CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

Biology

General comments

The biology questions catered for a wide range of ability, with only the very easiest and the most difficult of the questions making contributions that fell on the limits of the design criteria.

Comments on individual questions

Question 1

This was comfortably the easiest question in this section and served to indicate that candidates were very secure in their knowledge of the characteristics of mammals.

Question 2

The syllabus requires candidates to be familiar with the nature of products formed during photosynthesis. That well over half of them thought that it is only starch that is manufactured suggests that many were unfamiliar with the fact that some plants do not convert their glucose into starch.

Question 4

It was significant that over a half of the candidates believed that fat digestion occurs elsewhere than in the intestines, but, somewhat reassuringly, they did not include those who scored highly on the paper as a whole.

Question 6

Some candidates would have benefited from carefully reading the question which asked for what happens *during* (rather than after) anaerobic respiration in muscles. They may then not have been attracted by a reference to what happens to the lactic acid *after* anaerobic respiration has occurred.

Question 7

A common problem is to confuse the names and functions of the pulmonary arteries and veins. This may have been a contributory factor towards over a third of the candidates suggesting that veins will always contain blood with low oxygen content.

Question 10

The question states that the diagram is of a fruit, and the seed is labelled as being *inside* the fruit. A number of candidates incorrectly selected options **A** or **D**; candidates should be encouraged to consider carefully the information given in a question stem.

Chemistry

General comments

Overall the examination performed well with the Chemistry questions being of approximately the same difficulty as those for Biology and Physics.

Comments on individual questions

Questions 15, **17**, **21** and **23** proved to be the easiest for the candidates, while **questions 22** and **24** were the most difficult.

Question 24 Option **A** proved to be slightly more popular than the correct answer. Candidates may have chosen it because they had heard the expression 'emulsion paint'. Candidates need to be aware that an emulsion is a colloid formed from two liquids. A liquid plus a solid forms a sol.

Physics

General comments

Physics items that the candidates found the most difficult were **31**, **32**, **35** and **39.**

Comments on individual questions

Item **28** worked well, with option **A** being the most popular distractor.

Candidates performed strongly in the speed / time graph item **29**.

Although generally well answered, in item **30,** option **B** was the most common mistake; this option showed two identical forces acting in opposite directions. Those who chose it perhaps needed to appreciate that the two forces would have different lines of action, which would cause the beam to rotate.

Power was the subject of item **31**; the most commonly chosen incorrect option was **A**, which showed the smallest value for all three quantities, including time. A more productive approach would have been to look for a large time to give a small power.

Item **32** was incorrectly answered by many, indicating that candidates needed a greater facility with the concept of specific heat capacity.

Every distractor was effective in item **33** on circuits, with a slight preference for option **B**, which included one switch in a position which would prohibit the right bulb from ever being switched on alone.

In item **34**, of those failing to gain a mark, most believed that the connecting leads to the kettles would overheat.

Connection of a voltmeter in a circuit was covered by item **35**, and less than half of responses were correct; many candidates selected option **B**, which showed the voltmeter in the correct place to connect an ammeter.

Nearly one in four candidates opted for **D** in item **36**, confusing amplitude with peak-to-peak value.

The recall item **37** worked as intended.

Candidates fared well in the straightforward item **38**.

Item **39** required knowledge of the nature of ionising radiation.

With the half-life item **40** each distractor was almost equally popular; indicating that candidates would benefit from a more detailed understanding of the concept of half-life.

CO-ORDINATED SCIENCES

Paper 0654/12

Multiple Choice

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

Biology

General comments

The biology questions catered for a wide range of ability, with only the very easiest and the most difficult of the questions making contributions that fell on the limits of the design criteria.

Comments on individual questions

Question 1

The syllabus requires candidates to be familiar with the nature of products formed during photosynthesis. That almost 2/3 of them thought that it is only starch that is manufactured suggests that they were unfamiliar with the fact that some plants do not convert their glucose into starch.

Question 7

Candidates found this the easiest question in this section. There was a considerable amount of material to assimilate, and that they did so is much to their credit, and shows a sound grasp of the concept of food chains and the carbon cycle.

Question 8

A common problem is to confuse the names and functions of the pulmonary arteries and veins. This may have been a contributory factor towards over a third of the candidates suggesting that veins will always contain blood with low oxygen content.

Question 11

The question states that the diagram is of a fruit, and the seed is labelled as being *inside* the fruit. A number of candidates incorrectly selected options **A** or **D**; candidates should be encouraged to consider carefully the information given in a question stem.

Question 12

There was confusion here between the factors controlled and an agent that is involved in controlling one of them during homeostasis. As a result, many of the candidates chose the option that indicated that insulin levels in the blood are maintained at a constant level.

Chemistry

General comments

Overall the examination performed well with the Chemistry questions being of approximately the same difficulty as those for Biology and Physics.

Comments on individual questions

Questions 22 and **24** proved to be easiest, being answered correctly by over 80% of candidates, while q**uestion 23** was the most difficult.

Question 22 Option **A** was the most commonly chosen incorrect answer. Candidates may have chosen it because they had heard the expression 'emulsion paint'. Candidates need to be aware that an emulsion is a colloid formed from two liquids. A liquid plus a solid forms a sol.

Question 25 Option **A** was the most commonly chosen incorrect answer. Candidates correctly identified the group for element X but were too hasty in choosing option **A** and appeared not to correctly consider the charge on the ion formed.

Physics

General comments

Physics items that the candidates found more difficult were **29**, **30**, **33**, **35**, **37**, **38** and **39.**

Comments on individual questions

Item **28** on density showed option **A** as being clearly the most popular distractor.

All distractors were selected equally for item **29** on circuits.

Connection of a voltmeter in a circuit was covered by item **30**, and less than half of responses were correct; many candidates selected option B, which showed the voltmeter in the correct place to connect an ammeter.

In item **31**, of those failing to gain a mark most believed that the connecting leads to the kettles would overheat.

Although generally well answered, in item **32,** option **B** was the most common mistake; this option showed two identical forces acting in opposite directions. Those who chose it perhaps needed to appreciate that the two forces would have different lines of action, which would cause the beam to rotate.

Power was the subject of item **33**; the most commonly chosen incorrect option was **A**, which showed the smallest value for all three quantities, including time. A more productive approach would have been to look for a large time to give a small power.

Candidates performed strongly in the speed / time graph item **34**.

Item **32** was found incorrectly answered by many, indicating that candidates needed a greater facility with the concept of specific heat capacity.

In the recall item **36** the most common error was to believe that angle X was the angle of reflection,

Nearly one in four candidates opted for **D** in item **37**, confusing amplitude with peak-to-peak value.

Item **38** required knowledge of the nature of ionising radiation.

With the half-life item **39** each distractor was almost equally popular; indicating that candidates would benefit from a more detailed understanding of the concept of half-life.

Candidates performed well in the straightforward item **40**.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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

Biology

General comments

The biology questions catered for a wide range of ability, with only the very easiest and the most difficult of the questions making contributions that fell on the limits of the design criteria.

Comments on individual questions

Question 2

A common problem is to confuse the names and functions of the pulmonary arteries and veins. This may have been a contributory factor towards over a third of the candidates suggesting that veins will always contain blood with low oxygen content.

Question 8

There was confusion here between the factors controlled and an agent that is involved in controlling one of them during homeostasis. As a result, many of the candidates chose the option that indicated that insulin levels in the blood are maintained at a constant level.

Question 10

Candidates found this the easiest question in this section. However, there was a considerable amount of material to assimilate, and that they did so is much to their credit, and shows a sound grasp of the concept of food chains and the carbon cycle.

Question 11

The question states that the diagram is of a fruit, and the seed is labelled as being *inside* the fruit. A number of candidates incorrectly selected options A or D; candidates should be encouraged to consider carefully the information given in a question stem.

Chemistry

General comments

Overall the examination performed well with the Chemistry questions being of approximately the same difficulty as those for Biology and Physics.

Comments on individual questions

Questions 14, **15**, **16**, **19**, **20** and **24** proved to be easiest being answered correctly by over 80% of candidates.

Question 24 Option **A** was the most commonly chosen incorrect answer. Candidates may have chosen it because they had heard the expression 'emulsion paint'. Candidates need to be aware that an emulsion is a colloid formed from two liquids. A liquid plus a solid forms a sol.

Physics

General comments

Candidates found item **31** the easiest and items **32**, **33** and **36** the most difficult.

Comments on individual questions

Item **25** worked well, with option **A** being the most popular distractor.

Power was the subject of item **29**; the most commonly chosen incorrect option was **A**, which showed the smallest value for all three quantities, including time. A more productive approach would have been to look for a large time to give a small power.

Moments seemed to be widely understood, leading to a strong performance in item **30**.

The same was true of the speed / time graph item **31**.

Item **32** was found incorrectly answered by many, indicating that candidates needed a greater facility with the concept of specific heat capacity.

More than one in three opted for **D** in item **33**, confusing amplitude with peak-to-peak value.

The recall item **34** was well answered.

Candidates fared very well in the straightforward item **35**.

Connection of a voltmeter in a circuit was covered by item **36**, and over half of responses were correct; some candidates selected incorrect option **B**, which showed the voltmeter in the correct place to connect an ammeter.

In item **37** on circuits there was little difficulty.

The same was true of item **38** on electrical safety.

Item **39** required knowledge of the nature of ionising radiation.

The final item **40** on half-life showed a high facility.

CO-ORDINATED SCIENCES

Paper 0654/21

Core Theory

General comments

Most candidates were able to attempt most questions. Some parts of some questions were found challenging by many candidates. There was a good range of marks on most questions. Candidates generally scored on all questions. Very few gained no marks on any question and very few gained full marks on any question. Although it appeared that candidates often knew the answers to the questions, their answers were frequently very vague. Candidates must be encouraged to be more precise in their answers.

It was apparent that when a numerical answer was required, weaker candidates limited themselves to the numbers that were given in the relevant stem, and either multiplied or divided them. In some cases, it was necessary for the candidate 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 their choice and use of numbers. 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 designated area. 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

Almost all candidates did well on this question. Very few candidates were unable to gain some credit.

(a) A number of candidates wrote the equation in reverse (i.e. the respiration equation). Many candidates attempted to include light or energy in their equation.

(b) (i) Most candidates realised that light was the provider of energy for photosynthesis. A few candidates could explain what the energy was used for; others needed to include more detail.

(ii) Many candidates gained one mark here for recognising one of the features. Few were able to state two features.

(c) (i) Few candidates were able to place all five steps in the correct order. However, there was a good range of marks, suggesting that most candidates had a reasonable idea of the sequence.

(ii) Many candidates did not follow the instructions here and drew a separate diagram at the bottom of the page. Candidates need to be aware that diagrams drawn in the wrong place will not necessarily be scanned onto the electronic marking system and therefore could easily be missed.

Other common mistakes were not indicating the area which had been covered by the black paper and getting the colours the wrong way round.

Question 2

Most candidates gained marks on some parts of this question; a few answered the whole question consistently well.

(a) (i) Hydrogen was well known.

(ii) The test for hydrogen was well known.

(iii) Identification of **Z** as copper was well known.

(iv) Most candidates realised that increasing the surface area would increase the rate of reaction. Many candidates needed to make it clear which of the two reactants would react faster.

Candidates also need to make sure that they read the questions carefully. The question asked for the effect on the rate of reaction and therefore the answer given should have related to this rather than imprecise statements discussing the reaction and its products.

(b) (i) This was poorly answered. Few candidates realised that all the acid had been used up.

(ii) Zinc sulfate was not well known.

