CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

Comments on specific questions (Biology)

The biology questions were well answered by most candidates. **Questions 3**, **4**, **6** and **9** were found to be difficult by many candidates. Candidates found **Question 13** very easy to answer correctly.

Comments on specific questions

Question 1

This question was competently answered by most candidates, but a few candidates, appeared to believe that fish have lungs.

Question 3

There is a misconception about the concepts of solubility and diffusion, and some candidates believe that starch is a substance that can be transported around an organism.

Question 4

The flow of blood through the heart and the type of blood vessels in which it flows is a section of the that many candidates have difficulties. It appeared that most of the candidates who did not select the c response confused arteries with veins.

Question 6

Some candidates did not know the food tests and found this question difficult.

Question 9

A significant number of candidates did not appreciate that it is 'substances in solution' that pass across the placenta, not blood.

Question 13

This question was answered correctly by almost all candidates and indicates that candidates have an awareness of food chains, food webs and, more generally, of ecological issues.

Comments on specific questions (Chemistry)

Candidates performed reasonably well on the chemistry section of this paper.

Questions 14, 16 and **24** proved particularly straightforward with most candidates selecting the correct answer.

Questions 15, 23 and **25** proved to be the most difficult.

Comments on specific questions

Question 19

Candidates realised anode and cathode were wrong but chose option **C** rather than the correct option **D**.

Question 20

Candidates knew that an aqueous solution was needed but chose the wrong electrode (option **B**) rather than correct option **A**.

Question 22

Candidates knew the reaction was exothermic but confused a decrease in acidity with a decrease in pH.

Question 23

Candidates did not realise or had forgotten that aluminium is added along with sodium hydroxide in this test incorrectly choosing option **D**.

Question 25

The incorrect option **D** was more popular than the correct option **A**. Candidates appeared not to know that smoke is a colloid and what cellulose is.

Question 27.

Candidates simply looked for an element three columns in choosing option **C**. They did not realise that Group **3** is on the other side of the transition elements.

Comments on specific questions (Physics)

General comments

Physics questions that candidates found difficult were **29**, **30** (particularly difficult), **32**, **33**, **34**, **37**, **38**, **39** and **40** (particularly difficult).

Comments on specific questions

Question 28

This concerned taking measurements to find density, and a significant number of candidates chose option **C**, not including a means of measuring mass.

Question 29

Candidates had to identify an average value from ten readings, but almost half of the candidates chose option **C**, this being the value which appeared most frequently.

Question 30

There appears to be widespread confusion over pressure calculations, and all options were chosen.

Question 32

A significant minority of candidates believed green to be a secondary colour of light.

Question 36

Many chose option **A**, believing that cathode rays were emitted by the anode; candidates need to be aware that the hot filament is also the anode in a directly-heated cathode ray tube such as the one shown.

Question 38

This question dealt with nuclear power and was generally tackled well, the most common error being to understand the process of nuclear fusion, but to link it to a nuclear power station.

Question 39

A significant minority of candidates knew that transformers were used in an electrical transmission system, but believed that they worked with direct current.

Question 40

The wide range of responses indicated widespread lack of knowledge of the function of a reed relay; most opted for a transformer as the component required.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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1	**D**	21	**D**
2	**D**	22	**B**
3	**A**	23	**A**
4	**B**	24	**D**
5	**A**	25	**D**
6	**A**	26	**B**
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8	**B**	28	**D**
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17	**C**	37	**B**
18	**B**	38	**A**
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Comments on specific questions (Biology)

The biology questions were well answered by most candidates. **Questions 3**, **4**, **7** and **13** were found to be difficult by many candidates. Candidates found **Question 10** very easy to answer correctly.

Comments on specific questions

Question 2

This question was competently answered by most candidates, but a few candidates, appeared to believe that fish have lungs.

Question 3

There is a misconception about the concepts of solubility and diffusion, and some candidates believe that starch is a substance that can be transported around an organism.

Question 7

Some candidates did not know the food tests and found this question difficult.

Question 8

The flow of blood through the heart and the type of blood vessels in which it flows is a section of the syllabus that many candidates have difficulties. It appeared that most of the candidates who did not select the correct response confused arteries with veins.

Question 10

This question was answered correctly by almost all candidates and indicates that candidates have an awareness of food chains, food webs and, more generally, of ecological issues.

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CO-ORDINATED SCIENCES

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CO-ORDINATED SCIENCES

Paper 0654/21

Core Theory

Key message

Candidates should be guided by the number of marks allocated to each question. It is often beneficial for a candidate to read again through their answer to make sure that the meaning is clear. Candidates should be made familiar with scientific terminology and given opportunities to practise using that terminology for discursive explanations before they sit the examination.

General comments

Most candidates were able to attempt most questions. A few candidates found some questions challenging. Although it appeared that candidates often knew the answers to the questions, the answers that they gave expressed this understanding imprecisely. Language difficulties may have played some part here, although the general level of English was good. Performance depended not only on scientific knowledge but on the ability to interpret a question correctly.

It is clear that when a numerical answer was required, weaker candidates merely took any numbers that were given in the question and either multiplied them or divided them. In some cases it was necessary to refer back to previous parts of a question to find the correct data. Quite often the candidates made up a formula / equation to confirm this. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided.

Candidates need to be aware that their answers should be written in the area on the question paper designated for this purpose. Answers written elsewhere could well be missed.

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

Comments on specific questions

Question 1

(a) The idea of an alloy was well known. Candidates must take care to use correct terminology in their descriptions.

(b)

(i) Most candidates realised what was needed for rusting. Good answers described what was missing from test-tubes **A** and **C**.

(ii) Oxidation was fairly well known. Incorrect answers included rusting or corrosion.

(iii) The answer was well known. A few candidates tried to answer in terms of coating with paint.

(c)

(i) The best answers nominated all the hydrocarbons in the list, and explained correctly why the given examples were hydrocarbons. Most candidates who knew what a hydrocarbon was, and could explain it, usually only stated one example.

(ii) This was well known.

(d) Some candidates were successful here. Other candidates were challenged by [illegible] of describing the difference. Candidates need to be practised in the correct use of terminology the words 'atom' or 'molecule'.

Question 2

(a)

(i) This was quite well known although some candidates seemed confused by the time element.

(ii) The best answers gave the formula in conventional symbols or words; it was noted that many candidates are now following the good practice of giving the equation in words, which eliminates any ambiguity. Candidates needed to halve the distance to get the correct answer.

(b) This was well answered by the candidates who knew the formula

(c)

(i) Gravity was well known but drag / friction / air resistance for the second force was less well known. This meant that not many candidates gained any credit.

(ii) The idea that objects will travel at a constant speed when balanced forces are acting on them was well known.

(d) Many candidates managed to correctly complete the calculation.

Question 3

(a) This part was well answered.

(b)

(i) Many candidates gained partial credit here but few knew enough for the award of full credit. The best answers stated that an enzyme is a protein.

(ii) Many candidates knew that amylase broke down or digested starch. Fewer candidates were able to specify the end product of digested starch. Many candidates were able to describe that the products were moved into the blood.

(c)

(i) Most candidates successfully described how molar teeth help in the digestion of food. Many achieved full credit.

(ii) The idea of tooth decay was well known. Fewer candidates were able to describe how the decay was caused.

(iii) That these food products contain calcium was well known. The best answers went on to mention that calcium is needed to form enamel.

Question 4

(a)

(i) Electron was not very well known in answer to this question.

(ii) Candidates needed to state that the electron was negative.

(iii) Most candidates gained some credit here. Terminology was again a problem, with some candidates referring to heat rather than temperature.

(b)

(i) Red and blue were well known but many candidates chose yellow as their third colour rather than green.

(ii) Many candidates clearly had the right idea but were not able to express themselves clearly enough to explain that all the other colours could be made from the three primary colours.

(c)

(i) Heat or thermal energy was well known.

(ii) The best answers stated that the heat produced would increase the temperature of the create a convection current.

(iii) Many candidates found this question challenging. Some candidates presented confused working for their calculation yet still obtained the correct answer; candidates need to be aware of the need to lay their working out in an accessible form.

Question 5

(a) Most candidates gained at least partial credit. Paper was best known and then ceramics. Aluminium appeared incorrectly frequently.

(b)

(i) Poor expression of ideas meant that few candidates gained any credit here. The use of the words 'atoms', 'elements' and 'molecules' were again confused.

(ii) The best candidates suggested fractional distillation; many candidates suggested distillation.

(c) Many candidates gained at least partial credit here. 'Increasing the temperature' was the most popular answer.

(d) Very few candidates had sensible suggestions here. Candidates need to be aware that ammonia is an alkali.

Question 6

(a)

(i) Many candidates knew about chromosomes, but fewer were able to state the correct number.

