CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General comments: Biology

The majority of candidates successfully selected the correct responses.

Comments on specific questions

Question 2

The majority of candidates answered correctly, most of remainder thought oily fish contained a high level of iron, suggesting they had mixed up iron and vitamin D.

Question 3

Very few answered this question correctly. The question required candidates to correctly interpret a graph of rate of enzyme activity against time, most confused a maximum volume of oxygen having been produced with a maximum rate of production. Candidates should make sure that they can interpret the axes on graphs correctly.

Question 5

This question about movement of the ribcage caused some confusion, since candidates believed this was a feature of respiration, rather than movement. Candidates need to learn to differentiate between respiration and breathing in this context.

Question 7

This question produced a fairly even spread of answers, suggesting that the candidates have confused all the different neurone types and were guessing the answer.

Question 8

Although a majority answered this question correctly, many did not believe that the bronchi have a greater diameter than both alveoli and capillaries, and need to ensure that they understand the relative sizes of different parts of the breathing system.

Question 12

Rather than choosing the cross giving offspring with the same genotype, the majority of candidates favoured the cross giving the largest variety of genotypes. Candidates need to understand the concept of which gametes can be produced by different genotypes, and how these can be combined in the offspring.

General Comments: Chemistry

Candidates performed very well on **Question 14** and **Question 17**.

Question 16 and **Question 27** proved most difficult for the candidates.

Comments on individual questions

Question 14

Candidates understood well how to interpret diagrams representing elements, molecules and compounds.

Question 15

The incorrect **C** was chosen more often than the correct answer, **D**. Candidates did not relate the formula of the compound to the numbers of atoms of metals and of non-metals well enough.

Question 16

The three incorrect answers were each chosen more often than the correct answer, **D**. Candidates did not understand the names of the ions and the names of the electrodes well enough.

Question 17

Candidates understood well the exothermic reaction between sodium and water.

Question 18

Candidates understood well enough the effect of using a powdered solid on the rate of a chemical reaction.

Question 27

The incorrect **A** and **C** were chosen more often than the correct answer, **B**. Candidates did not know that poly(ethene) contains C–C single bonds and that it is made from ethene containing C=C double bonds.

General comments: Physics

In the physics section **Questions 34**, **37** and, particularly, **39** caused difficulty for many candidates.

Comments on individual questions

Question 28

Understandably, in this question on distance-time graphs, the incorrect option **C** was relatively popular, showing confusion with speed-time graphs.

Question 32

The topic here was energy transfer thermally, and a common error was to choose convection as the process in action, probably caused by candidates not looking carefully at the diagram.

Question 34

This total internal reflection question was not well answered. Although a sizeable majority knew that angle i had increased, approximately half of these also believed that the reflected ray had disappeared.

Question 37

For less able candidates, option **B** was more popular here than the correct option **D**. Possibly this was chosen by subtracting 1.5 from 3.0, or perhaps it was known as a typical p.d. of a cell.

Question 39

Here a large proportion of candidates, even the more able, believed that a transformer was the correct device, rather than a relay. They may have been confused by the fact that a magnetic coil is used in both these devices.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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

General comments: Biology

The majority of candidates successfully selected the correct responses.

Comments on specific questions

Question 6

Candidates were mostly aware that higher temperature increases transpiration rate, however, they were less sure of the effects of wind speed, with many thinking that increased wind speed decreases transpiration rate.

Question 7

This question produced a fairly even spread of answers, suggesting that the candidates have confused all the different neurone types and were guessing the answer.

Question 10

Candidates were fairly evenly divided over two answers here. They need to ensure that they fully understand the meanings of the words producer, consumer and herbivore.

General comments: Chemistry

Candidates performed very well on **Question 14** and **Question 18**.

Question 22 and **Question 27** proved most difficult for the candidates.

Comments on specific questions

Question 14

Candidates understood well how to interpret a chromatogram.

Question 16

The incorrect **C** was chosen more often than the correct answer, **D**. Candidates did not relate the formula of the compound to the numbers of atoms of metals and of non-metals well enough.

Question 18

Candidates understood well the exothermic reaction between sodium and water.

Question 22

The incorrect **B** was chosen more often than the correct answer, **A**. Candidates did not know that copper is a transition metal with a high density.

Question 26

Most candidates did know that lime affects the pH of soil, but they did not identify this effect correctly.

Question 27

The incorrect **B** was chosen more often than the correct answer, **C**. Candidates did not know that methane burns to form water and carbon dioxide.

General comments: Physics

In the physics section **Questions 33** and **39** were found to be difficult by very many candidates.

Comments on specific questions

Question 28

Understandably, in this question on distance-time graphs, the incorrect option **C** was relatively popular, showing confusion with speed-time graphs.

Question 29

The most common misconception here was a belief that mass would reduce as well as weight.

Question 30

This question on work and power was generally well answered. However several candidates who correctly deduced who did the most work were unable to determine who produced the greatest power.

Question 32

The topic here was energy transfer thermally, and a common error was to choose convection as the process in action, probably caused by candidates not looking carefully at the diagram.