(c) (i) Many candidates gave answers indicating that they believed that a pH slightly below 7 meant that the water was neutral and therefore no acidic gases had been dissolved.

(ii) Many candidates realised that minerals would be released and that this meant that plants would grow better.

Question 3

(a) Many candidates gained marks here. Other candidates selected options from the list that had little to do with the context, the transmission of sound waves.

(b) The transformation of electrical energy to chemical energy was not well known.

(c) (i) Most candidates successfully identified one other electromagnetic wave, Some candidates ignored the detail given in the question and answered with either radio waves or visible light.

(ii) Candidates should be made aware that the uses need to be stated clearly. For example, quoting 'hospitals' as a use for X-rays was too vague to be awarded a mark.

Question 4

(a) (i) Most candidates were able to use the information in the diagram to determine the formula for octane.

(ii) Many candidates correctly identified oxygen as the second reactant. Fewer were able to complete the right hand side of the equation. Candidates need to make sure that they read the instructions. A word equation was asked for and a number of candidates made the question unnecessarily difficult for themselves by attempting to write a balanced symbol equation.

(iii) A number of candidates made the connection with nitrogen being the main constituent of the air. A few explained that nitrogen was very unreactive.

(iv) Many candidates gained credit for a reference to the metal conducting the heat away from where the fuel was burning.

(b) (i) The number of neutrons and electrons in a carbon atom were well known.

(ii) Silicon was commonly recognised. The best answers followed the instructions, and gave the symbol, rather than the name.

(c) (i) There were few correct answers here. The best answers gave a definition of an alloy.

(ii) Most candidates gained some marks here for explaining at least one useful property of duralumin.

Question 5

(a) Receptors and nerves were not well known as the first two answers. The third answer, effector, was better recognised.

(b) (i) There was a lot of confusion about the function of amylase. The best answers referred to amylase breaking starch molecules down and the very best specified maltose as the product of the reaction.

(ii) Many candidates gained at least one mark here for a correct reference to absorption into the blood.

(iii) The mechanism of peristalsis was known by a number of candidates, but few used the term peristalsis.

Question 6

(a) (i) Most candidates were able to use the graph to determine the maximum speed of the rock.

(ii) Many candidates were unable to quote the correct formula and therefore calculated the wrong value.

(b) Many candidates quoted the formula used as distance equals speed divided by time and therefore calculated the wrong value.

(c) The density calculation was well answered, showing good data handling skills. Candidates need to be aware that they can generally quote answers to one decimal place.

(d) (i) Many candidates correctly suggested a Geiger-Muller tube or other suitable device.

(ii) The effects of radioactivity on the human body were quite well known.

Question 7

(a) 'Hair' or 'fur' was often given as the correct answer.

(b) A few candidates were able to gain more than one mark here. Other candidates needed to be able to state the differences between genus and species.

(c) (i) Most candidates correctly identified all the organisms and arranged them correctly. Many candidates drew the arrows the wrong way round. A few candidates included the coyote in the food web.

(ii) Many candidates appreciated that the significance of the arrow was energy transfer, although many other attempted to describe it in terms of what eats what.

(iii) Candidates need to be able to explain that energy is lost along the food chain and the consequences of this.

(d) (i) This was well answered. Many candidates read the information given carefully and were able to describe the limiting factors which would affect the wolf population.

(ii) Many candidates gained at least one mark here. This was usually for a reference to changes in the food chain, food web or ecosystem.

Question 8

Parts of this question were quite poorly answered.

(a) Candidates needed to know that convection is the main form of heat transfer through a liquid.

(b) (i) Few candidates were able to define specific heat capacity.

(ii) The formula was well known. Candidates needed to convert the number of minutes to seconds to reach the correct answer.

(c) (i) Coal, oil and gas were well known.

(ii) Candidates needed to explain their answers in clear detail to gain credit.

(iii) Most candidates were able to identify one alternative energy resource. A minority of candidates gave the answer 'water', which was too vague to be awarded credit.

Question 9

(a) Many candidates were able to give a simple explanation of oxidation.

(b) (i) The best answers specified which compound had one copper atom per molecule and which compound had two. Other answers were confused, needing more precision.

(ii) Many candidates knew that the copper oxides were black and red, but this was not enough to gain credit. The best answers referred more generally to the property of transition metals of having coloured compounds.

(c) (i) Candidates needed to label accurately to gain credit here. More precisely, candidates needed to label the anode, and not the electrical connection connected to the anode.

(ii) This was generally answered well. Most candidates were able to give one of the alternative answers.

(iii) The test for chlorine was known to many candidates.

(iv) Only a few candidates gave the correct answer, 'copper'.

Question 10

(a) (i) Most candidates drew a circuit with correct components. A number of candidates included extra components. Most candidates placed the voltmeter in series with the other components.

(ii) Most candidates were able to use the graph to determine the current.

(iii) The majority of candidates correctly identified the formula as potential difference divided by current. Other candidates needed to ensure that they did not invert the formula.

(b) In all three parts of this question, some candidates found it difficult to use the correct terms of attraction and repulsion.

(i) Generally well answered.

(ii) Generally well answered.

(iii) Many candidates suggested that nothing happened because the iron bar was not a magnet.

CO-ORDINATED SCIENCES

Paper 0654/22

Core Theory

General comments

Most candidates were able to attempt most questions. Some parts of some questions were found challenging by many candidates. There was a good range of marks on most questions. Candidates generally scored on all questions. Very few gained no marks on any question and very few gained full marks on any question. Although it appeared that candidates often knew the answers to the questions, their answers were frequently very vague. Candidates must be encouraged to be more precise in their answers.

It was apparent that when a numerical answer was required, weaker candidates limited themselves to the numbers that were given in the relevant stem, and either multiplied or divided them. In some cases, it was necessary for the candidate 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 their choice and use of numbers. 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 designated area. 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

Almost all candidates did well on this question. Very few candidates were unable to gain credit.

(a) (i) A number of candidates clearly knew the right answer. Others attempted to describe the forces as increasing or decreasing relative to each other.

(ii) This was well known.

(b) (i) Most candidates used the information on the graph to determine a section when the car was accelerating.

(ii) Most candidates were able to read this value from the graph.

(iii) The formula for kinetic energy was not well known. Incorrect formulae commonly given were '*mass times speed* or '*mass times acceleration*'.

(c) (i) Candidates needed to be able to relate power to energy conversion.

(ii) Most candidates were able to use the formula given to calculate the current. Candidates need to be aware that they can generally quote answers to one decimal place.

Question 2

Most candidates gained marks on some parts of this question. Only a few answered the whole question well.

(a) Most candidates correctly identified 'hair' or 'fur' as one feature of a mammal, but few were able to identify a second feature.

(b) (i) Homeostasis was not a term known to many candidates.

(ii) More candidates were able to identify respiration as the process for generating heat.

(iii) Most candidates gained one mark here. Many candidates needed to articulate the sequence of events more clearly in order to gain further marks.

(c) (i) The most common incorrect answer given here was 'kidneys'.

(ii) Only a few candidates were able to name amino acids as the substance from which urea is made.

(iii) Kidney was not a popular answer here. Bladder and anus were the two commonest incorrect responses.

Question 3

(a) (i) Some type of power supply was commonly given. A common, but incorrect, answer was some type of switch.

(ii) The gas, chlorine was usually the gas identified. Only a few candidates were able to explain why chlorine was liberated at the anode.

(iii) Many candidates were able to describe copper being deposited at the cathode.

(b) (i) Many candidates gained at least one mark here for identifying one of the products. Few correctly identified both.

(ii) Many candidates correctly identified a compound and some were able to give a definition of a compound.

(c) (i) Silicon dioxide was reasonably well known as the main chemical compound used in glass. A minority of candidates stated 'silicon'.

(ii) This was not well answered. Few candidates gave the correct answer copper oxide and those that did were generally unable to explain why.

Question 4

(a) Most candidates gained at least one mark here, showing some understanding of the properties of the different radiations**.**

(b) (i) The safety precautions needed when using radioactive materials were well known.

(ii) Most candidates were able to use the graph to calculate the reading on the Geiger counter.

(iii) A few candidates were able to use their answers to part **(ii)** to state the half-life.

(c) (i) Few candidates were able to describe the nature of ionising radiation.

(ii) Only the more able candidates were able to use the properties of alpha and gamma radiations to answer the question.

(d) Most candidates managed to describe the differences in the processes. Other candidates needed to realise that it was the nuclei rather than the atoms that were splitting or joining together.

Question 5

(a) (i) and **(ii)** The numbers of chromosomes in a sperm cell and in a zygote were well known.

(iii) The nucleus was usually identified as the part of the cell in which chromosomes were found.

(b) Many candidates were able to give a general description of fertilisation, but needed to make it clear that it was nuclei of the two cells which fused together.

(c) Most candidates gained at least one mark and many gained both marks.

(d) (i) Candidates needed to explain their answers clearly to be awarded credit.

(ii) Identifying the genotypes of the parents and identifying the gametes and completing the genetic diagram was generally done well. Fewer candidates identified the child with thalassaemia.

(iii) Candidates were challenged by this question. Some referred to the role of haemoglobin, but few were able to link the problem to thalassaemia.

Question 6

(a) Most candidates drew a circuit with correct components. A number of candidates included extra components. Most placed the voltmeter in series with the other components.

(b) (i) 3 A was the usual answer given. Only a few candidates were able to explain how they came to this answer.

(ii) Many candidates demonstrated that they needed a clearer understanding of the relationship between charge and current.

(iii) Candidates generally knew that electrons are the particle responsible for carrying the charge around the circuit.

Question 7

(a) (i) Almost all candidates got this correct. The most popular answers were references to animal wastes and pesticides.

(ii) Most candidates gained one mark for a reference to acid rain. More candidates needed to be able to explain in detail the process whereby sulfur compounds produce acid rain, and the effect of acid rain on the environment.

(iii) Many candidates knew that the answer was filtration. Fewer were able to explain why.

(b) (i) Calcium or calcium ions / compounds were well known as causes of hardness in water.

(ii) Many candidates managed to describe the results in a way which suggested the relative hardness of three samples and therefore gained one mark. Fewer candidates were able to describe the results in enough detail to gain further credit.

Question 8

(a) (i) That the water came from the plant leaves was well known. The reasons for the appearance of the water were less well known. Transpiration was sometimes mentioned; more candidates need to be aware of the role of stomata in transpiration.

(ii) This part of the question was poorly answered. Candidates needed to be able to explain condensation using kinetic theory.

(b) This part of the question was also not well known. A few candidates referred to xylem or lignin.

(c) (i) Most candidates did well here, gaining at least one mark and often two marks. All the possible answers were used by many candidates.

(ii) That water moved out of the cell was generally well known. Those candidates that could explain why gained further credit.

Question 9

Most candidates were able to achieve good marks on the question, especially the first two parts.

(a) (i) Oxygen and sulfur were usually quoted.

(ii) This part was very well answered. Most candidates were able to specify the number of protons and neutrons for oxygen and the identity of the element with 15 protons and 16 neutrons.

(b) Many candidates correctly identified the hydrogen atom and the covalent bond. A common error was to confuse the hydrogen atom with an oxygen atom.

(c) (i) Hydrocarbon was well known.

(ii) Some candidates were able to describe the idea of unsaturation in hydrocarbons. Other candidates gave confusing answers.

(iii) Candidates need to be able to recognise that a hydrocarbon produces carbon dioxide upon combustion.

(iv) Candidates need to be able to recognise, name and describe polymerisation.

Question 10

(a) (i) and **(ii)** Most candidates were able to select examples of longitudinal and transverse waves from a list.