(ii) A few candidates were able to identify the cytoplasm and cell membrane. A common wrong answer was cell wall.

(iii) Candidates lost marks here by answering a question not asked. The tail for swimming was well known, and many candidates recognised the pointed head, but then referred to the penetration of the egg, when the question was about swimming.

(b) This was well known.

(c)

(i) The best answers stated that a single sperm cell's energy use would be too small to measure.

(ii) Many candidates recognised the need for energy when swimming, but few candidates mentioned either of the other marking points.

Question 7

(a) This was well done by many candidates. A large number were able to draw a second switch in parallel with the original switch.

(b) Many candidates answered this well.

(c)

(i) Many candidates recognised that this was a convection situation, but then went on to describe convection of hot air.

(ii) Only the more able candidates manipulated the data and calculated the answer as 5000J.

(d) Many candidates realised that the contacts would break. The best candidates were a
why.

(e)

(i) Most candidates were able to identify a fossil fuel.

(ii) Many candidates were able to do this. Other candidates failed to gain credit as their answers were vague, referring only to 'pollution'.

(iii) Most candidates identified the fact that wind turbines do not work if there is no wind.

Question 8

(a) Most candidates gained at least partial credit.

(b) Few candidates were able to describe how nitrates help plants to grow better.

(c)

(i) Many candidates correctly explained that insecticides kill the insects which are damaging the crops and therefore gained full credit.

(ii) Most candidates described how insecticides would kill the cattle.

Question 9

(a)

(i) Thirteen was the commonest answer but there were many other incorrect answers.

(ii) Many candidates answered potassium, possibly because they knew that potassium gives the lilac colour. Correct answers gave the formula of the compound within which potassium is found.

(iii) Calcium and potassium were well known by many candidates. Other candidates gave silicon, incorrectly.

(b)

(i) Many candidates were able to give environmental conditions which cause weathering but were unable to link each condition to the different types of weathering.

(ii) Some candidates were able to explain the release of minerals into the soil and why plants needed them.

(c)

(i) Decomposition was not well known

(ii) Few candidates seemed to realise what the reaction and equation meant.

(iii) The best candidates recognised the alkalinity of the calcium oxide. Candidates need to know the pH of common substances in solution.

CO-ORDINATED SCIENCES

Paper 0654/22

Core Theory

Key message

Candidates should be guided by the number of marks allocated to each question. It is often beneficial for a candidate to read again through their answer to make sure that the meaning is clear. Candidates should be made familiar with scientific terminology and given opportunities to practise using that terminology for discursive explanations before they sit the examination.

General comments

Most candidates were able to attempt most questions. A few candidates found some questions challenging. Although it appeared that candidates often knew the answers to the questions, the answers that they gave expressed this understanding imprecisely. Language difficulties may have played some part here, although the general level of English was good. Performance depended not only on scientific knowledge but on the ability to interpret a question correctly.

It is clear that when a numerical answer was required, weaker candidates merely took any numbers that were given in the question and either multiplied them or divided them. In some cases it was necessary to refer back to previous parts of a question to find the correct data. Quite often the candidates made up a formula / equation to confirm this. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided.

Candidates need to be aware that their answers should be written in the area on the question paper designated for this purpose. Answers written elsewhere could well be missed.

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

Comments on specific questions

Question 1

(a)

(i) Most candidates were able to gain the first mark by recognising the long timescale involved in the formation of fossil fuels.

(ii) Oxygen was the most common answer. Incorrect answers included carbon, hydrogen and nitrogen.

(iii) Many candidates confused glucose and cellulose and stated either that cellulose molecules joined together to make glucose or that glucose broke down to make cellulose.

(b) Many candidates incorrectly chose methane as their answer and were then unable to give a correct explanation.

(c)

(i) Nitrogen and water vapour were well known here.

(ii) Most candidates were able to correctly describe the test for carbon dioxide gas.

(iii) Carbon monoxide was well known. Many candidates did not identify nitrogen dioxide and instead chose carbon dioxide.

Question 2

(a) Many candidates knew the correct formula but lost marks by failing to convert minutes to se

(b)

(i) The best candidates knew the correct formula. Candidates need to be given opportunities to learn this formula before sitting the examination.

(ii) The best candidates were able to demonstrate that they understood that the potential energy of the brick was converted into kinetic energy. Many other candidates halved the value.

(c) Many candidates gained partial credit on this part. This was usually for recognising that the aluminium foil reflected the heat back. A few candidates realised that the air in the polystyrene was a good insulator.

Question 3

(a)

(i) Triceps and biceps were well known although a considerable number of candidates mixed them up.

(ii) The roles of the triceps and biceps were well known.

(b)

(i) This was quite well answered. Most candidates realised that the mineral content of the bone increased each year. Many were able to describe the increase or give some numerical values to accompany their description.

(ii) This was well answered. Most candidates knew that the foods contained calcium and that calcium was needed for healthy bone growth.

(iii) Orange was the most popular correct answer, but it was encouraging to see many candidates opting for a fruit specific to their region of the world.

(c)

(i) Most candidates were able to find one difference between the properties of bone and cartilage.

(ii) Many candidates knew the function of cartilage. Fewer were able to state precisely where it is found in the human arm.

Question 4

(a) Although some candidates confused mass and weight, most candidates correctly stated the equation. Many used the wrong distance in their calculation. Candidates must consider carefully which information given in the stem to a question should be used in answering the question.

(b)

(i) The correct answer of fifty seconds was the answer most commonly given.

(ii) Most candidates were able to use the graph to work out that the skier was travelling at a constant speed and to state that speed.

(c) Few candidates were able to correctly describe the relationship between force, area and pressure and many candidates confused the terms force and pressure in their explanations.

(d) The idea of less friction was well known.

Question 5

(a)

(i) This was well known. Almost all candidates gained credit here. The few unsucc candidates were those who chose a feature which was not visible on the photogra Candidates should be reminded to make sure that they answer the question asked in the examination paper.

(ii) This was well answered. A few candidates lost marks through imprecise answers; for example candidates needed to state 'large ears' or 'large eyes' rather than 'ears' or 'eyes'.

(b)

(i) Many candidates gained partial credit here by referring to diffusion or by naming the alveoli.

(ii) Most candidates recognised the problem but struggled to articulate the solution. Some candidates correctly referred to respiration.

(c)

(i) Lack of grass and being eaten by predators were the most common answers here; a few candidates were able to gain full credit.

(ii) A few candidates correctly referred to species diversity.

Question 6

(a)

(i) Many candidates gained at least partial credit for correctly identifying the group number. Many candidates incorrectly thought that lithium was in period 3.

(ii) Lithium's reactivity was not well known nor was the function of the oil.

(iii) Most candidates were able to identify at least one mistake with the diagram. A number of candidates referred to possible errors which were not shown.

(b)

(i) The very best candidates named hydrochloric acid. Candidates should be familiar with the reactions of acids with carbonates.

(ii) Carbon dioxide was the gas usually given.

(iii) Chlorine was well known as the last part of the equation.

(c)

(i) A few candidates gave a suitable definition of the term drug.

(ii) Many candidates were able to explain that a high level of purity for drugs was essential to avoid harming the user.

Question 7

(a) Almost all candidates got this correct. Candidates need to remember that as light travels in straight lines, rays of light should be drawn as straight lines.

(b) Many candidates completed this correctly. A few candidates wrongly assumed that the open switch was the error in the circuit.

(c)

(i) Red and blue were well known but some candidates used yellow as the third colour.

(ii) The more able candidates stated either frequency or wavelength as a difference.

Question 8

(a)

(i) Petal was well known.

(ii) Anther or stamen was less well known.

(iii) Ovule was also less well known

(b) Only the more able candidates gained full credit. The most common correct statements referred to the idea that gametes fused.

(c)

(i) The correct answer, 17, was well known. A commonly given wrong answer was 33.

(ii) Nucleus was well known.

(iii) DNA was fairly well known. 'Gene' was a commonly given wrong answer for both part **(ii)** and part **(iii)**.

(d)

(i) Many candidates correctly stated that sugars were produced by photosynthesis but did not state where this happened. Some answers demonstrated that some candidates were confused between the roles of phloem and xylem.

(ii) The very best candidates were able to give answers referring to respiration or the production of energy.

Question 9

(a)

(i) Most candidates gained at least partial credit. 'The same temperature' was the most popular answer.

(ii) This part was very well answered. The positive result of the hydrogen test is well known.

(iii) Some candidates answered this correctly. Many candidates missed the similarity of **A** and **C**.

(b)

(i) Many candidates gained full credit here. A similar proportion gained no credit; many candidates tried to include a battery/cell in the circuit.

(ii) A few candidates were able to state that the voltage would change. Very few candidates were able to explain why it changes.

Question 10

(a)

(i) Uranium was well known.

