance of the meter. Values of 2.22 or 2.23 were expected and credited. Candidates were given the formula to calculate the resistance of the lengths of wires, and again answers to two decimal places, correctly rounded, were credited.

(b) (i) Candidates had to plot a graph of their values for resistance against length of wire. In this case, a grid was provided with the axes already printed. Almost every candidate plotted their points accurately and drew in a line of best fit, although some failed to follow the instruction that the line should pass through the origin, and others failed to use a ruler. Candidates should be reminded to follow the instructions given.

(ii) While many candidates correctly calculated a gradient, a significant number did not indicate on the graph the values they used or how they did this. The clearest way of doing this is with a 'triangle' under the line, but any *clear* and unambiguous method is acceptable and creditworthy.

(iii) The cross-sectional area could be worked out using the formula provided. A value in the region of 0.0004 was expected, depending on the gradient. Some candidates gave an incorrect number of zeroes in their answer.

(iv) Candidates had to predict that the resistance would decrease if the wire had a greater cross-sectional area.

Question 3

The candidates worked through a series of tests in order to identify a mixture containing two cations and two anions.

The question demanded a working knowledge of practical chemistry rather than the reproduction of facts and there were some good answers given by candidates.

Candidates should be reminded that unless the formula is asked for, a name will gain credit; however an incorrect formula, even if the name is correct, will not be credited.

(a) (i) Following the addition of hydrochloric acid, carbon dioxide is evolved. Candidates were asked to give the test and result to prove the gases identity. Many candidates were able to correctly state that limewater turns milky. However, fewer candidates were able to give the anion that must be present. Some, correctly stated carbonate, but were not credited as they had given an incorrect formula, usually CO_3^-.

(ii) Candidates then had to identify the cation responsible for the blue precipitate produced when aqueous sodium hydroxide was added to the residue left from the above test. Only a small minority correctly identified the copper ion, many giving either zinc or iron.

(b) (i) The filtrate from previous tests was now tested, with the candidates being asked for a sulfate test. Few candidates knew the reagent barium chloride (or nitrate) as the test for sulfate ions, and that the result would have been no precipitate formed. Some candidates stated that a white precipitate *would* be produced, indicating that they had not read the question fully.

(ii) A second sample of the filtrate was tested with acidified silver nitrate. A number of candidates correctly identified the chloride ion, but a number suggested it was chlori**ne** or gave an incorrect formula.

(iii) Aqueous sodium hydroxide was added to the final sample of the filtrate produced above, no precipitate was formed. After warming gently, a piece of damp red litmus paper showed no change when held over the mouth of the test-tube. This should have led candidates to the conclusion that

the ammonium ion was not present. Common incorrect answers were 'ammonia' and / or an incorrect formula.

(c) Candidates had to suggest a possible second cation using the information above. They should have noted that only ammonium, potassium or sodium ions fail to give a precipitate with aqueous sodium hydroxide. The ammonium ion has already been discounted, so either of the other two was an acceptable answer.

Question 4

Oscilloscope traces were used to investigate how exercise affects breathing rates.

(a) The three sections of this part required candidates to use a diagram of an oscilloscope trace to find out the volume of air inhaled in one breath (0.5 dm^3), the number of breaths in one minute (12) and therefore the total volume inhaled in one minute (6 dm^3). This was successfully achieved by most candidates, but a common answer in part **(a) (i)** was 0.45 dm^3 suggesting that the graph scales had been misinterpreted.

(b) (i) A second trace was provided showing the readings of a candidates breathing pattern after exercise. Candidates were required to describe two differences between this trace and the original. Some candidates, however, only described this second trace without reference to the first trace.

(ii) Most candidates were able to give the volume of the first breath as 1.6 dm^3.

(iii) Candidates were asked to explain why this volume was different to the resting value. Many candidates answered that 'more air' was required; this answer was insufficient as oxygen had to be named. Few candidates mentioned the need to remove the increased volume of carbon dioxide, although a number referred to 'oxygen debt' and gained credit.

(c) Candidates had to give reasons why it would be undesirable to breathe in the exhaled air. Many candidates answered that the exhaled air would *only* contain carbon dioxide and no oxygen; these answers were not creditworthy. Candidates who stated that the exhaled air had 'an increased proportion of carbon dioxide and a reduced amount of oxygen' gained full credit. Candidates who said that there would be 'too much carbon dioxide and not enough oxygen' were given credit.

Question 5

This question was based on the expansions of different metals.

While many candidates scored well on this question, a significant number did not gain credit because they had not read the information carefully enough.

(a) Candidates had three different figures to study and complete a table using them. Almost all candidates correctly completed the first column giving the original lengths of the metals, but there were many errors in the second column, where candidates had to read the increase in length from the scales in the three figures. Some candidates gave the new, expanded length of the metal, but as they were clearly asked for the increase in length, these answers were not awarded credit.

(b)(i) Candidates were given the formula to calculate the coefficient of thermal expansion. Many calculated correctly, but some, having not read all the information provided, failed to use the correct temperature rise of 100 °C.

(ii) Candidates were asked to state the unit for the coefficient ($°C^{-1}$). A significant number of more able candidates were able to work this out.

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(c) Candidates were then required to suggest where, in everyday life, expansion of metals is useful and where it is a problem, Examiners were expecting to see real-life cases. The use of expansion in thermostats, fire alarms and thermometers were some of the expected answers for the former

and the buckling of railway tracks or the need to leave expansion gaps in bridges for the latter. General responses such as 'railways' were not creditworthy.

Question 6

In this question candidates had to determine which of two household cleaners would be the best for removing fat.

(a) (i) Universal Indicator was used to follow the neutralisation of the alkali and candidates were asked for the colour change. Therefore two colours were required; the colour changes from blue / purple to green. A number of candidates gave a single colour and many gave wrong colours.

(ii) Candidates were supplied with titration figures for the first cleaner and were required to calculate the volume of acid added in two titrations and then the average. Although this caused few problems to the majority of candidates, a significant minority did not correctly complete this section.

(iii) To calculate the concentration of the first cleaner, candidates had to divide their average (whether it was a correct figure or a reasonable answer if an error had been made) by 25. Most were able to do this.

(b) (i)(ii) Candidates had to do a similar exercise with the second cleaner. This gave similar results as in the previous section.

(c) The second cleaner candidates had to consider a dilution factor. Many candidates were able to calculate this using their answer to part **(b) (ii)**. Some however, used an incorrect figure in their calculation (usually 25).

(d) Candidates had to select the cleaner that would be more effective at removing fat and explain why. The best answers selected the first cleaner, stating that 'it was the most concentrated'.

(e) Finally, candidates had to provide a balanced symbol equation for the reaction, having been given a word equation. A large number of candidates gave the symbol for sodium as S and did not correctly write H_2O for water.