(iii) and **(iv)** Most candidates were able to select infra-red and microwaves from the list. Many candidates, however, gave the answers in the wrong order.

(b) (i) Many candidates were able to name blue as the third primary colour. Other candidates gave yellow as the answer.

(ii) Magenta and yellow were well known. Cyan was less well known.

CO-ORDINATED SCIENCES

Paper 0654/23

Core Theory

General comments

Most candidates were able to attempt most questions. Some parts of some questions were found challenging by many candidates. There was a good range of marks on most questions. Candidates generally scored on all questions. Very few gained no marks on any question and very few gained full marks on any question. Although it appeared that candidates often knew the answers to the questions, their answers were frequently very vague. Candidates must be encouraged to be more precise in their answers.

It was apparent that when a numerical answer was required, weaker candidates limited themselves to the numbers that were given in the relevant stem, and either multiplied or divided them. In some cases, it was necessary for the candidate 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 their choice and use of numbers. 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 designated area. 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 position of the heart was well known. The regions where the trachea, bronchi and bronchioles start and finish were less well known.

(b) Candidates needed to realise that the pulmonary artery and pulmonary vein are involved to gain credit.

(c) A number of candidates recognised the role of haemoglobin in the process; candidates needed to mention red blood cells as well.

(d) Most candidates gained at least one mark here, by referring to either the role of the mother's blood or the role of the placenta and umbilical cord.

Question 2

Most candidates gained marks on some parts of this question, but few answered the whole question consistently well.

(a) (i) Candidates needed to realise that the reactants in electrochemical cells are used up.

(ii) Many candidates needed to explain their answers more clearly in order to achieve full credit.

(b) (i) Candidates needed to explain that the potato was an electrical conductor.

(ii) Methods for changing the voltage supplied by the cell were not well known.

(c) (i) Most candidates were able to correctly answer this question.

(ii) This was also well answered, although candidates need to be aware that they did need to specify fractional distillation and not just distillation.

(iii) Water and carbon dioxide were well known as the products of combustion.

(iv) Candidates needed to use information from earlier parts of the question to synthesise an answer to this part, and explain their reasoning precisely in order to achieve high marks on this part.

Question 3

(a) This was well answered. Many candidates gained at least two marks here. The commonest error was to suggest that beta radiation had no mass.

(b) (i) The process of ionisation was not well known.

(ii) None of three alternatives were known by more than a few candidates.

(iii) The effects of ionising radiation on the human body were well known.

Question 4

(a) (i) The term 'nitrogen fixation' was not known by most candidates.

(ii) Methods by which nitrogen fixation occurred were not well known.

(iii) Some candidates realised that nitrogen was unreactive. More candidates need to be able to explain that substantial amount of energy is needed to break the bonds in nitrogen molecules.

(b) (i) Most candidates used the information in the table to successfully identify sugar beet.

(ii) Many candidates were able to complete the calculation correctly.

(c) (i) Clues in the question allowed candidates to determine that this was a neutralisation reaction; candidates should be directed to make use of all the information given in a question.

(ii) Although 16 was the commonest answer, there were many alternatives given.

(iii) Most candidates knew that ammonia was an alkaline gas. To achieve higher marks, candidates needed to describe how to release the ammonia gas from a solution containing ammonium ions.

(d) (i) Candidates needed to draw a structure including at least three linked glucose units.

(ii) Carbon, hydrogen and oxygen as the three elements in glucose was well known.

Question 5

(a) (i) Many candidates gained at least one mark here. Many candidates omitted at least one piece of apparatus.

(ii) Many candidates correctly calculated the answer as 1.67 Ω. Many others inverted the formula and calculated the answer as 0.6 Ω.

(b) (i) The power calculation was well answered.

(ii) Candidates needed to be able to explain that a high voltage means a low current for the same power transmission; and that energy lost is proportional to the square of the current, meaning that less energy is lost in transmission with the high voltage / low current option. Few candidates were able to gain high marks on this question.

(iii) Most candidates scored at least one mark on this part, usually for suggesting either that aluminium was a good electrical conductor or that it had a low density.

Question 6

(a) (i) The nucleus and cell wall were generally correctly identified.

(ii) and **(iii)** Many candidates got one or the other of these correct. Few candidates were able to give both correctly.

(b) (i) Chloroplasts were successfully identified by most candidates.

(ii) Candidates needed to identify both the reactants and products in the photosynthesis reaction in order to give achieve full marks for the description.

(iii) Most candidates gained at least one mark for either suggesting that the process provided food or that oxygen was released.

Question 7

(a) (i) Most candidates correctly interpreted the graph to determine that the athlete was travelling at a constant speed.

(ii) Good data handling skills were also shown in this part to determine that the athlete was slowing down.

(b) Chemical energy and kinetic energy were both well known.

(c) (i) The process of evaporation was not well described.

(ii) Candidates needed to be more precise when describing how the shiny metal blanket helps reduce energy losses to achieve higher marks.

Question 8

Some parts of this question were poorly answered.

(a) (i) Many candidates needed to demonstrate a knowledge of the genotype **ff**.

(ii) A few candidates seemed to understand what was meant by ‘a phenotype’. A common wrong answer was to give another genotype.

(iii) The few candidates who followed the suggestion of drawing a genetic diagram here achieved higher marks.

(b) (i) The role of amylase in the breaking down of starch to maltose was well known.

(ii) Few candidates gained credit here. Candidates needed to use the information given in the question and use it together with their knowledge and understanding to answer the question.

Question 9

(a) (i) Many candidates were able to complete this simple calculation.

(ii) This calculation was also well done by most candidates.

(b) Most candidates correctly stated that the forces were balanced.

(c) (i) Many candidates were able to complete this simple calculation.

(ii) Many candidates were able to use the formula given to calculate the pressure.

(iii) This calculation was less well completed. Candidates needed to rearrange the formula correctly to achieve higher marks.

Question 10

(a) (i) **R** and **T** were usually identified as being in the same group and a correct explanation was invariably given.

(ii) **Q** and **S** were usually identified as being metals and a correct explanation was usually given.

(iii) **P** and **T** were usually identified. Few candidates were able to explain significance of the boiling points of these elements.

(b) (i) A number of candidates were able to do this well. Other candidates gave vague answers which did not contain enough precise information to be awarded credit.

(ii) Most candidates gained a mark for correctly deciding that the compound would be a solid. Only a few were able to describe any of the features of an ionic solid.

(c) (i) The colour change resulting due the formation of brome was well known.

(ii) Candidates needed to use the relative reactivity of the halogens to answer this question.

CO-ORDINATED SCIENCES

Paper 0654/31
Extended Theory

General comments

There were some excellent responses to all questions. A few candidates showed good understanding of all the parts of the syllabus that were tested. Some candidates were unable to demonstrate knowledge of the content of the supplement of the syllabus, which greatly restricted the marks available to them. Candidates need to improve their examination technique; many candidates lost marks unnecessarily by, for example, repeatedly excluding units from their answers.

Comments on specific questions

Question 1

Most candidates demonstrated familiarity with the reaction between metal and acid, and with factors that affect rate of reaction.

(a) (i) This was usually answered correctly.

(ii) The best candidates gave the correct answer, H^{+}. A common incorrect answer was H^{-1}.

(b) (i) Most candidates gave at least one correct variable, usually temperature or concentration of the acid. Other correct responses included the size of the test tube in which the gas was collected, or the degree of stirring.

(ii) This was generally answered well, in terms of the longest time taken for the test tube to fill with gas. Candidates who referred only to the 'time taken for the reaction to finish' were not awarded marks as they needed to explain how the time taken for the reaction to finish can show when the rate of reaction is lowest.

(iii) Most candidates recognised that there would be a lower rate of reaction with the single piece of metal, and related to this to surface area. Candidates needed to explain the relationship between the rate and the surface area in terms of frequency, or chance, of collisions to be awarded further credit.

(c) (i) Most candidates showed good understanding of how to write a balanced equation, and many gave entirely correct answers. The most common error was to include 2H instead of H_2 in the products. A few candidates attempted to write ionic equations, which generally led to confused answers.

(ii) Good answers stated that, as water flows through the ion exchange resin, magnesium ions from the water are retained in the resin while sodium ions from the resin enter the water. Some answers stated only that magnesium ions are exchanged with sodium ions, without making clear where these ions were removed from or added to.

Question 2

(a) Most answers correctly described the transfer of electrical energy to chemical energy in the phone. Only a few candidates mentioned heat. Some misunderstood the question or the context, and included kinetic energy in their answer. Some did not mention energy changes at all, instead describing movement of electrons.

(b) The best candidates answered correctly, explaining that digital signals are less likely to be altered by distortion or interference. Many candidates showed that they needed a clearer understanding of this topic.

(c)(i) Most candidates gave the correct answer (0) here. The most common incorrect response was 0.16, calculated by multiplying 2 m (meters) by 0.08 g.

(ii) This was usually answered well. Candidates were able to use the unfamiliar formula, substitute correct values and obtain an answer with the correct unit. If a wrong answer had been given in **(i)**, values for change in momentum that involved this answer were accepted. However, many candidates who had given a wrong answer in **(i)** generally ignored it and used 1.2 kg m / s in their calculation. The most common error was a wrong unit (usually J), or a lack of a unit, with the final answer.

(iii) The best answers used the formula relating force to change in momentum and time taken to stop, explaining that the phone landing on the carpet would take longer to stop, which would reduce the force acting on it. Few candidates, however, realised that they had been given information to help them to answer this question. Most gave very general and unscientific answers, such as the carpet being 'soft' and the concrete 'hard'.

Question 3

(a)(i) Most candidates obtained at least one mark, and many candidates were entirely correct.

(ii) This, too, was well answered. Most of the correct responses mentioned the spinal cord, with others giving the brain. The most common incorrect response was 'spine'.

(b) Many candidates showed good understanding of the terms 'effector' and 'response'. Others did not understand that an effector must be a muscle or a gland and gave incorrect answers such as 'ear drum' or 'head'.

(c)(i) The expected answer was that saliva contains amylase, which breaks down starch to maltose. Many answers did mention amylase, but it was rare to see a mention of its substrate and product.

(ii) Good answers described the breakdown of large molecules to small ones, so that these could be absorbed through the wall of the small intestine and pass into the blood, which can then distribute them to body cells. Many candidates confused this process with peristalsis, suggesting that digestion helps food to pass along the alimentary canal. Some wrongly believe that digestion helps the body to sort out what it needs from the food, and eliminate the rest.

(iii) Most candidates knew that enzyme activity increases to a maximum and then falls as temperature continues to increase. In most cases, the maximum was shown at a suitable value. Other candidates needed to think more carefully and showed a maximum that was far too high or too low for an enzyme from the human body. The most common incorrect response was to draw a line that reached a maximum and then levelled off rather than falling.

Question 4

(a)(i) This was usually answered correctly. Incorrect responses included C^8H^{18} and $C_{18}H_8$.

(ii) Most answers did use words instead of formulae, as the question asked. Many correctly wrote 'oxygen' in the first box, but many other substances also appeared here, including carbon dioxide, air and hydrocarbon. Some candidates correctly gave carbon dioxide and water as the two products. However, hydrogen was commonly given instead of water. Other incorrect answers included 'waste gases' or 'nitrogen'.

(b)(i) The majority of answers correctly gave the number 5. Of the incorrect responses, the most common answer was 7.

(ii) Where a correct answer had been given to **(i)**, candidates were generally able to show the three shared pairs of electrons and the lone pairs on each nitrogen atom.