(ii) Nuclei and nuclear were often confused here. Candidates also demonstrated confusion between the terms 'turbine' and 'generator'.

(b)

(i) Lead and concrete were well known as shielding materials for nuclear reactors.

(ii) Most candidates were able to give at least one effect of exposure to radiation.

(c)

(i) An instrument to measure the count rate was correctly identified by most candidates.

(ii) Many candidates managed to work out that three half-lives were involved. Fewer were able to calculate the time involved correctly.

CO-ORDINATED SCIENCES

Paper 0654/23

Core Theory

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(i) The best candidates knew the correct formula. Candidates need to be given opportunities to learn this formula before sitting the examination.

(ii) The best candidates were able to demonstrate that they understood that the potential energy of the brick was converted into kinetic energy. Many other candidates halved the value.

(c) Many candidates gained partial credit on this part. This was usually for recognising that the aluminium foil reflected the heat back. A few candidates realised that the air in the polystyrene was a good insulator.

Question 3

(a)

(i) Triceps and biceps were well known although a considerable number of candidates mixed them up.

(ii) The roles of the triceps and biceps were well known.

(b)

(i) This was quite well answered. Most candidates realised that the mineral content of the bone increased each year. Many were able to describe the increase or give some numerical values to accompany their description.

(ii) This was well answered. Most candidates knew that the foods contained calcium and that calcium was needed for healthy bone growth.

(iii) Orange was the most popular correct answer, but it was encouraging to see many candidates opting for a fruit specific to their region of the world.

(c)

(i) Most candidates were able to find one difference between the properties of bone and cartilage.

(ii) Many candidates knew the function of cartilage. Fewer were able to state precisely where it is found in the human arm.

Question 4

(a) Although some candidates confused mass and weight, most candidates correctly stated the equation. Many used the wrong distance in their calculation. Candidates must consider carefully which information given in the stem to a question should be used in answering the question.

(b)

(i) The correct answer of fifty seconds was the answer most commonly given.

(ii) Most candidates were able to use the graph to work out that the skier was travelling at a constant speed and to state that speed.

(c) Few candidates were able to correctly describe the relationship between force, area and pressure and many candidates confused the terms force and pressure in their explanations.

(d) The idea of less friction was well known.

Question 5

(a)

(i) This was well known. Almost all candidates gained credit here. The few unsucc candidates were those who chose a feature which was not visible on the photogra Candidates should be reminded to make sure that they answer the question asked in the examination paper.

(ii) This was well answered. A few candidates lost marks through imprecise answers; for example candidates needed to state 'large ears' or 'large eyes' rather than 'ears' or 'eyes'.

(b)

(i) Many candidates gained partial credit here by referring to diffusion or by naming the alveoli.

(ii) Most candidates recognised the problem but struggled to articulate the solution. Some candidates correctly referred to respiration.

(c)

(i) Lack of grass and being eaten by predators were the most common answers here; a few candidates were able to gain full credit.

(ii) A few candidates correctly referred to species diversity.

Question 6

(a)

(i) Many candidates gained at least partial credit for correctly identifying the group number. Many candidates incorrectly thought that lithium was in period 3.

(ii) Lithium's reactivity was not well known nor was the function of the oil.

(iii) Most candidates were able to identify at least one mistake with the diagram. A number of candidates referred to possible errors which were not shown.

(b)

(i) The very best candidates named hydrochloric acid. Candidates should be familiar with the reactions of acids with carbonates.

(ii) Carbon dioxide was the gas usually given.

(iii) Chlorine was well known as the last part of the equation.

(c)

(i) A few candidates gave a suitable definition of the term drug.

(ii) Many candidates were able to explain that a high level of purity for drugs was essential to avoid harming the user.

Question 7

(a) Almost all candidates got this correct. Candidates need to remember that as light travels in straight lines, rays of light should be drawn as straight lines.

(b) Many candidates completed this correctly. A few candidates wrongly assumed that the open switch was the error in the circuit.

(c)

(i) Red and blue were well known but some candidates used yellow as the third colour.

(ii) The more able candidates stated either frequency or wavelength as a difference.

Question 8

(a)

(i) Petal was well known.

(ii) Anther or stamen was less well known.

(iii) Ovule was also less well known

(b) Only the more able candidates gained full credit. The most common correct statements referred to the idea that gametes fused.

(c)

(i) The correct answer, 17, was well known. A commonly given wrong answer was 33.

(ii) Nucleus was well known.

(iii) DNA was fairly well known. 'Gene' was a commonly given wrong answer for both part **(ii)** and part **(iii)**.

(d)

(i) Many candidates correctly stated that sugars were produced by photosynthesis but did not state where this happened. Some answers demonstrated that some candidates were confused between the roles of phloem and xylem.

(ii) The very best candidates were able to give answers referring to respiration or the production of energy.

Question 9

(a)

(i) Most candidates gained at least partial credit. 'The same temperature' was the most popular answer.

(ii) This part was very well answered. The positive result of the hydrogen test is well known.

(iii) Some candidates answered this correctly. Many candidates missed the similarity of **A** and **C**.

(b)

(i) Many candidates gained full credit here. A similar proportion gained no credit; many candidates tried to include a battery/cell in the circuit.

(ii) A few candidates were able to state that the voltage would change. Very few candidates were able to explain why it changes.

Question 10

(a)

(i) Uranium was well known.

(ii) Nuclei and nuclear were often confused here. Candidates also demonstrated confusion between the terms 'turbine' and 'generator'.

(b)

(i) Lead and concrete were well known as shielding materials for nuclear reactors.

(ii) Most candidates were able to give at least one effect of exposure to radiation.

(c)

(i) An instrument to measure the count rate was correctly identified by most candidates.

(ii) Many candidates managed to work out that three half-lives were involved. Fewer were able to calculate the time involved correctly.

CO-ORDINATED SCIENCES

Paper 0654/31
Extended Theory

Key message

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

General comments

Candidates should pay careful attention to exactly what the question has asked them to do and use wording to ensure that their meaning is clear. Candidates should ensure that they use technical terms whenever this is appropriate in their answers, rather than relying on everyday language.

No candidates appeared to have any difficulty in completing the Paper in the time allowed.

Comments on specific questions

Question 1

Several parts of this question required candidates to use their knowledge in a new situation, rather than simply repeating facts that they had learned. Many did this very successfully.

(a)

(i) There were many good answers, explaining that hot water is less dense than cold and therefore rises. Some also mentioned convection currents. Several candidates incorrectly described how hot 'air' rises. Some thought that hot particles become lighter than cold ones.

(ii) Those candidates who appreciated that a watt is the same as one joule per second were able to answer this question quickly and easily, and they generally included the correct unit. Numerous candidates carried out quite complex calculations, almost always arriving at an incorrect answer.

(iii) This was a demanding calculation, and credit was given to individual correct steps in the working even when mistakes had been made elsewhere.

Many candidates were able to state a correct formula, although subsequent working often made clear that they did not know the meaning of some of the symbols they had used, such as Q or c. Some formulae did not include energy, and many incorrectly included time.

Most candidates correctly calculated the change in temperature, and some also worked out the mass, using information provided about the volume and density of water. The calculation of energy proved difficult, and relatively few candidates successfully multiplied their answer to **(ii)** by 60 x 60 x 2.

Even where mistakes had been made in finding these values, credit was given for correct substitution in the equation and the arrival at a correctly calculated answer with appropriate units. Candidates need to ensure that their working is presented in such a way that it can be followed, which makes it possible to give credit for working even if the final answer is incorrect.

(b) In general, candidates appreciated that the current would be switched off as a result of the contacts separating. Many also correctly described the increase in strength of the electromagnet, and the consequent attraction of the iron. Some simply stated that the electromagnet 'becomes magnetic',

which was not credited. Others misunderstood entirely, suggesting for example th heated up and melted, or that the electromagnet expanded.

Question 2

(a) Relatively few candidates gave two correct responses to this question. Many were able to name glass as a useful product made from sand and metal oxides, but few could also name chlorine as a product of rock salt.

(b)

(i) Most candidates gave only one answer here. This may be because they had not read the question carefully, and so did not notice that they were asked for 'substances' rather than 'a substance'. As a result, it was rare to see any candidate gaining credit here. There were three substances in the list that have a giant structure, and credit was given for naming any two of these. The one 'wrong' substance, argon, appeared frequently.

(ii) The same problem occurred here, with many offering only one substance in their answer. Where two substances were named, the second was often sodium chloride, which is incorrect.

(iii) There were some excellent answers to this question, explained in terms of the strong bonds within the molecule and weaker bonds between them. A significant number of candidates had problems with the terms 'within' and 'between', using them either interchangeably or in the wrong context. Some used the terms 'intermolecular' and 'intramolecular', although these terms were sometimes used the wrong way round. This is not an easy topic, and candidates need to be equipped with suitable vocabulary to enable them to understand questions and to write clearly expressed answers.