Question 33

This wave question was very poorly answered. Two thirds of candidates of all abilities opted for **B**; this gave the correct amplitude, but confused frequency with period.

Question 39

A large proportion of candidates confused a parallel arrangement of resistors with a series one, leading them to choose option **D**. Although they are not expected to be able to calculate the combined resistance, they needed to know that it is less than the lower of the two values in the diagram (i.e. less than 3.0 Ω).

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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

General Comments: Biology

The majority of candidates successfully selected the correct responses.

Comments on specific questions

Question 3

Many candidates wrongly believed that amylase is found in the stomach. Candidates should ensure that they are familiar with different digestive enzymes, their locations and optimum pH.

Question 5

Only a small majority of candidates selected the correct answer to this question. Candidates need to ensure that they understand the consequences to oxygen concentrations in rivers of sewage leakage, and to be able to interpret simple diagrams.

Question 7

This question produced very few correct answers, suggesting that the candidates have confused all the different neurone types and were guessing the answer.

Question 9

Candidates were evenly divided over two answers here, both of which were wrong. They need to ensure that they know the names of major blood vessels, and the order in which blood travels through them.

Question 12

Candidates appear to have muddled up the food tests for protein and glucose. Confusing two words which start with the same letter (as is the case of the reagents used in these tests) seems to be a fairly common problem.

General Comments: Chemistry

Candidates performed very well on **Question 14**, **Question 15** and **Question 24**.

Question 19, **Question 20** and **Question 21** proved most difficult for the candidates.

Comments on specific questions

Question 14

Candidates knew well the charges on protons and electrons.

Question 15

Candidates understood well enough how to relate the formula of the compound to the numbers of atoms of metals and of non-metals.

Question 19

There was evidence of guesswork by candidates, who chose the incorrect **C** more often than the correct answer, **B**. They did not understand well enough how to identify a substance being oxidised during a chemical reaction.

Question 20

The three incorrect answers were each chosen more often than the correct answer, **D**. Candidates did not know that ammonia is alkaline and that it increases the pH of water.

Question 21

The incorrect **C** was chosen more often than the correct answer, **A**. Candidates did not know well enough the result of the test for iron(II) ions.

Question 23

The incorrect **A** was chosen more often than the correct answer, **C**. Candidates did not know well that argon is used as an inert atmosphere in lamps.

Question 24

Candidates knew well the physical properties of nickel as a transition metal.

Question 25

The incorrect **B** was chosen more often than the correct answer, **D**. Candidates did not know well enough the simple chemical tests for water and the results of these tests.

Question 26

The incorrect **C** was chosen more often than the correct answer, **D**. Most candidates did know that lime affects the pH of soil, but they did not identify this effect correctly.

General comments: Physics

In the physics section question **29** was very well answered, with questions **30**, **39** and, particularly, questions **31**, **36** and **37** being found difficult by many candidates.

Comments on specific questions

Question 28

Understandably, in this question on distance-time graphs, the incorrect option **C** was relatively popular, showing confusion with speed-time graphs.

Question 30

The topic here was pressure, and candidates found it difficult to relate this to the common examples given, with many choosing the nail or the needle.

Question 31

This question on change of state caused widespread difficulty. Many candidates of all abilities opted for **D**, either not noticing that the temperature of the substance had started to increase again at the end of the 20 minutes, or not appreciating the significance of this increase.

Question 36

The reason why steel is an unsuitable material for the core of an electromagnet was not known by many, with options **A** and **B** both being much more popular than the correct **C**.

Question 37

This also proved a taxing question, with evidence of much guessing about what can be measured with a voltmeter; a very large proportion of candidates thought that it could be used to measure current.

Question 39

Guessing was also apparent in this question on resistors in parallel. It was clear that many candidates added the two values of resistance; although they are not expected to be able to calculate the combined resistance, they needed to know that it is less than the lower of the two values in the diagram (i.e. less than 3.0 Ω). The current part of the question also caused difficulty.

CO-ORDINATED SCIENCES

Paper 0654/21
Multiple Choice

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

General comments: Biology

The majority of candidates successfully selected the correct responses.

Comments on specific questions

Question 3

Answers were fairly evenly divided between all four choices, suggesting that candidates were confusing the roles of insulin and glucagon. Candidates need to ensure that they are familiar with the contrasting roles of these two hormones, and at what point each will be secreted.

Question 5

This question was correctly answered by the vast majority of candidates.

Question 10

This question about movement of the ribcage caused some confusion, since many candidates believed this was a feature of respiration, rather than movement. Candidates need to learn to differentiate between respiration and breathing in this context.

Question 13

A fairly small majority of candidates correctly selected the correct answer, however, overall, most candidates believed that excess fertiliser in a stream increased, rather than decreased, oxygen concentration.

General comments: Chemistry

Candidates performed very well on **Question 15**, **Question 19**, **Question 21** and **Question 22**.

Question 24 and **Question 26** proved most difficult for the candidates.