(iii) There were some very good, clear answers to this question, mentioning that the bond between the nitrogen atoms is very strong, and therefore requires a lot of energy to break. Others answers did not provide sufficient detail, with statements such as 'nitrogen is very unreactive' or 'the nitrogen atoms are held together by a triple covalent bond'. These statements are entirely correct, but candidates need to take care that they give a complete answer to the question that has actually been asked.

(c) (i) Almost all candidates made a creditable attempt to explain why the very high strength and low density of duralumin make it suitable for the construction of aircraft. Good answers related the properties of duralumin to the large forces that act on the plane in flight and the need to reduce weight in order to reduce fuel usage. Generally, however, answers were not sufficiently related to the particular requirements of an aeroplane. A common misconception was that the plane is subjected to high air pressure in flight; in fact, air pressure outside the plane is much lower at high altitudes than on the ground. Statements about pressure were only credited if the answer made clear that there is a high pressure difference between the relatively high pressure air inside the plane, and the low pressure outside it.

(ii) The best answers clearly showed the relative atomic mass of aluminium and then used it appropriately in a calculation. There were several ways of doing this, and all valid methods were accepted. Some candidates incorrectly used 13 instead of 27 in their calculation. Candidates must ensure that they set their answers out in a way that makes it possible to understand what they are attempting to do in order that they may achieve working marks if their final answer is incorrect.

Question 5

(a) (i) Most answers were correct, although in some cases the unit was omitted.

(ii) This was well answered by most candidates, who gave a correct formula followed by a calculation and final answer with the correct unit. Candidates must ensure that they write the formula appropriately. Those candidates that drew a formula triangle instead of writing the formula, or wrote the formula using units e.g. *ohms* = *volts* ÷ *amps* rather than *resistance* = *voltage* ÷ *current* were not awarded marks

(b) (i) Most candidates knew that the magnets would repel, but not all implied in their wording that the resulting movement was the result of a force. Wording including phrases such as 'repel' or 'push away from each other' was accepted, but the answer 'move away from each other' was not.

(ii) This was almost always answered correctly.

(c) (i) The best answers explained that the current passing through the aluminium foil would produce a magnetic field, which would then interact with the field of the horseshoe magnet and produce a force. Most candidates did not mention current or magnetic fields.

(ii) There were many good answers to this question, generally involving more current or a stronger magnet. Some candidates gave answers that would be appropriate in other situations but not in this one, in particular increasing the number of coils (even though there are clearly no coils involved). The use of a 'bigger' magnet was not credited, as this does not necessarily mean that the magnet would be stronger.

(d) Most were able to do this calculation correctly. The most prevalent errors were in the manipulation of the formula, or in the calculation, resulting in an answer that could be out by a factor of 10 – most commonly 1458.3.

Question 6

Although most candidates demonstrated some knowledge of food chains and pyramids of biomass, many answers were given at a much lower level than is expected from candidates who have studied the supplement material in this syllabus. It is important that candidates move on from the level of understanding that they would have gained in their studies prior to IGCSE.

(a) (i) Food chains are generally well known, and this was answered well. Some answers had the arrows pointing in the wrong direction, and a few candidates drew an entire food web instead of a simple food chain as the question required.

(ii) It is important that, at this level, candidates understand that pyramids of biomass are quantitative representations of the biomass at each trophic level. This means that the pyramid must be drawn as stacked rectangles – the size of each rectangle represents the quantity of biomass, just as a bar on a bar chart would do. Triangles are therefore not a suitable way to represent the pyramid.

Most answers did correctly name the organisms at each trophic level, and also gave the correct terms – producer, primary consumer and secondary consumer. A few answers included decomposers, which were not credited.

(iii) This question tested the supplement material relating to the loss of energy along food chains. The best answers included a reference to energy loss and the energy available, gaining both marks. Most candidates found this question very challenging.

(b) (i) This question tested the supplement material relating to population growth curves and limiting factors. Most answers gave a sensible suggestion of a relevant limiting factor, such as 'food running out', but needed to refer to the concept of limiting factors to be awarded full credit.

(ii) Many answers gave one good suggestion, but needed to provide more details to gain two marks. Correct responses included references to extinction, or to the effect of the loss of wolves on other organisms in the food chain or the ecosystem.

Question 7

(a) (i) The best answers made a clear statement about variable valency or having coloured compounds. Many answers wrongly referred to the metals themselves being coloured. Other incorrect answers gave properties that are common to all metals, such as being good conductors of electricity.

(ii) Most candidates did arrive at the correct answer of Cu^{+}. Some candidates needed to provide explanations that were easy to follow. The requirement was for an explanation in terms of the balance of charge in the compound. Candidates had been told that there was a 2^{-} charge on the oxide ion, so all they needed to do was to state that this needed to be balanced by a 2+ charge on the copper ion, producing an overall charge of 0 in the compound. There were many examples of 'criss-cross' diagrams, which use a set of rules to arrive at the answer without correctly explaining what is taking place. Some candidates also made the error of using the formula of copper(II) oxide.

(b) (i) This was generally well known, with lines clearly drawn to the anode and electrolyte. Candidates need to take care that their labels pointed accurately at the correct structure – in some cases, the labels pointed to the plus symbol or a wire rather than the anode itself (the grey shaded area). The cathode was sometimes labelled as the electrolyte; other times the 'cathode' was labelled correctly, with no label for the electrolyte.

(ii) Relatively few answers were correct. A common error was to give an element, frequently copper.

(**iii)** This was frequently answered correctly. The most common incorrect response was 'chlorine'. Oxygen was another commonly made incorrect suggestion.

(iv) There were some good answers from candidates who recognised that bromine would produce an orange solution, and that bromide ions would be attracted to the anode. Some also used the argument that potassium is a reactive metal, so the gas at the cathode would be hydrogen. These answers were relatively rare. Candidates need to be able to use the information provided in a question to make a correct deduction.

Question 8

(a) Most answers gained one mark, either for a statement that light provides energy, or for explaining that is necessary to make carbon dioxide and water react together. Answers including both of these points were not common.

(b) (i) This was well answered, with many candidates not only describing the procedure correctly but also (unnecessarily) giving reasons for each step. A significant number of answers needed to include steps prior to the addition of iodine solution.

(ii) The drawings given by candidates usually indicate a difference in colour between the covered area of the leaf and those parts that had been exposed to light, but in many cases the colours given were not correct. A frequently given incorrect response was to suggest that the central, covered area would be green after testing. Some candidates reversed their colours, stating that the central area would be blue-black and the uncovered area brown.

(c) Answers to this question demonstrated that some candidates hold a common misunderstanding, incorrectly stating that plants photosynthesise during the daytime but respire only at night. Candidates need to be aware that plants are respiring all the time. Those candidates who recognised that respiration takes place all the time generally gained at least two marks.

Question 9

(a) This was answered well. The most frequent error was failure to convert 2000 g to kg. A few candidates used a value for *g* different to the value that was given in the question.

(b) (i) Where the formula for kinetic energy was known, this was generally answered correctly. Some candidates attempted to use *ke* = *mgh*. Most correctly used the speed of 40 m / s in their calculation, but some used 9.8, given as the value of *g* in the previous part. Some, having given the correct formula, failed to square the velocity in their calculation. Units were correct in most cases.

If a mark had already been lost in **(a)** for failing to convert 2000 g to kg, and the same error was repeated here, it was not penalised again.

(ii) Candidates found this a little more challenging than **(i)**, but there were many entirely correct answers, generally calculated by finding the area under the graph. Others answers used a more complex, but still correct, method, involving the potential energy of the rock at the top of the cliff. The most common wrong answers were 40 and 160.

(c) (i) The great majority of answers were entirely correct. Some made their calculation more difficult than necessary by changing the volume to cm^3 and the mass to kg, but this was perfectly correct as long as their units matched. Some missed off units altogether.

(ii) Answers generally demonstrated that this procedure is very well known. A few did not make clear that the container of water must be graduated (e.g. a measuring cylinder), or that the displaced water must be collected in a graduated container or poured into one. Some candidates misread the question and explained at great length how the density of the object would be measured. Although this made more work for candidates, it was usually possible to pick out the points relevant to this question from within the answer, and these answers were able to gain credit.

(d) (i) Methods of detecting radioactivity are not well known. A range of answers was accepted, but the most common answer, 'a radioactivity meter', was too general to gain credit.

(ii) This is well known, and most candidates gained credit.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

General comments

There were a few excellent performances on this Paper. The majority of candidates were appropriately entered and showed knowledge and understanding of a good range of the syllabus areas tested. Some candidates did not appear to be familiar with the supplement content of the syllabus, and these candidates struggled to achieve marks. These candidates would be likely to do better if entered for Paper 2.

Comments on specific questions

Question 1

(a) (i) Most candidates recognised that copper ions would move to the cathode, but many were not able to translate this into an observation, as asked by the question. There were many references to 'copper ions' appearing, which were not credited as ions cannot be seen.

(ii) The majority of answers correctly stated that the charge on the copper ion is 2+. The best candidates also showed clearly that they had arrived at this value by considering the need for a balance of charge, so that the negative charges of the two chloride ions must be balanced by the positive charge on one copper ion. Candidates should be made aware that 'criss-cross' diagrams that do not explain the idea of charge balance do not gain credit.

(iii) Many candidates found this question challenging. Good answers identified particle **L** as being a negatively charged ion, and explained that it would be attracted to the positively charged anode. Many candidates incorrectly identified particle **M** as being the one that would move towards the anode. Some explanations incorrectly described the particles as having a purpose, such as 'because it needs to get another electron'.

(iv) This was answered very well, with the great majority of candidates clearly showing one pair of shared electrons, and six other electrons on each chlorine atom.

(b) (i) The majority of candidates correctly identified the gas as carbon dioxide. Other candidates needed to read the question more carefully to ensure that they did as the question asked, giving a formula rather than the name.

(ii) Where candidates used the formula PbO, which was given to them in the stem of the question, the balanced equation was usually correct. Where candidates wrongly used the formula PbO_2 one mark was available for a correctly balanced equation. Some candidates, having correctly named carbon dioxide in **(i)**, failed to include this as a product in their equation, instead using the formula CO.

(iii) Most answers stated clearly that potassium is more reactive than carbon, and some went on to explain that this means that carbon could not remove the oxygen from potassium.

Question 2

(a) Few candidates gave two correct values for the current in the two branches of this parallel circuit. The most common incorrect answers were: 0.2 for both ammeters, 0.4 or 0.7 for ammeter A_2, and 0.3 for ammeter A_3.

(b) (i) Almost all answers correctly stated that Ohm's Law is obeyed, the best candidates went on to state that the graph showed that current is directly proportional to voltage.

(ii) The current was normally predicted correctly, although some answers did not include the unit. There were many different acceptable ways of arriving at the answer.

(c) (i) Good responses explained that the soft iron core in the transformer allows reversal of the magnetic field, and some also stated that it makes the magnetic field stronger. Many answers indicated that the candidate needed a better understanding of how a transformer works. The most frequently seen response was that the iron core is used because it is a good conductor of electricity.

(ii) This was generally answered correctly, with working shown.

Question 3

(a) (i) A wide range of answers was seen to this question. There were some excellent answers, explaining how water vapour is lost from the leaves by transpiration, and that this vapour cools and condenses on the bag to form the droplets. Other answers indicated that candidates needed a clearer understanding of the biological processes taking place in a plant, attempting to explain the appearance of the water droplets with reference to photosynthesis or respiration; there was also evidence of considerable confusion about what plants do during the daytime and at night. Many answers stated that photosynthesis happens during the day, and respiration and transpiration only happen at night. Some candidates suggested that various substances (for example carbon dioxide, hydrogen, oxygen) were lost from the plant and then combined to form water.