(c)

(i) This was usually answered correctly, with either a statement that the reaction is reversible, or a description of the reaction working in both directions. The statement that 'the equation is reversible' was not credited. Candidates should take great care with the use of the word 'it''; here, the statement that 'It is reversible' was taken to mean that the equation is reversible. In general, it is wise to avoid using 'it' wherever possible.

(ii) Most candidates appreciated that this would produce a larger surface area, speeding up the reaction even more than a catalyst in a single large piece would do.

(iii) Credit was given for the idea that the two nitrogen atoms in a nitrogen molecule are strongly bonded, requiring much energy to break the bond, and many candidates correctly stated this. Some were also able to explain how high temperature increases kinetic energy, and to relate this to collision frequency.

Question 3

While much of this question required simple recall of cell structure and the events at fertilisation, all parts of **(c)** required candidates to apply their knowledge in a novel situation. Many found this difficult.

(a) It was expected that this would be a relatively easy question, and indeed many candidates were able to label two of the nucleus, cell membrane or cytoplasm. However, there were many answers that included a cell wall, the vacuole, the tail or the head. Candidates need to take care that label lines touch the part of the diagram that they intend to label. For example, a label to the cell membrane that ends in the cytoplasm cannot be credited.

(b) This was usually answered correctly.

(c)

(i) A minority of candidates appreciated that the use of oxygen or energy by a single sperm would be so small that it would be very difficult to measure. Many said that it would be 'too small to calculate', which was not credited. Others answered in terms of being able to calculate an average, which is not an appropriate answer in this particular context.

(ii) Most answers correctly made reference to respiration. Candidates must take the statement that this 'produces' energy. They should ensure that they use s correct terms, for example by stating that energy is released from glucose, or transferred into a useful form.

(iii) Many candidates did not know the formula relating power, energy and time. Even those who did were frequently unable to select the appropriate figures from the table, or to convert one hour to seconds. (This was often done by multiplying by 60, rather than by 60 x 60.) Units were not always given.

(iv) Most candidates answered a different question here; a more familiar question asking how a sperm is adapted for its function. A large proportion of answers did not focus on the shape of the sperm; many discussed its size. Similarly, most did not focus clearly on how the energy required for swimming is reduced; many described the use of the tail for swimming. Good answers described the shape of the head, and how this would reduce friction or drag as the sperm moves through liquid. Many candidates did not use scientific terminology, stating for example that the shape 'makes it easy to swim through the liquid', which was not credited.

(d) Some candidates gave clear and simple descriptions of the fusion of the nuclei of the egg and sperm to form a zygote, and used the term 'fertilisation' correctly. Many were not able to do this, and instead gave complex and generally inaccurate detail (for example, how the egg prevents other sperm from entering) or described events occurring much later (for example, the development of an embryo or implantation in the uterus).

Question 4

(a)

(i) Many candidates knew that the particles emitted from the hot wires are electrons. Others thought that they were ions, protons or alpha particles.

(ii) Almost all candidates that had given electrons as their answer to **(i)** correctly stated that they have a negative charge.

(iii) There were relatively few correct responses to this question. Only a minority of candidates appreciated that the electrons collect on the screen. Many answers referred to the electrons 'hitting' the screen, without implying that they remained there. Answers often implied that the charge was something that was left behind after the electrons had moved on elsewhere. Others attempted to describe more complex situations, such as protons being attracted to the screen, or some process involving friction.

(iv) This was generally well answered, the most common correct responses being length, diameter, the material from which the wire is made and its temperature.

(b) Some candidates were able to give a suitable simple description of a microprocessor.

(c)

(i) This was usually answered correctly.

(ii) This, too, was usually correct.

(iii) Not all candidates knew that efficiency is calculated by dividing the *useful* energy output by the total energy input. Many wrote the formula as 'energy output ÷ energy input', and arrived at an answer of 100 %. Some gave 66 %, by using the value for heat energy in their calculation.

Question 5

(a) Candidates who knew that iron rusts in the presence of oxygen and water generally had no problems with this question. Some did not give suitably precise explanations why the nail would not rust in **A** and in **C**; they needed to state that **A** did not have water and that **C** did not have air (or oxygen).

(b)

(i) Only a very small minority of candidates identified element **Q** as carbon. By fa common answer was 'iron', suggesting that they did not appreciate that the ma atoms in steel are iron atoms, with smaller numbers of carbon atoms. Many other were suggested, such as nickel and copper. Some named alloys, such as brass.

(ii) There were some good answers here, providing simple explanations in terms of the presence of different sizes of atoms making it difficult for layers to slide. Such responses were relatively rare, and many tried to explain this in terms of bonding or other inappropriate (and often complex) concepts.

(c)

(i) Many candidates correctly showed, or described, the presence of single bonds in saturated hydrocarbons and double bonds in unsaturated ones. Their diagrams often conveyed this more clearly than words, and also made clear that the bonds in question are between carbon atoms (rather than between carbon and hydrogen).

(ii) A simple diagram showing several Ms linked by single lines was the quickest and easiest way of answering this question. Frequently, bonds were still shown as double. Several answers showed the 'monomers' linked in complex patterns, such as squares.

Question 6

Answers to **(b)** and **(c)** indicated that many candidates confuse 'digestion' and 'absorption'. For example, they stated that teeth or amylase break food up so that it can be more easily digested. Care needs to be taken that the precise scientific meanings of these two terms are understood.

(a)

(i) Most candidates answered this incorrectly. Common incorrect answers included 'smell' and 'hunger'. Care needed to be taken with spelling, as 'reflection' was not credited.

(ii) There were many good answers, describing how electrical impulses pass along neurones, often with reference to sensory and motor neurones at appropriate points, and to the brain or central nervous system. Some candidates thought that the smell itself travels along this pathway (sometimes diffusion of particles was mentioned), while a few described the neurones themselves moving.

(b) The majority of candidates understood that molar teeth break food up into smaller particles. They needed to use a suitable term for how they do this; 'crush', 'grind' or similar were acceptable, while 'cut' or 'chew' were not. The idea of increasing the surface area of the food was credited, and also that this makes it easier for enzymes (not just 'saliva') to act on the food. Some candidates incorrectly stated that the teeth break large molecules into small ones. Statements that the teeth make the food easier to swallow did not answer the question.

(c)

(i) While some candidates could give a good definition of an enzyme, many gave incorrect answers such as 'a chemical that breaks down food into smaller molecules'. Some candidates thought that an enzyme is a cell or a bacterium.

(ii) Relatively few candidates knew that amylase breaks down starch to maltose. Proteins, fats, and 'carbohydrates' were commonly given as substrates. Those who did correctly give starch often said that amylase breaks it down to glucose, which is not correct.

(ii) Many correctly stated that amylase is also made in the pancreas, and some knew that it is active in the small intestine.

Question 7

There were numerous calculations in this question. Many candidates could give an appropriate form did not then use the data to carry out the calculation correctly, or did not give suitable units with their an

(a)

(i) The formula was usually given correctly. Only a small minority then substituted correctly and arrived at a correct answer with a unit. MHz caused problems for many.

(ii) Almost all candidates knew the formula relating distance, speed and time. Many forgot that the pulse had been reflected and so gave an answer twice as large as it should be.

(b) This calculation was the one that was most often entirely correct. Care needs to be taken with units; some gave their answer as kg m/s, which was not accepted.

(c)

(i) Candidates must ensure that their formula for calculating acceleration includes a *change* in velocity (not just velocity). Care also needs to be taken with units; m/s appeared very frequently.

(ii) The graph was generally very well done. Most candidates were able to place time on the *x*-axis and speed on the *y*-axis and to include suitable units, to work out a suitable scale for both axes, to plot the two points correctly, and to draw a straight line between them. Some scales were not correct, and some used very awkward divisions, for example going up in 17 s (0,17,34...). Some *y*-axis scales went up in 20 s as far as 80, and then went to 90 instead of 100, so that the value of 85 was incorrectly plotted. A few candidates drew curves, and a few labelled their *y*-axis 'distance'.

Question 8

(a) Flame tests were reasonably well known, and many candidates could state that potassium would give a lilac flame, or that sodium would give a yellow flame. Care needs to be taken with wording. Answers such as 'potassium would turn lilac' were not credited. Many candidates stated only that the two substances would give different coloured flames, which again did not earn credit.

(b) A minority of candidates answered this question successfully. Some got part way to the answer, appreciating that the charge of +4 on the calcium and magnesium ions had to be balanced by a charge of –4 on the carbonate ions, but then forgot that there were two carbonate ions so the charge on each one would be –2. Most candidates did not know how to work out the answer and gave either no answer at all or an entirely incorrect one.