(b) (i) Good answers tended to use correct terminology, such as 'turgidity', also explaining that water was lost from cells in the leaf (rather than just being lost from the leaf). Some candidates tried to explain wilting in terms of photosynthesis.

(ii) The best candidates knew that xylem or lignin help to support the stem. Other candidates demonstrated a need for a clearer understanding of the structure of plants, mentioning xylem, but explaining its role in support as being because it is full of water. Some candidates incorrectly described the roots as holding the stem up.

(iii) This was often answered well. Most diagrams showed a plant cell like the one in Fig. 3.3, but with slightly caved in sides and with a smaller vacuole. Some diagrams also showed the cell membrane pulled away from the cell wall, but this detail was not essential for full marks to be awarded. The most frequent errors were to show the cell wall as a single line, or to show the cell with no chloroplasts.

Question 4

(a) (i) Most candidates knew that sound or ultrasound are longitudinal waves.

(ii) Many candidates gave 'microwave' as their answer. The correct answer here is ‘infra-red’.

(iii) This was often answered correctly. The most common wrong answer was 'ultrasound', which often occurred even when 'sound' had been quoted as a longitudinal wave in **(i)**.

(b) (i) The majority of candidates had learnt a correct definition of frequency.

(ii) This was well answered, with many answers including a reference to the upper limit of human hearing being a frequency of 20 000 Hz. A few candidates confused frequency with loudness.

(iii) This was generally done well, with the formula and working clearly shown. Some candidates were unable to rearrange the formula and so ended up dividing 50 000 by 330. Some used 300 instead of 330 in their calculation. Many candidates needed to include a correct unit with their answer.

Question 5

(a) The great majority of candidates correctly chose filtration. Some candidates need to be aware of reasons why filtration is not the most effective way of removing bacteria.

(b) This was less well answered than part **(a)**. The answer needed to include some reference to light rays being reflected by the solid particles in the colloid, resulting in scattering of the light rays. Candidates were allowed to show scattering on the diagram, with rays clearly bouncing back from the white circles. Some candidates indicated a need for a better understanding of the difference between reflection and refraction, giving answers that stated that the light rays were refracted by the particles. Others showed the rays reflecting back from the outer surface of the water in the colloid.

(c) All three parts of this question were found challenging by many of the candidates. Answers indicated that candidates need a better understanding of the concepts of moles and molar concentrations. Many candidates tried to do calculations that involved the relative molecular masses of one or more substances.

(i) A few candidates gave the correct answer of 0.05. Many answers showed evidence of finding the relevant information (that 0.05 mol / dm^3 sodium hydroxide solution was used) but were not able to translate this into a statement that 1.0 dm^3 of the solution contains 0.05 moles. Most candidates tried to do some kind of calculation, often involving the relative molecular mass of sodium hydroxide, or multiplying 0.05 by 12.5.

(ii) Good answers simply multiplied 0.05 by 12.5, and divided this by 1000. Some candidates forgot to divide by 1000, but could still earn one mark if the working had been clearly shown. It was, of course, acceptable to use a wrong answer from **(i)** without further penalty. Correct responses were rare with many candidates doing complicated calculations involving various relative molecular masses.

(iii) The best answers recognised that there is a 2:1 ratio of sodium hydroxide to sulfuric acid and simply divided the answer from **(ii)** by 2. Other candidates incorrectly divided their answer to **(i)** by 2. Many answers contained unnecessary calculations of relative molecular masses, often of all four substances in the equation.

Question 6

(a) This was almost always answered correctly.

(b) The best answers recognised that the area under the graph equated to the distance covered. Other answers used the incorrect relationship *distance = speed x time*, resulting in an answer of 102.4 m. Some candidates erred by misreading the speed at 8 seconds from the graph.

(c) The formula for kinetic energy is well known by most candidates. Some candidates did not square the speed in their calculation, even when this had been correctly shown in the formula. Other candidates multiplied mass by velocity and then squared the product. Units were sometimes missing, and sometimes incorrect. Candidates need to have practice in using formulae before sitting the examination.

(d) There were some excellent answers to this question, clearly stating the relationship between momentum and speed, and using this and the kinetic energy equation in the explanation. Some candidates pleasingly used numbers to illustrate their answers. Those candidates that did not know that *momentum = mass x velocity* were not able to begin to give an appropriate answer. Some answered only in terms of momentum or kinetic energy, rather than both.

Question 7

(a) Most candidates could give one correct visible characteristic of mammals but many candidates were unable to give two. The most common answer was ‘fur’. The other appropriate answers that were frequently seen were the presence of a pinna (not 'external ear', which is the part of the ear between the eardrum and the surface of the head) or of mammary glands. Many answers gave characteristics that are not visible, such as being warm-blooded.

(b) Some candidates gave very good answers. Many answers indicated that candidates need a clearer understanding of vasodilation and to be able to differentiate this process from sweating.

(c) (i) There were some excellent responses to this question, but there was also much evidence of confusion about the control of blood glucose concentration. The best answers stated that the pancreas itself senses blood glucose level. Incorrect answers often wrongly said that the brain or pituitary gland does this. Most candidates knew that insulin is involved, but many did not state that insulin is secreted by the pancreas, or that it affects the liver. Some wrongly said that insulin is an enzyme; others confused insulin with glucagon. There was also confusion between glucagon and glycogen. Credit for stating that glucose is converted to glycogen was not given if the answer said the glucose is 'broken down' to form glycogen. Candidates need to be made aware that kidneys are not involved in this process.

(ii) Most candidates scored at least one mark, generally for the urethra. The most common error was in drawing and labelling the renal arteries and veins; often, the vena cava and aorta were labelled as either the renal artery or vein, and only one vessel was shown connecting each kidney. Ureters were often drawn connecting directly with the blood vessels, rather than coming from the kidneys. Some candidates did not draw anything at all, simply labelling what was already on the diagram, so could not be given any credit. Some misspelt urethra or ureter, despite having been given these words to copy; where spelling made it uncertain which one they meant, credit could not be given.

Question 8

(a) Most candidates were able to correctly calculate half-life, clearly showing their working either in the space provided or on the graph.

(b) (i) Answers indicated that candidates need a better understanding of the nature of ionising radiation. Many answers stated that the radiation itself is made of ions.

(ii) Good answers explained that alpha radiation is much less penetrating than gamma, which is why it is less harmful if the source is outside the body, and also that alpha is more ionising than gamma, making it more harmful if inside the body. Candidates need to read questions carefully to discern exactly what is required in an answer; many candidates did not give a comparative answer, making a statement about either alpha or gamma but not both.

(c) (i) Answers indicated that candidates need to clarify their understanding of the differences between nuclear **fusion** and nuclear **fission**. Credit was given for answers making it clear that nuclei are involved in both processes, but many answers described atoms or molecules joining or splitting.

(ii) Candidates also need to clarify their understanding of this topic. The most commonly seen correct responses related to the disposal of radioactive waste, and the difficulty of safe storage as it remains radioactive for very long periods. The majority of answers implied that the process of fission is intrinsically unsafe, rather than relating their answer to accidents. General statements about the effects of radioactivity on the body did not answer the question and were not credited.

Question 9

(a) This was almost always answered correctly.

(b) (i) Some candidates recognised the pattern shown in the graph, and were able to predict that silicon would have the highest melting point in Period 3 because it is in the same group as carbon. More answers needed to make use of the information in Fig. 9.1. A few candidates identified the element with the highest melting point as being carbon, but then gave this as their answer, rather than taking the second step and finding the element in Period 3 that would have the highest melting point. Most answers made no reference at all to the data in Fig. 9.1.

(ii) A few candidates made very good responses, referring to the strength and numbers of bonds in the two types of structure, and the energy required to break them. Many candidates who were able to state that carbon has a giant structure and nitrogen a simple molecular structure were not able to explain what this meant or relate these structures to the melting points of the two substances. Some answers that did refer to bonds being broken as the substance melted showed confusion about which bonds were involved. For example, some candidates referred to the bonds holding the atoms together within nitrogen molecules. Answers that consisted of no more than diagrams of

a nitrogen atom and a carbon atom, complete with all the nucleons and electrons, were not given credit.

(c) (i) Almost every answer did show two carbon atoms and four hydrogen atoms, but there was often no double bond, and the hydrogen atoms were often shown joined to each other rather than to the carbon.

(ii) Many candidates knew that the process is cracking. Candidates needed to describe how cracking is made to happen to be awarded further marks. Some candidates explained the chemical process that takes place during cracking, which did not answer the question. A number of candidates described fractional distillation.

(iii) Once again, there were some very good answers to this question. Good answers addressed the part of the question that asked for the answer to be given 'in terms of changes to chemical bonds', stating that the double bond becomes two single bonds, and showing how a long chain of molecules is formed. Some candidates ignored this part of the question. Others candidates did state that the double bond 'breaks', but did not go on to say that it becomes single bonds, or to show this on a diagram. Those candidates who chose to draw diagrams to help their explanations often gained both marks.

Question 10

(a) All three parts of this question were generally answered correctly. The part that was most likely to be incorrect was **(iii)**, where DNA was sometimes given as an answer.

(b) This was not as well answered as **(a)**. Many candidates knew that the zygote is produced in the oviduct and that the fetus develops in the uterus. Ovary was often given for **(i)** and answers such as 'belly' for **(ii)**.

(c) This was generally well answered. Most candidates knew that the amnion has a protective function; some candidates seemed to confuse the amnion with the placenta, suggesting that it supplies the fetus with nutrients, blood or other substances. Some wrongly thought that the amnion prevents the blood of the mother mixing with that of the fetus.

(d) There were some excellent answers to this question, demonstrating a clear understanding of the role of variation in evolution. The best answers gave simple descriptions of natural selection, writing about an advantageous mutation occurring in an individual, the subsequently greater chance of that individual's survival and reproduction, and the increased likelihood of the inheritance of that characteristic by the individual's offspring. Many of the best answers used an example, either real – such as populations of rats becoming resistant to warfarin or melanism in peppered moths – or imaginary. Many answers indicated that those candidates needed a greater understanding of the process of natural selection. Some candidates described deleterious mutations. Some described mutations as being purposeful, suggesting that an organism mutated in order to become better adapted. Many simply described adaptations of a particular species, with no reference to change over time.

CO-ORDINATED SCIENCES

Paper 0654/33
Extended Theory

General comments

There was a broad continuum of marks across the candidates entered for this Paper. The responses suggested that the majority of candidates had studied the supplement material in the syllabus and had been entered appropriately. Most candidates had little difficulty in interpreting the questions, and were able to express their answers clearly. Some candidates demonstrated a need for better knowledge of terminology, and other candidates would have benefitted from more practice in applying knowledge to novel contexts.

Comments on specific questions

Question 1

(a) (i) Most candidates were aware that the reactants in the cells have been used up, or that no more chemical reaction was possible.

(ii) This was also well answered. Most answers stated that car batteries are rechargeable.

(b) (i) There were many good answers that mentioned the presence of an electrolyte inside the potato, or that it could allow the movement of ions.

(ii) Many answers correctly gave magnesium and copper, and some also explained this in terms of their difference in reactivity. The most common incorrect answer was magnesium and zinc, because these are the most reactive.

(c) (i) Many candidates could complete the equation for the combustion of heptane by inserting O_2, but there were frequent errors in balancing.

(ii) The best answers made full use of the information provided in the question, giving clear statements and detail. Many candidates recognised that electric motors do not produce pollutants, but some stated that these produce less pollution (rather than none), and most answers needed to mention a particular pollutant, such as carbon dioxide, to be awarded further marks. General statements that the hybrid cars would produce less pollution, without reference to the usage of the electric motor, or specifying when the normal engine was switched off, were not credited.

Where a pollutant was specified, credit could also be given for a statement about a specific effect of that pollutant. The effects of pollutants were often confused – for example, carbon monoxide was sometimes related to global warming, or carbon dioxide was said to affect the ozone layer.

Very few answers picked up on the part of the question that referred to towns and cities in particular, so did not attempt to relate their answer to this situation. In general, candidates need to read information provided in the question very carefully, and ensure that their answer contains clear, precise and scientifically correct information relating to the question asked.

Question 2

(a) (i) This was well answered, although chloroplasts were sometimes confused with chlorophyll, or identified as vacuoles.

(ii) The majority of candidates answered this correctly.

(b) (i) Most candidates realised that more water was lost because the plant had more leaves, or because it had a larger surface area. Many did not recognise that this is due to transpiration, instead attempting to give answers in terms of photosynthesis or respiration. Candidates should appreciate that only a tiny proportion of the water taken up by a plant is used in photosynthesis.

Many candidates wrongly believed that the plant took up water actively, according to its requirements. They should understand that the uptake of water by a plant is entirely passive, dependent on the reduction in pressure in the leaves that results from transpiration. The rate of water uptake therefore depends on the rate of transpiration, and not on the rate of photosynthesis or any other activity within the cells.

(ii) The best answers stated that the water level would drop at a faster rate than previously, explained that transpiration rate would increase at a higher temperature, and gave a reason for this in terms of faster diffusion of water vapour, or a greater rate of evaporation. A statement that the water level would drop 'further' could not be taken as an indication that it would drop 'faster' or 'by a greater amount than on the previous day', and candidates need to ensure that they have conveyed their meaning clearly. Once again, numerous explanations wrongly involved photosynthesis or respiration. A few excellent answers referred to the kinetic energy of water molecules as part of the explanation.

Question 3

(a) (i) Most candidates attempted to give a definition of radioactive decay, but it was clear that the majority needed a greater awareness of this process. Good answers referred to the breakdown of an unstable nucleus. The term 'half-life' was better known, and many were able to recall a correct definition. If loss of mass is referred to, it is important that this is related to a particular isotope or nuclide.

(ii) Many candidates successfully calculated the decay time from the data provided, and were able to show their working clearly.

(b) Most candidates could give an example of the use of radioactive isotopes. Confusion sometimes arose between radiotherapy and chemotherapy as a treatment for cancer. Smoke alarms were frequently cited, but the working was often incorrectly described. X-rays were the most common incorrect answer.

Question 4

(a) (i) Candidates should be aware that a question requiring an explanation of a scientific term requires an explanation of all the words in italics. In this case, one mark was awarded for the explanation of *discontinuous* and another for *variation*. It was rare to see any attempt to define 'variation' as differences between individuals. About half of the candidates correctly described the meaning of the term 'discontinuous', but there was much evidence of misunderstanding or unfamiliarity with this term.

(ii) Correct answers stating that blood groups are caused by genes were common. The majority of the candidates struggled to articulate the reasoning behind their answer for the second mark.

(b) (i) The majority of examples of continuous variation were correct. Benefit of doubt was given to the candidates who made choices such as eye colour, which can be considered to be continuous as eye colour does not fit neatly into definite categories.

(ii) Success in this part of the question depended partly on the choice made in **(i)**. Those who had chosen height as their example often went on to label the *x*-axis correctly with numbers, and the *y*-axis with frequency (or number or percentage), frequently producing a curve of a sensible shape, such as a normal distribution. Those who had chosen eye colour had more difficulty, and often labelled the *x*-axis with distinct categories. They then tended to draw a bar graph rather than a line graph or histogram.

(c) There were some excellent answers to this question, usually based around a specific example such as the ability of some rats to survive warfarin, or the ability of dark coloured peppered moths to avoid predation in a polluted environment, or gazelles with longer legs to run faster and escape predators. These excellent answers then continued, to explain how individuals with the

advantageous variation would be more likely to survive and reproduce, passing on their characteristic (or alleles) to their offspring and that over time, the characteristic would become more common in the population. The excellent answers were in the minority, and many answers produced by candidates did not relate to evolution at all. These other answers tended to concentrate on the species as a whole, rather than on variation between individuals within the species. They often described how variation could ensure that a species survived attack by a particular disease, rather than how *change* might be brought about over time.

Question 5

(a) These were usually correct, although some candidates gave 0.6 A for the two ammeters, or 12 V for each voltmeter.

(b) (i) The majority of candidates knew the Ohm's Law formula. However, many substituted into it incorrectly, often working out 0.6/1 rather than 1/0.6. Most gave the correct unit with their answer.

(ii) Reasons for the lamp not obeying Ohm's Law were usually given either as current not being proportional to voltage, or the lamp getting hot causing its resistance to change. Both answers were required for the two marks, but were rarely seen together. Candidates should use the number of marks to guide them in the construction of their answers.

(iii) Most candidates correctly drew a straight line through the origin, with a positive gradient. The most common error was to draw a curve. A significant number of candidates did not answer the question. Candidates must ensure that they read the paper carefully and answer all questions posed.

(c) The best answers showed that the lamp could only be lit by a transformer connected to an a.c. source. There were a few answers that demonstrated a sound understanding of electromagnetic induction. Many candidates described a lamp flashing when connected to a.c. This was awarded the 'lamp lights' mark but in practice, the flashing would not be visible at 50 Hz.

Question 6

(a) These questions were well answered, with candidates being able to select the correct data from the table. The greatest problem was experienced in part **(iii)** when relating the properties of element T to its atomic structure. Vague statements relating volatility to reactivity or mass were not sufficient to gain marks.

(b) (i) Many candidates could describe how ionic bonds are formed in terms of electron transfer and ion formation, although it was rare to see mention of the attraction between the ions of different charges. Some candidates incorrectly described electron sharing rather than electron transfer. Candidates need to be aware of the nature of ionic and covalent bonding, and the differences between them.

(ii) Even when covalency had been described in **(i)**, most went on to produce a suitable explanation of the high melting point of the compound in terms of the high energy required to overcome the forces between ions. Even the best candidates, however, had a tendency to write about 'intermolecular' forces between the ions. Relatively few referred to the large number of bonds that would need to be broken.

(c) Most answers referred to the high reactivity of potassium; only a relatively small number went on to suggest electrolysis as the method of extraction.

Question 7

(a) While there were many entirely correct answers to this, not all candidates recognised that they needed to first calculate distance travelled, and then use the formula *work = force x distance travelled*. Candidates must ensure that they give the correct units when they are not already given as part of the answer line.

(b) (i) If the correct formula was recalled and used, candidates had no difficulty with this question. Many candidates tried to use incorrect or inappropriate formulae. Of the three calculations in **(a)** and **(b)**, this was the one that was most often incorrectly answered.

(ii) Again, success depended on using the appropriate formula.

(c) (i) Most correctly gave 0.12 m^3, but some incorrectly added 0.1 to this answer.

(ii) The majority of candidates could use the formula supplied. Some answers demonstrated that those candidates needed to be more familiar with the unit of pressure. The unit was often missing or incorrect.

(iii) Most answers were entirely correct. A few candidates demonstrated difficulty with the correct rearranging of the formula. The area of piston **X** was often given as 0.03 m^2. Once again, the unit was often missing.

Question 8

(a) These structures were generally well known. The most common incorrect response was to label an intercostal muscle as a structure that rises during expiration.

(b) The best candidates were able to describe the blood flowing from the heart to the lungs in the pulmonary artery, and back to the heart in the pulmonary vein; many candidates reversed these blood vessels. Few mentioned the capillaries in the lungs, or the chambers of the heart from which the blood leaves or to which it returns.

(c) Most knew the role of haemoglobin in the transport of oxygen, but did not always mention that it is carried in the red blood cells.

(d) Many answers correctly described the movement of oxygen from the mother's blood, through the placenta by diffusion and into the blood of the fetus, often also mentioning the umbilical cord. Some misconceptions were also evident. In particular, the idea that the mother's blood flows directly into the fetus along the umbilical cord was common. Candidates needed to be aware that the two blood systems are independent and that oxygen is transferred to the foetal blood system through the fetus.

Question 9

(a) (i) Good answers stated that nitrogen fixation involves the conversion of nitrogen gas to a nitrogen compound (such as nitrate) and gave one way in which this is done; for example, by referring to the effects of lightning or to bacteria in the soil or root nodules. A common error was to use the term 'nitrifying bacteria' for these. Many candidates need to understand that atmospheric nitrogen is an element and that ‘fixed’ nitrogen occurs in compounds.

(ii) Most candidates knew that nitrogen in the air is too unreactive to be used by plants. However, some wrongly stated that plants cannot absorb it.

(b) (i) The best answers used the 2:1 ratio indicated by the equation to work out that 0.05 moles of diammonium phosphate will be produced when 0.1 moles of ammonia react. The most common answer was 0.1.

(ii) Attempts at working usually conveyed the intent of candidates to multiply the mass of 1 mole by the number of moles. However, candidates did not always carry forward their answer from **(i)**.

(c) (i) The polymerisation of glucose to form starch was generally well understood, although a minority incorrectly described the glucose molecules as 'breaking up' or 'breaking down'. Candidates should be encouraged to use the appropriate scientific vocabulary when presenting reasoning or giving explanations.

(ii) Most candidates knew the difference in appearance between a glucose solution and a starch sol, and could use the terms transparent and translucent. The third mark awarded for the explanation was gained by those who described the scattering of light, but the word 'dispersion' was sometimes used inappropriately as the effect is largely due to reflection from the starch colloidal particles.

Question 10

(a) Most of those who knew the formula for kinetic energy went on to gain full credit. Some did not square the speed, while others squared *mv*.

(b) (i) Very few answers referred to particles, as required by the question. Those who did appreciate this requirement generally correctly explained that energy is needed to turn a liquid into a gas because particles must overcome the forces between them, and this energy is gained as heat from the body. More often the information in the question was simply repeated in a different form, such as 'when the sweat evaporates it cools the athlete down'.

(ii) There were some good answers that scored at least two of the three available marks, but this question brought to light some misconceptions about heat transfer when applying knowledge of principles to a particular situation.

For convection, it was often stated that 'heat' is trapped under the blanket, rather than air. Correct answers stated that this trapped air prevents convection of heat away from the athlete, but an inaccurate argument was sometimes made that convection of the air spreads the heat around the athlete.

For conduction, it was seldom realised that the trapped air acts as an insulator. It was usually stated that foil is a good conductor, but the argument was often that it conducts heat from the outside inwards, rather than from the athlete.

For radiation, many knew that the shiny foil reflects heat radiation, but they would often then describe how radiation is reflected from the Sun, keeping the athlete cool, rather than being reflected back to the athlete.

CO-ORDINATED SCIENCES

Paper 0654/04

Coursework

(a) Nature of tasks set by Centres.

Only a few Centres submitted coursework for the November examination. The standard of candidates work was comparable with previous years with candidates covering the whole mark range.

All the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates.

(b) Teacher's application of assessment criteria.

Centres understood and applied the assessment criteria well for all of their activities.

Centres assessed skills C1 and C4 in different investigations.

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

Tick lists were used widely, with particularly skill C1.

(d) Good practice.

There was evidence showing good practice in all of the assessments.

CO-ORDINATED SCIENCES

Paper 0654/51

Practical Test

General Comments

There were some very good answers and very few poor ones, covering the whole range of marks. All three questions were readily accessible and did not appear to present any time problems. Supervisors played their part in preparing the examination and carrying out the experiments. A complete set of results is essential as the Examiners can learn a great deal from these and ensure candidates achieve the marks that are merited.