(c)

(i) A small majority of candidates calculated this entirely correctly, finding the relative molecular mass of dolomite, dividing it into 1.84 and arriving at an answer of 0.01 moles. The most common error was in the calculation of the M_r. Others divided their calculated M_r by 1.84, and so obtained an answer of 100.

(ii) Most of the candidates who had given correct answers to **(i)** realised that they did not need to do a further calculation here, and simply doubled their answer to **(i)**.

(d)

(i) This was often well answered. A few candidates did not read the question carefully and gave formulae rather than names. Many gave inappropriate suggestions, including many substances that are not salts, such as magnesium or water.

(ii) A few candidates were able to write the correct balanced equation for this reaction. Many gave the wrong formula for magnesium chloride, writing MgC*l* instead of MgCl_2. Some gave OH instead of H_2O as a product, and many other incorrect products appeared, frequently including elements that were not present on the left hand side of the equation, such as calcium or sodium.

Question 9

(a)

(i) Relatively few candidates knew a feature that is common to all arthropods and that is visible in the diagram.

(ii) This was well answered. Most candidates correctly gave an answer of six legs, while others stated that the beetle has a body divided into head, thorax and abdomen. A few correctly stated that it has one pair of antennae. The presence of an unspecified number of antennae was not credited, and nor were 'anthers' or 'antlers'.

(b) This question required candidates to apply their knowledge of the carbon cycle in a novel situation, and few were able to do this successfully. Most did not appear to notice the reference to the carbon cycle in the question, and no part of their answer referred to any of the processes in this cycle. Very few recognised that the beetle would release carbon dioxide in respiration and that this would then be taken in by the plant and used in photosynthesis. Many appeared to be distracted by the idea that the ball of dung was buried, and suggested that the plant would take up carbohydrates from the soil through its roots.

(c)

(i) Some candidates correctly stated that nitrates are taken up by plant roots, and explained that they are used to produce proteins within the plants. Many answers got no further than repeating the question, for example by saying that nitrates help plants to grow, or that they act as fertiliser.

(ii) There were some very good answers to this question. Candidates who knew how nitrogen-containing fertilisers can cause eutrophication often explained in detail how a reduction in their use could reduce these problems. Most candidates did not make this link, instead making incorrect links between fertilisers and other environmental problems such as global warming. A significant number thought that this would reduce the amount of 'poisonous' nitrogen in the air. Some thought that fertilisers would poison the cattle or plants, and numerous answers confused fertilisers with herbicides or insecticides.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

Key message

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

General comments

Very few questions were not attempted. There was no evidence that candidates were short of time. The use of English was good, with ideas clearly expressed. Extended answers were generally well structured. Handwriting was usually good with very few scripts that were difficult to interpret.

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.

There was evidence that not all candidates appreciated the guidance that could be provided by the number of marks given for each part question in planning the number of assessable items they provided in their response.

Comments on specific questions

Question 1

(a)

(i) Nearly all candidates suggested fur or hair as the visible feature indicating that guanacos were mammals.

(ii) Most chose a visible feature that could help guanacos to avoid being killed by pumas, and referred to the size of ears, eyes, neck or legs. A substantial number incorrectly suggested camouflage, which was not apparent from the photograph.

(b) Generally candidates explained why guanacos had extra red blood cells in terms of compensation for lack of oxygen at high altitude, and some described their role in the transport of oxygen. Others inappropriately constructed an argument in terms of maintenance of body temperature.

(c) It was clear that the majority were familiar with the population graph. Candidates sometimes only explained the central portion due to reproduction, and neglected the stabilization region caused by limiting factors. The most successful candidates used the regions of the graph to help in the structuring of their response.

(d) The basic principle of artificial selection was well known. Full credit was obtained by those who appreciated that selection continued in successive generations. A minority confused the practice with natural selection, genetic engineering or *in vitro* fertilization.

Question 2

(a) Most candidates correctly suggested that high reactivity was the reason why lithium wa found as the uncombined element. Some described the electronic structure without stating th with reactivity.

(b)

(i) Many could explain the charges on a lithium atom and ion. Some responses described the electronic structure without mentioning the charge on the nucleus. Candidates need to appreciate that they can only gain credit for what they write and not for what is assumed.

(ii) The explanation for the high melting point of lithium chloride was often provided in terms of the large amount of energy required to break the many strong ionic bonds. The term 'intermolecular force' was frequently used, even when ionic bonding had been identified and the term did, therefore, not apply. There was some misconception that the properties of a compound were the same as those of its constituent elements.

(c) The word equation for a reaction for the conversion of lithium carbonate to lithium chloride was well known, with neutralization being the most popular method. Some candidates opted for a precipitation method which was acceptable, provided an insoluble carbonate was produced. The reaction with sodium chloride, for example, would not occur. The incorrect suggestion of a reaction with elemental chlorine was also common.

(d)

(i) Many candidates knew that an electrolyte must be kept molten in order to conduct electricity or to allow mobility of ions. The involvement of electron movement was often incorrectly suggested.

(ii) That a lithium ion gains an electron at the cathode was usually stated. Some did not specify that one electron was involved, while others wrote about the loss of an electron.

(e) Most recognized the potential harmful effects of impurities in drugs.

Question 3

(a) The formula for work as force x distance was well known. A minority appreciated that the distance should be in the same direction as the force. Many substituted the weight of the skier but used the length of the slope instead of its height.

(b) Many answers demonstrated a good understanding of the concept of pressure by being able to explain the difference in that being exerted by the point and being exerted by the disc of the ski pole. This was facilitated if the formula, $p=f/a$, was supplied. Some candidates attempted to explain the use of the pole in terms of the force required to apply sufficient pressure to penetrate the surface. This would have been acceptable but proved to be a more difficult option. A minority confused force and pressure and made statements referring to the spreading of pressure.

(c) Friction was usually given as the reason why a skier polished her skies. The purpose of this, to increase speed, was often omitted.

Question 4

(a)

(i) Candidates were usually awarded at least partial credit for explaining why wood is not a fossil fuel, by reference to timescale, heat, pressure or decay. Answers often contained irrelevant material sourced from the diagram.

(ii) Oxygen was usually correctly suggested as the extra element in carbohydrates.

(b)

(i) The graphical formula of hexane was usually well drawn.

(ii) Many candidates could suggest boiling point, viscosity or another difference in ... of alkanes. There was a tendency to write about molecular structure instead of ... chemical properties.

(c)

(i) Most candidates recognized that air contains a high percentage of nitrogen while not necessarily noting that it did not react as it passed through the engine. It was rare to see a reason for lack of reactivity. The presence of nitrogen in fuel was sometimes incorrectly suggested as a reason for it being an exhaust gas.

(ii) The purpose of a catalyst to increase rate of reaction was well known. Some read the question as requiring the purpose of the catalytic converter itself.

(iii) There were good answers derived from the information in the root of the question.

Question 5

(a) Atom **Z** was usually correctly identified as krypton, although zirconium was sometimes suggested.

(b)

(i) Lead or concrete were the usual suggestions for nuclear reactor shielding although aluminium was sometimes given.

(ii) The effects of ionizing radiation were well known. Some candidates inaccurately wrote about ionized cells or a mutated body.

(c)

(i) An acceptable definition of an isotope was usually given.

(ii) Many candidates arrived at the correct half-life of 300 years. Those that did not achieve this tended to employ a learned method without displaying understanding of the concept.

Question 6

(a) Structure **A** was usually recognized as a tendon. There was some confusion between tendon and ligament.

(b) Most candidates wrote that the triceps contracted and the biceps relaxed. Few received credit for the role of the tendon. The term flex was sometimes employed to mean contract or relax.

(c) The majority of candidates found it difficult to explain why a pair of antagonistic muscles was required. Most repeated their response to **(b)** or wrote that it was too much effort for one muscle.

(d)

(i) Many accurately described the relationship between age and mineral content as a proportional increase. Alternatives that were not acceptable included constantly increased or increased in direct proportion. The magnitude of the increase was not always included.

(ii) While most candidates knew that dairy products were a good source of calcium, not all mentioned its role in the growth and maintenance of bones. In spite of the guidance given in the text of this question, many did not record the need to build up calcium content to prevent osteoporosis in later life.

(e)

(i) Most could describe the properties of bones and cartilage, even if their wording was not strictly comparative. There was some confusion between properties and functions.

(ii) A minority knew that cartilage is found on the ends of bones. More common was a vague reference to the region between bones or in the joint. Most candidates could describe its role in reducing friction or absorbing shocks. There was again some confusion between cartilage and ligaments.

Question 7

(a) Most candidates stated that the counterbalance was needed to prevent the crane tippi Few explained that its purpose was to ensure equalization of the clockwise and anticloc moments of the forces acting on the horizontal beam, and many gave a more superficial rea involving balanced forces.