Specific Comments

Question 1

The question was well answered with the majority of candidates scoring the first six marks. Although purple was the expected colour for the reaction between biuret and solutions **C** and **E**, credit was awarded so long as there was a suitable contrast to the colour reported for the other solutions. The logical approach to the question was not always appreciated in that many candidates tested all solutions with Benedict's solution. Part **(c)** stated that there should only be two solutions remaining for testing. It was necessary to have the correct observation for the action of Benedict's on solution **D** to obtain the mark in **(c)(ii)**. Part **(d)** required that the candidates devise a plan and then for the plan to be carried out. Candidates need to be reminded to read instructions carefully, as many missed the requirement to carry out their plan. Again, credit can only be awarded if the correct tests and observation were reported. The most common answer to part **(iii)** was stating the need to use the same amount of each solution. Other acceptable answers included using the same reaction time and carrying out at the same temperature.

Question 2

Not surprisingly, no two lamps are identical and therefore the values of current in the experiments were not likely to be exactly what the theory indicates. For example, the current when two lamps were in series was unlikely to be exactly half that when one lamp was used. However, results should have been sufficiently close for candidates to realise that the statement was correct. Many were able to deduce this from their results and score two marks. When results could not support the statement, one mark was awarded providing the candidate stated that the results could not support the statement. Candidates do need to be familiar with the meters they are using to avoid misreading a current of say 0.1 A and reporting it as 1.0 A. The majority were able to draw a correct circuit for the two lamps in parallel and construct a suitable table. Parts **(e)** and **(f)** were marked in a similar fashion to parts **(a)** and **(b)**, that is making an allowance for experimental error in the values for current.

Question 3

Candidates need to understand that heating strongly means just that and do not stop heating as soon as one change is seen. Heating the compound iron(II) ammonium sulfate produces many observations including ammonia, a white solid followed by a brown solid, a white smoke and a gas that turns litmus red. Ammonia was correctly identified in part **(b)** by almost all candidates. Candidates should be reminded to use the work 'precipitate' where appropriate, as it is more specific than general descriptions such as 'cloudy' or 'milky', which cannot be credited. **(c)(i)** is the sulfate test, described on the back page of the question paper. Part **(ii)** is the chloride test but in this instance did not produce a white precipitate; therefore the substance cannot be a chloride. Silver ions are reduced by the iron(II) to a suspension of silver producing a brown precipitate. Variations on the colour brown were acceptable answers. Many correctly recorded the colours green and brown for **(d)(i)**. The most common answer for **(ii)** was blue which was not surprising since copper sulfate was being added. A blue precipitate or a deepening of the blue colour was required. Many candidates were able to correctly deduce the three ions and it was particularly good to see that most were able to distinguish between ammonium and ammonia.

CO-ORDINATED SCIENCES

Paper 0654/52

Practical Test

General Comments:

There were no particular problems and answers were in general very satisfactory. There was a good spread of marks. Supervisors reports were invaluable and are needed to ensure candidates are awarded all of the marks that are merited.

Specific Comments:

Question 1

If both the instructions to Supervisors and candidates were followed the mass of protein weighed should have been close to 10 g. In practice the Examiners allowed a mass between 5 g and 15 g. Candidates do need to try and understand the degree of accuracy required when taking measurements. The constructed table was usually satisfactory although many were drawn free hand without the use of a ruler. Candidates need to remember to include appropriate units in the headings of their tables. Some of the masses appeared to gain mass from the first measurement to the second; this may be due to excess liquid left on the mass by candidates who did not follow the instruction to 'blot the protein dry'. Most realised that the juice showing the greatest protease activity was the one producing the largest change in mass. However, the change needed to be a loss in order to gain credit. The answers to part **(d)** were very variable. The expected answer was the use of the protein with water instead of juice. A small number realised that the answer to part **(e)** was to repeat the experiment with protein and acid alone. A larger number described a process that neutralised the acid in the juice before repeating the experiment. This showed some originality and credit was awarded as appropriate.

Question 2

Candidates need to always consider whether or not a measurement has a unit. In this question two measurements of length were made and in both cases the unit was indicated. Despite this a significant number recorded their value in centimetres. Apart from this error, part **(a)** was well answered. The majority produced sensible values for **r** and correctly read off the sine value. Plotting was good and many realised that the value (0,0) was a value to be plotted. Candidates were instructed to use the graph to find the answer to parr **(c)(ii)**; some candidates instead took figures from the table, leading to unexpected answers. Although the expected answer to **(iii)** was a comment to the effect that an average of several readings is better than one single reading, a number stated that obtaining the measurement of $\mathbf{d}_1$ was difficult. This was accepted.

Question 3

Most candidates were able to connect the use of sodium carbonate with the identification of an acid and to follow this with correct identities of the solutions in so far as was possible at this stage. Many missed the significance of the silver nitrate test. Candidates need to be reminded that questions of this type cannot be 'hedged'; there is either a white precipitate or not, indicating the presence or absence of a chloride. There is no halfway answer to this kind of question. This test should have indicated that solutions **A** and **B** contained a chloride. Linking these results with those obtained in test **(a)** should have enabled the identity of each solution to be concluded.

CO-ORDINATED SCIENCES

Paper 0654/61

Alternative to Practical

General comments

Questions 2 and **3** are based on the corresponding experiments in the Practical examination, paper 51, so this paper is also firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated a good practical knowledge. Others showed a weaker appreciation of the principles and practice of science, especially in the chemistry **Questions 3** and **5**.

Comments on specific questions

Question 1

The effect of light on the mass of seedlings is explored in this question.

(a) Batches of ten seeds are placed in different lighting conditions and their mass measured over a number of days. Candidates had to read the scale on two balance readings, which most were able to do.

(b) Candidates then had to calculate the average mass of a single seed by dividing by ten; again this was achieved by most candidates.

(c) The graph of average mass of seeds against time had to be drawn. Many candidates plotted the points correctly but less success was achieved in drawing the curves. Candidates need to appreciate the importance of drawing lines of best fit that are also smooth. Duplicate lines or a series of lines connecting the points will not gain credit.

(d) The seedlings left in the dark increased in mass, as did the ones left in the light. Candidates were expected to realise that as water was provided, this was taken up by the seedlings as they germinated. When left for a few weeks, however, the seedlings would die as they would be unable to carry out photosynthesis.

Question 2

In this question, candidates are comparing the power used by one lamp with that used by two similar lamps in series and in parallel.

(a) The applied voltages, around 1.5 V, must be accurately read from the voltmeter dials and then multiplied by the current to give the power in Watts. Some candidates did not know that the unit of power is the Watt.

(b) A circuit must be completed showing two lamps in parallel. Then the ammeter dial is read to find the current and the power output found as before. Most candidates gained credit for this section.

(c) A comment is needed on two statements: two lamps in series use only half the power of a single lamp, and two lamps in parallel use twice the power of the single lamp. Candidates are expected to state that when the data obtained from parts **(a)** and **(b)** are compared, these statements are true. The slight discrepancies can be explained by the slightly varying applied voltages, due to internal resistance of the cells used. Some candidates gave acceptable answers.

(d) What other piece of apparatus must be used, in order to find the total energy used by the lamps in a circuit? The best answers suggested a timer of some sort.

Question 3

In the practical examination, compound **X**, a light green crystalline solid, was analysed. The same tests are used in this question. Candidates must complete the descriptions of the test, results and conclusions. The Examiners expect candidates to be able to recall the standard tests for cations and anions and to deduce the composition of a mixture of ions using these logical steps.

(a) Only one strong-smelling gas, ammonia, is liberated when sodium hydroxide reacts with a salt. Thus ammonium ions must be present.

(b) A green hydroxide precipitate that turns brown in air should always indicate to candidates that iron(II) ions are present, which are oxidised to iron(III) in the air.

(c) This was based on the standard test for a sulfate.

(d) A chloride is detected by the use of silver or lead nitrate in the presence of nitric acid.

Some candidates who had experience of the use of these analytical tests scored well.

Question 4

The temperature of 50 g of cold water can be increased by passing in steam, an observation that forms the basis of this question.

(a) to **(d)** Diagrams of the thermometer scales and the balance windows before and after passing the steam enable candidates to find the increase in temperature, 21.6 °C, and in mass, 2.1 g, of the cold water. Most candidates scored well here.

(e) If steam at 100 °C becomes water at 100 °C, heat is liberated. Candidates had to describe this as condensation and then use their knowledge of the kinetic theory to explain why heat is given out. There were many confused answers, with some saying that this process is 'boiling'. Others said that collisions between molecules gave out energy.

(f) The condensed steam gives 2.1 g of water that is still at 100 °C, so when it cools down to the final temperature of the water, 44.8 °C, more heat is liberated. Few candidates suggested this source of heat; many said that heat was radiated from the Bunsen burner or the surroundings.

Question 5

Although this question was headed to be about the diseases kwashiorkor and diabetes, in effect it was examining simple food tests.

(a) Candidates were told which two of five solutions tested with biuret solution contained protein and they were asked to record the expected colours in a table. Many answers featured different colours for these tubes other than the expected: purple for positive and blue for negative.

(b) Similarly, candidates were told that one tube contained starch and they were expected to know the colour of iodine solution in the presence of starch (blue / black) and its absence (brown). As in **(a)** this proved challenging for many.

(c) This part stated that one of the two remaining solutions contained glucose and the question required a choice between the red and blue test results with Benedict's solution. Most candidates answered this well.

(d) It was suggested that one of the two protein solutions contained amylase. Candidates were told that amylase breaks down sugar to starch and they were asked to plan an experiment to find which of the two solutions contained this enzyme. Candidates should be aware that planning an experiment requires careful thought and correct detail. In the description they should avoid giving vague answers as full credit cannot be awarded.

Question 6

Study of the Periodic Table should include the properties of Groups of elements such as the halogens.

(a) Few candidates knew the colours of liquid bromine and solid iodine.

(b) More knew that chlorine bleaches litmus or turns it white.

(c) (i) Starch solution is turned blue or black by the displaced iodine. This was well answered by most candidates.

(ii) Few candidates gave a properly constructed equation for the reaction between chlorine and potassium iodide solution.

(d) Which hydrocarbon gas reacts with bromine, and why? Good candidates answered this well.

(e) Heated iodine crystals vapourise and then turn back to a solid. Better-prepared candidates knew the colour of the vapour and the name of the process.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

General comments

Questions 3, **4** and **5** of are based on the corresponding experiments in the Practical examination, paper 52, so that this paper is also firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated a good practical knowledge. Others showed a weaker appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. There were a number of instances of candidates not attempting the questions.

Comments on specific questions

Question 1

Some fruit juices were examined in this question and the loss in protein mass used as a measure of the activity of the enzyme protease.

(a) Two balance windows showing the mass of two of the juices had to be read and recorded, then the change in mass for each fruit had to be calculated. This was no problem for most candidates, although a few lost a mark for not recording the answer to one decimal place.

(b) Candidates then had to choose which of the four juices, showed the greatest protease activity and explain why. Pineapple juice caused the greatest loss of protein mass, so this was the expected answer.

(c) It was suggested that as the orange and lemon juices are both acidic, it was the acid that caused the protein to lose mass rather than the enzyme. Candidates were asked to plan an experiment to find out if it was the acid rather than the protease that caused the loss. Correct answers described the acid alone being added to the protein and the change in mass measured after ten minutes as in the original experiment. Some candidates mentioned only fruit juice and enzyme and so gained no credit.

Question 2

In this question, samples of two elements were being tested in a variety of ways.

(a) Candidates were shown an incomplete electrical circuit, and asked to draw two different symbols to show that a current was flowing. Many candidates drew one correct symbol, usually a lamp, with some drawing two different symbols. Most realised that the current flowed due to the presence of a metallic element, and a few gave the name of a particular metal, usually iron.

(b) How can iron be separated from the mixture? Most candidates gave the expected answer of using a magnet.

(c) Most candidates were able to draw a simple diagram of the mixture being heated in a test-tube or crucible, but surprisingly a large number did not indicate adding water or an acid and so did not gain full credit. Only the most able candidates could state that the heating supplies the energy required and that the reaction was exothermic.

(d) A test to show that the compound produced is different from its elements was asked for. Any physical or chemical test was acceptable; the easiest and most common answer was to use a magnet.

Question 3

In the practical examination, candidates had to determine the refractive index of a semi-circular glass block; this was adapted here.

(a) Although the distances to be measured were indicated by arrows, a number of candidates were unable to measure the two lengths correctly or accurately. In **(a)(iii)** most scored the refractive index mark, since the relative lengths recorded in **(a)(i)** and **(ii)** were correct.

(b)(i)(ii) Two angles had to be measured and recorded in the table, and this proved difficult for some candidates who did not have access to a protractor. Although the values for sines were given in the table, they were frequently mis-read and credit could not be awarded.

(iii) A graph then had to be drawn; three points were already given and candidates were asked to draw the best straight line. Those who attempted to plot points on the graph needed to realise that their values for sine r were wrong if they did not fit the straight line. Many lines were drawn which almost ignored the three points which had already been plotted. The gradient had to be calculated, and candidates were expected to show their x and y values on the graph to gain credit. A value of about 1.5 should have been found.

(c) Candidates had to suggest which one of the two methods would be the more accurate. Many left this blank. Answers were expected suggesting that it was difficult to see and measure the correct distances on the graph paper in method one or that using several values, as in method two, would be more accurate than just the one.

Question 4

In this experiment a potometer was being used to study transpiration.

(a) Candidates were shown diagrams of the air bubble in the capillary tube and told to measure distance from the top of the bubble. Despite this many measured from the bottom of the bubble and some tried to estimate a half way point. Then after calculating the distance moved by the bubble they had to divide by four to find the rate of water lost per minute.

(b) (c) Only a few candidates answered these two sections of the question, a number just repeated the values from **4(a)(ii)** without explaining their meaning. Some stated that the wind blew the water vapour away from the leaf while a few referred to the effect this would have on the leaf through increased evaporation.

The precautions taken were little understood. Most candidates suggested the reason why the stem should be kept under water was that it would lose water, while some stated it would go dry or the plant would die. Very few realised that the plant would continue to draw liquid up the stem and create an air bubble.

Few candidates suggested that the stomata would get flooded or blocked if the leaf got wet; those that answered thought the leaf would rot.

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Question 5

In this question four solutions had to be identified. The names of the solutions were known, but not their order. Two tests were carried out on the samples and their identities discovered.

(a) Each of the samples was tested with sodium carbonate solution. The possible names were given and candidates were required to state the observations expected. Effervescence or bubbling was expected with the acids, and no change with the others.

(b) Test two was adding silver nitrate solution. This time the observation was given and candidates invited to name the possible solutions. Sodium chloride or hydrochloric acid gave white precipitates while no change occurred with nitric acid and potassium nitrate.

(c) Candidates were now expected to be able to name the four solutions. A number of those who attempted the question used made-up names such as hydrogen nitric or sulfur nitrate, suggesting a lack of both understanding and reading of the question.

(d) The test for nitrates was attempted by a few of the best candidates; fewer mentioned the flame test for potassium.

Candidates need to be able to demonstrate an understanding of chemical analysis.

Question 6

A question on electromagnetism.

(a) A simple question to start with: two numbers when multiplied together make 5. For this candidates needed to read the question more carefully.

(b) Two ammeter readings were required here; most scored a mark for 0.75, but candidates also needed to write 0.90 to two decimal places, in line with the other readings in the column.

(c) Most candidates explained that an increase in resistance would result in a reduced current. The best answers quoted Ohms law, referring to the inverse proportionality of current to resistance.

(d) Most candidates plotted their points correctly and most drew a straight line. Candidates should be discouraged from drawing two lines, one connecting one point to the next alongside the single line of best fit.

(e) When asked why the straight line drawn on the graph did not pass through the origin the majority suggested that a piece of card was left on the pan rather than that the pan itself had mass.

(f) Candidates were told that both soft iron and steel are magnetic materials and asked to suggest why soft iron was used in preference to steel. Most suggested that steel would be too heavy for the electromagnet to hold. A number thought it was something to do with steel or iron not being able to conduct electricity. The most able candidates referred to temporary and / or permanent magnetism.

(g) The final part asked candidates to explain why the copper wire was insulated. Some answers suggested there would be a risk of an electric shock; others mentioned that a short circuit would occur. Both responses were credit-worthy.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

General comments

Questions 1 and **3** are based on the corresponding experiments in the Practical examination, paper 53, so that this paper is also firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated a good practical knowledge. Others showed a weaker appreciation of the principles and practice of chemical analysis in **Question 2**.

Comments on specific questions

Question 1

Four test-tubes, with different coverings, were filled with hot water. As the water cooled temperatures were taken for five minutes.

(a) Two thermometers had to be read and the readings recorded in the table. Most candidates gained full credit.

(b) A second table required candidates to calculate the total temperature drop and the average temperature drop per minute. Again the vast majority of candidates gained full credit for this part.

(c) Suggestions were asked for why there was an initial large drop in temperature. The expected answer, that the heat was transferred to, or used to heat up, the cold tube, was not often seen.

Tube **D** was set up without any covering; candidates were asked the purpose of this tube. 'As a control' was all that was required, but credit was also given to many candidates who wrote two or three sentences about a reference or comparison.

(d) The absorbent paper wrapped around two of the test-tubes represents skin; one of them was soaked with water to represent sweat. Candidates were asked to compare the results of the two tubes and describe the benefits of sweating. Many candidates noted that the tube cooled down or there was heat loss. This was insufficient to gain credit as all the tubes cooled down. The Examiners were looking for explanations that the process happened more quickly if the paper was wet. The heat transfer process involved was evaporation, although conduction was also allowed.

Question 2

A mixture of chemicals had to be separated by simple physical means followed by standard chemical analysis techniques.

(a) A mixture of sand, iron filings and zinc sulfate powder had to be separated. A magnet will separate out the iron. Adding water dissolves the zinc sulfate and filtering will separate out the sand. A labelled diagram was required. Examiners expected to see, either in the diagram or in the labelling, a piece of filter paper inside the funnel. Candidates then had to describe how dry crystals of zinc sulfate could be obtained. Two processes were required: heating to evaporate some of the water, and then drying, e.g. by using a desiccator or filter paper.

(b) A straightforward analysis question then followed. Candidates need to be able to recall the sulfate test, where barium chloride gives a white precipitate, and the test for zinc ions, in which a white precipitate soluble in excess of sodium hydroxide is produced.

(c) It was stated that if lead sulfate was used instead of zinc sulfate the process would not work. The idea that the lead sulfate is insoluble was given by the better candidates.

Question 3

The relationship between potential difference, current and resistance of a wire was investigated in this question.

(a) Apparatus **X** changes the potential difference and current by altering the resistance in the circuit, therefore it is a rheostat or variable resistor.

(b) A table of voltmeter and ammeter readings needed completing by reading two dials. Most candidates had little problem here.

(c) A graph of the readings now had to be plotted. Candidates were told that the voltmeter readings should be on the vertical axis; a few ignored this instruction. However many candidates correctly plotted their points and drew acceptable lines of best fit. Incomplete or missing labelling the axes resulted in credit not being awarded. The mathematical relationship expected was 'proportional'; answers stating that as the current increased so did the potential difference gained no credit.

(d) The idea that something had gone wrong for the reading to suddenly fall to zero was looked for, and ideas that a wire had melted, the ammeter had broken or burned out were acceptable.

(e) Finally candidates were asked to suggest what would happen to the ammeter readings if an increased length of wire was used. Many incorrectly stated it would increase.

Question 4

This question used potato pieces and salt solutions of various concentrations to investigate osmosis.

(a) Potato pieces were placed in different concentrations of salt solution and left for thirty minutes. Their mass was recorded before and after and the candidate was required to calculate the change in mass.

(b) A grid was provided for candidates to plot the points, which was completed with very few errors

(c) Candidates were required to read the value from the graph at the value equal to the concentration of salt solution that produced no change in mass, i.e. where the line crosses the x-axis. Most candidates scored well here.

(d) Candidates had to describe a source of error in the experiment, and how this could be improved. Answers should have considered that drying of the potato pieces might be inadequate before weighing or that the surface area exposed might be different in each sample. A number of candidates gave rather vague or too general answers to gain credit.

(e) Red blood cells were placed in distilled water. Candidates were then invited to suggest and explain what would happen. Although many answers stated that the cells would expand, few said they would burst. Candidates also omitted to link this test back to the potato experiment, where plant cells have a cell wall that prevents plant cells from bursting.

Question 5

The effect of concentration on the reaction between marble chips and hydrochloric acid was investigated in this question.

(a) Two times were missing from the table and the candidate had to read two stop clocks and transfer the times to the table. The readings were in minutes and seconds but had to be recorded in seconds. Most candidates scored well here.

(b) Some of the marble chip remaining in the test-tube would show that marble was in excess in the experiment.

(c) The reacting test-tubes were set up with graph paper behind them, the idea being that the effervescence makes the tube opaque. As the reaction is finishing the tube clears and the time can be taken. This is a rather inaccurate way of experimenting, hence part **(f).**

(d) The four points were plotted on a grid with scales and labels supplied. The points were chosen to be slightly off a perfect straight line, which is a more realistic situation, especially with the method given.

Most candidates drew a single straight line of best fit, as required by the question. A minority drew a second zigzag line joining up the points, and so gained no credit.

Candidates were then asked to read off from their graph a value corresponding to a reaction time of ten minutes. It was important here to convert the time to seconds before the correct answer could be found.

(e) Many candidates drew the line correctly, i.e. below that in **(d)**, to represent a set of results carried out at a higher temperature, which will shorten the reaction time. Some lines were wrongly drawn above the first line, and a few intersected it. Some candidates omitted this part.

(f) As already mentioned in **(c)** above, use of the graph paper would make the timings inaccurate. Comments such as 'human error' failed to score. More precise answers such as the varying surface areas of marble chips were credit-worthy.

Question 6

The subject of the last question on the paper was a rather unusual way of finding the density of an object. It was an adaptation of a question on the practical paper. The use of a toy dog was to avoid the confusion that might arise from using blocks of metal at both ends of the metre rule.

(a) Measurements had to be made and entered into tables. This was accurately done by most candidates. Some candidates did not gain credit because the measurements were not written to one decimal place in line with the numbers already in the table. Candidates should be reminded to check significant figures in their answers.

(b) In this section the candidates were provided with a graph and asked to find the gradient. They were instructed to show on the graph how they did the working. This proved challenging to many. A few candidates showed the 'triangle' beneath the line and determined the gradient.

(c) The last part asked how the volume of a toy dog could be measured. As there are a number of ways this could be achieved many candidates gained credit. Some candidates confused mass with volume and so gained no credit. Others gave answers without referring to the use of a measuring cylinder to measure the volume of water. In general, candidates needed to be more specific in answering this question.