(b) The working given for the calculation of the position of the counterbalance was usually well structured. Some incorrectly gave the formula for moment as mass x distance, but the majority who used force x distance went on to obtain the correct results. The unit for moment was sometimes given as J or was missing.

(c)

(i) The time of fall was usually evaluated correctly. Many candidates incorrectly gave the starting formula as speed / time rather than change in speed / time.

(ii) The speed-time graph was usually well drawn.

(iii) The formula for the kinetic energy of the brick, $\frac{1}{2} mv^2$, was well known. A common error was not to square the speed. The unit was sometimes incorrect or omitted.

(iv) The potential energy of the brick before the fall was usually quoted as the same as its final kinetic energy. There were a few incorrect answers of zero potential energy due to lack of motion. Some candidates deserved full credit when they chose the more challenging route by obtaining the height of fall from the speed-time graph or calculation and applying the formula potential energy = mgh.

Question 8

(a)

(i) Petals, nectary or nectar were usually stated as attracting insects to a flower.

(ii) Anthers or stamens were usually given as the structures making pollen. Stigma was also common.

(b) Most knew the difference between positions of the stigma in insect and wind-pollinated flowers. Difficulty was experienced in describing the shape of the stigma in insect-pollinated flowers.

(c) In this question candidates were required to describe the process occurring after pollination, ending with the formation of a zygote. It was evident that many knew the basic sequence, but were hampered by confusion over the names and positions of structures. Those who were most successful kept to the terminology used in the syllabus, by describing the growth of the pollen tube from style to ovule, and the passage of the male nucleus along it, before fusion with the female nucleus to form a zygote.

(d) In suggesting how cells in flowers obtain sugars and other nutrients, only higher achieving candidates could describe the formation of sugars in leaves by photosynthesis. Few distinguished between sugars and minerals, classifying them simply as nutrients, or between phloem and xylem. Consequently answers often implied that sugars were obtained through roots. Some thought sugars were brought in by pollinating insects. The word flower was interpreted by some as meaning flowering plant.

Question 9

(a)

(i) Temperature or concentration were the most likely variables chosen to be kept constant for reliable results, and their effect on reaction rate was usually included. An explanation in terms of frequency of collision of particles was sometimes provided, although some just wrote about more collisions, which was insufficient. Amount of acid was allowed but candidates usually found an explanation more difficult. The idea of a fair test often gained further credit.

(ii) Almost all knew that the lighted splint would produce a 'pop', caused by the f hydrogen.

(b)

(i)(ii) There were a lot of good answers to both parts, but some were spoiled by writing that metal was being *used* as an electrode with a particular polarity. This implied confusion with electrolysis and was not credited. Some candidates offered a valid theoretical explanation of the idea in terms of electron flow, which did not answer the question.

(c) A few candidates drew a suitable diagram of the bonding in a metal, with atoms and delocalized electrons labeled. Representation of a useful model showed atoms of equal size, regularly arranged, with small spaces to allow the random arrangement of delocalized electrons. There was more success in describing electrical conduction in terms of free, mobile electrons carrying charge. An inaccurate idea, frequently expressed, involved passing charge or vibrations from atom to atom.

Question 10

(a)

(i) The majority of candidates drew rays in the optical fibre as straight lines with equal angles of incidence and reflection. Taking care with the first reflection usually ensured that subsequent angles exceeded the critical angle and an excessive number of reflections was avoided.

(ii) Successful responses related to the use of optical fibres for telecommunications rather than as light guides for internal examination. Thus speed of transmission, interference, amount of data, attenuation and resistance to moisture were appropriate areas for discussion, rather than safety and flexibility.

(b) Many candidates presented a well-structured calculation showing the formula, substitution and evaluation of the correct current. The table was usually used correctly to predict the effect on the body. Sometimes credit could not be awarded due to omission of the unit.

CO-ORDINATED SCIENCES

Paper 0654/04
Coursework

Key message

- Centres continue to show a good understanding of the skills required when undertaking coursework and have chosen tasks which allow candidates to demonstrate their ability.

(a) Nature of tasks set by Centres.

Of the Centres who submitted coursework for the June examination, most have provided coursework in previous years and have acted on advice given. All the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates.

All Centres including those new to the coursework component had a good understanding of the skills being assessed.

The standard of candidates work was the same as in previous years.

(b) Teacher's application of assessment criteria.

In all 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.

Centres are encouraged to produce assessment criteria specific to the tasks set, rather than awarding marks on the general criteria in the specification.

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

Tick lists remain popular, particularly with skill C1.

Many Centres prefer to write a brief summary at the top of the script justifying their marks. There is a great advantage to Centres and to candidates to know the point at which they gained a mark.

Recommendations have been made encouraging the use of annotation on candidates' scripts.

(d) Good practice.

Many Centres have developed a booklet of tasks and dedicated assessment criteria.

CO-ORDINATED SCIENCES

Paper 0654/51

Practical Test

Key message

- to ensure that candidates are awarded appropiately, the Supervisors results need to be as full and accurate as possible.

General comments

Candidates did not appear to run out of time to complete this paper and all parts of the three questions proved to be accessible. The inclusion of the Supervisor's results for all three questions helped with the marking and it was clear that the apparatus and chemicals for the examination had been well prepared in most Centres. It is worth noting that Supervisors are invited to plot any graphs and carry out any calculations using readings from the graph because credit may be available for accuracy relating to the Supervisor's final answer. This was the case in **Question 2**.

Comments on specific questions

Question 1

Generally the question was well answered. A number of candidates had clearly confused inhaled air and exhaled air in their answers. In **(c)(ii)** often there were references to carbon dioxide instead of oxygen; these were simply ignored. Although there were several options for the award of credit in **(c)(iii)** very few candidates referred to respiration or to humans breathing out carbon dioxide. Most candidates were able to describe a suitable experiment but often did not include sufficient detail. It is important to state what is varied and what is kept constant, and the experiment should be repeated to check reliability and essential equipment should be listed. Many candidates monitored pulse rate rather than breathing rate. Although 'breaths per minute' was expected, an answer of 'counting of breaths in a specified time' was accepted.

Question 2

The Examiners relied on information provided by Supervisors, as the *length* of the elastic band was often given in **(a)** although the *width* had been asked for. Generally the experiment was carried out well and sensible results were obtained. The most common error in **(b)** was the increase in the length since the previous reading being calculated instead of the *total* increase in length. Graphs were well plotted with very few plotting errors. There were several instances of no units for the axis labels, non-linear or transposed axes and use of less than half of the graph paper area provided. Many candidates drew a line through their points before answering **(d)** and then used the shape of their line to answer **(d)**. Candidates were expected to state that the line should go through the origin because there is no increase in length when the mass is zero; this statement was not often seen. If candidates wrongly predicted that the graph should not go through the origin, they were then given credit for drawing a line which did not go through the origin. In **(g)** candidates were expected to respond in terms of proportionality or a lack of proportionality; the use of 'almost proportional' was not an acceptable response. Part **(h)** was well answered. Only the more able candidates knew how to represent the breaking of the elastic band.

Question 3

Supervisors must take care to read the instructions carefully and provide the chemicals specified. The appearance of iron(III) ammonium sulfate changes if the crystals are crushed and this was allowed for when the Supervisor recorded the appearance of the crystals. Where iron(II) ammonium sulfate was provided instead of iron(III) ammonium sulfate, the Examiners were able to make an allowance, but this may not always be the case. Centres are reminded that 'strong heating' means heating beyond the first change or observation. In this case, the salt **Z** undergoes several stages of thermal decomposition. Part **(c)(i)** was a 'dissolving test' and it is important for such tests that a small amount of material is tested to ensure that candidates do not move on to use unnecessary solvents. The rest of the practical was well done and did not

cause difficulties with observations. In **(e)**, credit was available for each ion so minimal [illegible] accepted but candidates should be encouraged to write more fully and clearly in support of conclu[illegible]

More scripts than usual had chemicals split on them and this emphasises the need for candidates [illegible] familiar with the techniques of heating and shaking test-tubes.

Centres are reminded that candidates are expected to be made familiar with the practical tests leading to the identification of ions and gases as specified in the curriculum and the *Notes for Use in Qualitative Analysis* provided in each practical paper. This also provides information to help candidates spell the names of ions and write formulae correctly. For example, ammonia was not accepted as an alternative to ammonium.

CO-ORDINATED SCIENCES

Paper 0654/52

Practical Test

Key message

- to ensure that candidates are awarded appropiately, the Supervisors results need to be as full and accurate as possible.

General comments

Centres are to be congratulated on the setting up of the practical exercises in this paper. Supervisors' results, which are essential to ensure fair marking, were mostly helpful. Supervisor are reminded to plot any graphs and carry out any calculations using readings from the graph because there credit for accuracy may be available relating to their final answer; as was the case in **Question 2**. Very good answers were seen and there were relatively few very weak answers. All three questions were accessible and there did not appear to be any time issues regarding the completion of the paper.

Comments on specific questions

Question 1

Parts **(a)(i)** and **(a)(ii)** were very well done with very few instances of inappropriate recording of results. A small number of candidates gave the energy content of the bread to more than three decimal places. Candidates seemed relatively unaware of the likely sources of error in this experiment although loss of heat and incomplete combustion were seen in answers. There was little confidence seen in the answers to **(a)(iv)** and the most common acceptable answer involved reducing the distance from the flame to the tube. The food tests in **(b)** were well done and many candidates were awarded full credit. The Supervisors recorded results of the biuret test were required in order for candidates to gain credit. Descriptions of colours of solutions, not mixtures, were asked for, so *white* was not an acceptable part of any answer.

Question 2

Despite the complexity of the apparatus, candidates were able to produce very good sets of results. Some candidates did not follow the instructions which stated clearly that the 500 g mass should be moved 50 mm each time and the commonest error was to have the first reading of **d** at 250 mm. A small number of candidates recorded the distances in centimetres. A few candidates recorded the force as values which must have been mass rather than force. Graphs were well plotted with very few plotting errors. However there were a number of cases of no units for the axis labels, non-linear or transposed axes and use of less than half of the graph paper area provided. A large number of candidates missed the significance of the (0,0) on the graph and started the *x*-axis at some other value. Clearly these candidates did not appreciate that any reading of the intercept on the *y*-axis was going to be invalid. Candidates were told to draw a straight line which would **not** pass through the origin. Despite this a significant number of candidates drew curves or lines which passed through the origin. Extended lines which cut extended axes were accepted but values read in such circumstances were not accepted. Many candidates were able to work through the calculations in **(d)** and there was credit for accuracy for being within 10 % of the Supervisor's value; this was not often gained. Part **(e)** required a description of what would be done and with what measuring instrument to make sure that the rule was horizontal. Most candidates attempted this but generally descriptions were rather vague, often missing the point that measurement "either side of the pivot" was required.

Question 3

The mixture of copper carbonate and aluminium sulfate gave obvious results for most of the tests however there were difficulties towards the end of the question because sufficient shaking was very important here to enable the two compounds to react fully. For the colours of the solid **X** and the residue in **(a)(ii)**, additional colour references were ignored. Consequently the colour of the solid **X** was very well answered but only about half of the candidates obtained a white residue. In **(b)**, the expected precipitates were usually seen

but candidates did not always record this in an appropriate manner nor did they document th f these precipitates. It is clear that the terms *soluble in excess* and *insoluble in excess* a understood. Also it is important to add reagents slowly in order to observe precipitation be precipitate dissolves. The naming of the two ions in the filtrate was done well as was the name of the in the residue which was accepted without a matching observation of effervescence with acid. A signific number of candidates used chemical symbols when (chemical) names had been asked for. This practice should be discouraged as symbols can so easily be incorrect. Candidates with good experimental technique observed the expected white precipitate in **(d)** and were awarded full credit. Some candidates did not see a white precipitate; this may have been because not all of the copper compounds had reacted and dissolved in **(a)**.

Centres are reminded that candidates are expected to be made familiar with the practical tests leading to the identification of ions and gases as specified in the curriculum and the *Notes for Use in Qualitative Analysis* provided in each practical paper. This also provides information to help candidates spell the names of ions and write formulae correctly.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key message

Candidates who have carried out experiments themselves will have a greater understanding of the principals and practice of practical work in science. Ensuring that candidates have practical experience is therefore the key to improving the performance of candidates on this paper.

General comments

Questions 1, 2 and **3** are based on the corresponding experiments in the Practical examination paper 51, so that this paper is firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated their practical knowledge. Nevertheless, others showed poor appreciation of the principles and practice of science, especially in the chemistry questions. There were a number of completely blank spaces where candidates did not attempt the question.

Candidates appeared to have few problems in reading dials and scales and there was significant improvement in the drawing of graphs.

Candidates would benefit from experience in the correct use of decimal places. In the main, answers should be at least to the same number of decimal places as on the question paper, remembering there is a difference between 2 and 2.0. When truncating a long string of numbers after the decimal point correct rounding is expected, 2.47 should be correctly given as 2.5 to one decimal place and not 2.4.

Comments on specific questions

Question 1

(a) Despite being asked, in **(i),** to record the times in seconds a number of candidates did not do this and answered in minutes and seconds. In **(ii)** it was left to the candidates' judgement to say yes or no, providing they gave a suitable explanation. A good proportion of candidates gave a suitable comment in **(iv)** to explain the oxygen content of inhaled and exhaled air and the subsequent effect on the time the candle flame stayed alight.

(b) The vast majority realised that carbon dioxide was responsible for the difference in appearance and the more able candidates realised that respiration was responsible.

Question 2

(a) Most candidates were able to complete the table successfully, converting the mass to force and calculating the total increase in length. Although many candidates drew very good graphs, there were some missing or inaccurate labels. Some candidates did not use a ruler to draw the straight line and so could not receive credit for this. Candidates were asked, in **(iv)** to describe and explain the relationship between the applied force and the total increase in length. The values are proportional (one marking point) because it is a straight line graph (second marking point). Very few gained full credit here. Most were able to use the graph to predict the required value and most showed clearly how they did it. Examiners were expecting lines drawn on the graph from the *x*-axis to the line and then to the *y*-axis. Little dots on the axes or line were insufficient.

(b) Only the most able candidates correctly answered this part. A line vertical from the end of the graph to the *x*-axis was expected as the increase in length would be zero if the band broke. Many candidates showed the graph tailing off slowly to the *x*-axis, others started off vertically but then turned 90° and finished off parallel to but well above the axis.

Question 3

This question, again based upon the corresponding practical paper, was a collection of standard analysis questions concerning an unknown solid containing a mixture of two cations and an anion. Examiners noted that many candidates left parts of this question completely blank, and as chemical analysis questions often appear, it was unclear whether this was because candidates ran out of time or were unfamiliar with this type of experiment. A number of candidates who had learned these tests scored very highly.

(a) Litmus turning blue was known by many, but disappointingly was often the only credit scored in the entire question. Many gave the ion responsible for the gas as ammo**nia** rather than ammo**nium**.

(b)

(i) The answer, iron(III), was not well known.

(ii) A number of candidates appeared to be giving a test for chlorine gas. The negative test result was also required. Acidified silver nitrate solution that gave a white precipitate if chloride was present, and no change or no precipitate if not present, would have gained full credit.

(iii) The standard test for a sulfate was not well known.

(iv) Only a few candidates gave a valid reason for the addition of hydrochloric acid.

(c) A candidate that successfully answered all previous parts would identify the unknown as iron(III) ammonium sulfate.

Question 4

(a) Although the instructions clearly stated that the reading had to be taken from where the dough touched the side of the measuring cylinder, many candidates disregarded this and gave incorrect readings.

A number of candidates were unable to fill the table in correctly, sometimes giving negative increases in the volume of dough. This shows a lack of understanding of the question. This is an example of where candidates should check their answers to ensure that they are logical and 'make sense' given the context of the question.

(b) This should have been 40 °C, but error carried forward was applied and therefore partial credit could be gained.

(c) Many candidates gave the correct answer as a 'water-bath', although a large number gave 'thermometer' as their answer (probably misreading the question).

(d) The final part of this question was very poorly answered. The rate of reaction (of the enzyme) increased as the temperature increased from 20 °C to 30 °C, and activity (of the enzyme) decreased above 40 °C as the enzyme was denatured.

Question 5

(a)(b) The vast majority gained full credit here, although a few candidates misread the scales.

(c) Candidates were given the equation to calculate the density, but some used incorrect values from their tables. The main reason for credit not being awarded however was incorrect rounding of answers. Candidates using calculators often find themselves with a string of numbers after the decimal point, some then incorrectly forget to round up or down as necessary. For instance, a value of 8.87 expressed to one decimal place should be 8.9 rather than 8.8, and a value of 11.33 should not be given as 11.4.

(d) The table of densities given should have led candidates to the metals lead, gold and copper. Weaker candidates seemed to manipulate their answers in **(c)** to exactly match values in the table.

Question 6

(a) A number of candidates were confused by the upside-down nature of the readings. How graph was often very well plotted. There were instances of not labelling the lines or of joinin points with very thick lines. A single, carefully drawn curve passing through as many points possible gained credit. Manganese(IV) oxide was often identified as the best catalyst, and most noted that the graph showed more gas being given off or that the line was steeper. A number of candidates gave copper(II) oxide as the best catalyst for the opposite reason.

(b) Candidates had difficulty in finding a credible source of error in the experiment. The expected answer of spatula measurements being inaccurate was given by the more able candidates. Many vague answers such as 'timing errors', 'temperature variations' or 'being unable to read inverted cylinders' did not gain credit.

(c) Candidates had already been told that a catalyst is not used up in the reaction, so when asked how they could prove that the oxide is a catalyst some detail was required. A simple statement saying none was used up or it could be used again did not gain credit. The expected answer that 'The catalyst had to be retrieved, filtered, decanted etc. then washed and dried so that the mass could now be compared with the starting mass' gained credit. However valid alternatives of stated were given full credit.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key message

Candidates who have carried out experiments themselves will have a greater understanding of the principals and practice of practical work in science. Ensuring that candidates have practical experience is therefore the key to improving the performance of candidates on this paper.

General comments

Questions 1, 3 and **6** are based on the corresponding experiments in the Practical examination, paper 52, so that this paper is firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated their practical knowledge. Nevertheless, others showed poor appreciation of the principles and practice of science, especially in the chemistry questions. There were a number of completely blank spaces where candidates did not attempt the question.

Candidates appeared to have few problems in reading dials and scales and there was significant improvement in the drawing of graphs.

Candidates would benefit from experience in the correct use of decimal places. In the main, answers should be at least to the same number of decimal places as on the question paper, remembering there is a difference between 2 and 2.0. When truncating a long string of numbers after the decimal point correct rounding is expected, 2.47 should be correctly given as 2.5 to one decimal place and not 2.4.

Some candidates seemed to be unaware of the difference between accuracy and reliability. Any number of repeats (and taking the average) will not improve the accuracy if there is an underlying fault in the procedure.

Comments on specific questions

Question 1

(a) The vast majority of candidates read the thermometers accurately. Given other necessary information candidates had to calculate the energy content of the bread and the majority were able to gain full credit.

(b) Only the more able candidates understood the principles behind the experiment, many thinking it was because only a small piece of bread was burned and not the whole slice or loaf. Another common misunderstanding was that the bread lost energy because it was burned. The expected answer that energy was lost to the air or to the glass of the test-tube was seen along with other valid comments that were creditworthy such as a long delay in placing the lit bread under the test-tube. Suggestions were then sought to increase the accuracy of the experiment, the expected answer was to apply some sort of wind-proof insulation so that most of the heat was directed at the test-tube and there were many ways of expressing this.

(c) About half the candidates thought the butter would reduce the total energy released, either because it insulated the bread and stopped it burning or because it absorbed the energy as it melted. The more able candidates stated that the energy output would be higher as fat contains more energy than carbohydrate.

Question 2

(a) This was well answered by the majority of candidates, with only the weakest misreading the Any errors in this part of the question were taken into account in subsequent calculations.

(b) Examiners were expecting answers involving shielding the flame or moving the burner closer to the beaker. Many correct answers were seen. Answers suggesting 'using more fuel', 'burning the fuel for a longer time' and 'using a Bunsen burner', indicates some candidates did not understand the experiment.

(c) This was part well answered, as were most of the calculations on the paper.

(d) Many candidates suggested that it would give off too much heat or was flammable, or other standard properties of a fuel. Examiners were looking for reasons why we would not use it such as, too expensive, gives off too much smoke, too difficult to light etc.

Question 3

(a) Candidates were provided with two newton meters and asked to read the values, most did this correctly. The vast majority of candidates plotted good graphs, with well thought-out linear scales and accurate plotting. Lines of best fit, however, are sometimes drawn without a ruler or join every point in a jagged line which cannot be awarded credit.

(b) The calculations were well done by most candidates.

(c) The more able candidates gave the expected answer, use of a spirit level, or correctly described the process if they were unable to name it. Other candidates suggested measuring the height of each end to make sure the distance from the bench was the same. Weaker candidates suggested levelling it by eye or putting another newton meter at the other end.

Question 4

(a) When asked to measure from the paper candidates should note carefully what they are asked to measure and the units to use. The paper clearly expected answers in mm but a number of candidates gave answers in cm or answers ten times the expected.

(b) Due to incorrect measurements in **(a)**, some candidates had answers showing the actual fruit to be smaller than the photograph. It would be expected that candidates seeing this obvious contradiction should return to and check their previous measurements. It was expected that candidates should have used the equation provided to work out the decimal value of 'fraction of actual size', however many candidates gave an actual fraction (e.g. 55/120). Correct fractions were given full credit.

(c) Many candidates produced a valid working key based initially on the actual size of the fruit (greater or less than 100 mm) and then on the number or position of the seeds. Incorrect keys had information not given such as colour, taste, firmness etc. or used the fractions of actual size, many of these answers gained partial credit.

Question 5

(a) Most candidates were able to do this, although some had difficulty in calculating the total extension. This is an example where candidates should check their work; the extension should increase each time, if it goes up then down then up again candidates should realise that something is amiss.

(b) The graph, if plotted correctly, showed the first seven points in a perfect straight line with the final plot very obviously much higher. The graph clearly showed that it confirmed Hooke's law because it was a straight line between 0 N and 9 N but then the elastic limit had been reached, shown by the last point. However, many candidates were unable to accept this and just gave a statement that it did not follow Hooke's law as the last point was not in line. Candidates should be aware of the mark allocations given for each question, as a simple 'No' is unlikely to gain full credit in a three mark question.

(c) Weaker candidates stated that the spring had been 'stretched'. This was not credit
spring had been stretched each time. The important point was that the spring had bee
too much that it had passed the elastic limit.

Question 6

The final question, based upon the corresponding practical paper, was a collection of standard chemical analysis questions concerning an unknown solid containing a mixture of two compounds. The Examiners noted that many candidates left this question completely blank, and as chemical analysis questions often appear, it was unclear whether this was because candidates ran out of time or were unfamiliar with this type of experiment. A number of candidates who had learned these tests scored very highly.

(a) The best candidates gave the expected answer of a carbonate ion which gives off a gas that turns limewater milky. This type of question is frequently asked and is based on a standard chemical test; candidates should be made familiar with these tests before the examination. Zinc should have been identified as the cation which produces a white precipitate with aqueous sodium hydroxide, dissolving in excess. The range of answers suggests that many candidates need a greater familiarity with these tests as well as the difference between anions and cations.

(b) The effects of aqueous sodium hydroxide and ammonia on copper ions were not well known.

(c) The final chemical test, the barium chloride test to identify a solution containing sulfate ions, was poorly answered. Only a few candidates knew that dilute hydrochloric acid was added to dissolve any carbonate ions present.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key message

Candidates who have carried out experiments themselves will have a greater understanding of the principals and practice of practical work in science. Ensuring that candidates have practical experience is therefore the key to improving the performance of candidates on this paper.

General comments

Questions 1, 3 and **6** are based on the corresponding experiments in the Practical examination, paper 52, so that this paper is firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated their practical knowledge. Nevertheless, others showed poor appreciation of the principles and practice of science, especially in the chemistry questions. There were a number of completely blank spaces where candidates did not attempt the question.

Candidates appeared to have few problems in reading dials and scales and there was significant improvement in the drawing of graphs.

Candidates would benefit from experience in the correct use of decimal places. In the main, answers should be at least to the same number of decimal places as on the question paper, remembering there is a difference between 2 and 2.0. When truncating a long string of numbers after the decimal point correct rounding is expected, 2.47 should be correctly given as 2.5 to one decimal place and not 2.4.

Some candidates seemed to be unaware of the difference between accuracy and reliability. Any number of repeats (and taking the average) will not improve the accuracy if there is an underlying fault in the procedure.

Comments on specific questions

Question 1

(a) The vast majority of candidates read the thermometers accurately. Given other necessary information candidates had to calculate the energy content of the bread and the majority were able to gain full credit.

(b) Only the more able candidates understood the principles behind the experiment, many thinking it was because only a small piece of bread was burned and not the whole slice or loaf. Another common misunderstanding was that the bread lost energy because it was burned. The expected answer that energy was lost to the air or to the glass of the test-tube was seen along with other valid comments that were creditworthy such as a long delay in placing the lit bread under the test-tube. Suggestions were then sought to increase the accuracy of the experiment, the expected answer was to apply some sort of wind-proof insulation so that most of the heat was directed at the test-tube and there were many ways of expressing this.

(c) About half the candidates thought the butter would reduce the total energy released, either because it insulated the bread and stopped it burning or because it absorbed the energy as it melted. The more able candidates stated that the energy output would be higher as fat contains more energy than carbohydrate.

Question 2

(a) This was well answered by the majority of candidates, with only the weakest misreading the Any errors in this part of the question were taken into account in subsequent calculations.

(b) Examiners were expecting answers involving shielding the flame or moving the burner closer to the beaker. Many correct answers were seen. Answers suggesting 'using more fuel', 'burning the fuel for a longer time' and 'using a Bunsen burner', indicates some candidates did not understand the experiment.

(c) This was part well answered, as were most of the calculations on the paper.

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