Comments on specific questions

Question 15

Candidates understood well enough how to relate the formula of the compound to the numbers of atoms of metals and of non-metals.

Question 19

Candidates knew that ammonia is alkaline and its effect upon the pH of water.

Question 21

Candidates understood well the position and properties of metallic and non-metallic elements in the Periodic Table.

Question 22

Candidates knew well the use of carbon in the extraction of copper from its ore.

Question 24

Most candidates did not know the conditions used in the Haber process nor the source of nitrogen well enough.

Question 26

Most candidates did not know well enough the products of addition reactions of ethene. The incorrect **B** was chosen as often as the correct answer, **C**, and the incorrect **D** was chosen almost as often.

General comments: Physics

In the physics section **Question 36** was well answered and no questions were found particularly difficult.

Comments on specific questions

Question 28

In this question on a speed-time graph, weaker candidates often chose option **D**, found by multiplying the maximum speed by the total time.

Question 32

The most common error here was to believe that quadrupling the pressure would also quadruple the volume (option **D**), rather than dividing it by four.

Question 33

The topic here was energy transfer thermally, and a common error was to choose convection as the process in action, probably caused by candidates not looking carefully at the diagram.

Question 34

The incorrect option **B** was more popular than the correct option **D** in this question on waves. This mistake involved using the period as the frequency and therefore dividing 20 cm/s by 10 s.

Question 35

Here too option **B** was chosen by more candidates than the correct **A**, a virtual image being confused with a real image.

Question 38

Less able candidates tended to treat the parallel resistor combination as a series one, therefore choosing **C**.

Question 39

This question on electrical power transmission led weaker candidates to opt for **B**, in the belief that both current and voltage are reduced by the transformer.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice

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

General comments: Biology

The majority of candidates successfully selected the correct responses.

Comments on specific questions

Question 1

The vast majority of candidates selected the correct answer to this question.

Question 8

Very few candidates correctly selected the correct answer to this question. Candidates need to understand the meaning of the term vasodilation, and which blood vessels it applies to.

Question 13

This question gave an even spread of answers over three of the possible choices. Candidates need to ensure that they are familiar with the functions of the ciliary muscles, and the radial and circular muscles of the iris.

General Comments: Chemistry

Candidates performed very well on **Question 14**, **Question 16, Question 21** and **Question 24**.

Question 23 and **Question 27** proved most difficult for candidates.

Comments on specific questions

Question 14

Candidates understood very well how to interpret a chromatogram.

Question 16

Candidates understood well enough how to relate the formula of the compound to the numbers of atoms of metals and of non-metals.

Question 21

Candidates understood very well the relationship between Periodic Table group number, the type of element and the number of outer-shell electrons.

Question 23

The incorrect **C** was chosen more often than the correct answer, **B**. Candidates did not know that oxides of nitrogen are formed in car engines when oxygen and nitrogen in the air react together at high temperature.

Question 24

Candidates understood very well the relationship between rusting and the proportion of oxygen in air.

Question 27

The incorrect **B** was chosen more often than the correct answer, **C**. Candidates did not understand well enough the hydrolysis of proteins.

General comments: Physics

In the physics section **Question 32** was particularly well answered, with no questions posing particular problems.

Comments on specific questions

Question 28

In this question on a speed-time graph, weaker candidates often chose option **D**, found by multiplying the maximum speed by the total time.

Question 31

The topic here was kinetic energy, and many less able candidates overlooked the fact that speed is squared in the relevant expression, leading them to opt for **B**.

Question 34

Considering energy transferred thermally, several less able candidates tended to choose convection as the process in action, probably caused by not looking carefully at the diagram.

Question 38

High ability candidates scored very well in this question on resistors in series and parallel, but others failed to notice that the initial value of 40 Ω was for two resistors in series; this oversight led them to choose option **B**.

CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice

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

General comments: Biology

The majority of candidates successfully selected the correct responses.

Comments on specific questions

Question 2

Candidates generally had little problem in correctly choosing the formula for glucose, which could have been chosen either by prior knowledge, or working out how to balance the equation.

Question 3

Although a majority of candidates selected the correct answer, many believed amylase is found in the stomach. Candidates need to ensure that they are familiar with locations of digestive enzymes, and their ideal pH in relation to that location.

Question 8

The majority of candidates correctly answered this question, but a substantial number selected an incorrect statement. Candidates need to understand the concept of which gametes can be produced by homozygous and heterozygous genotypes, and how these can be combined in the offspring.

Question 11

Candidates were fairly evenly divided over two answers here; however, the majority were correct. They need to ensure that they know the names of major blood vessels, and the order in which blood travels through them.

General comments: Chemistry

Candidates performed very well on **Question 15** and **Question 22**.

Question 14, **Question 16**, **Question 20** and **Question 23** proved most difficult for the candidates.

Comments on specific questions

Question 14

The incorrect **C** was chosen more often than the correct answer, **D**. Candidates did not understand well enough how to determine the electronic structure of a fluoride ion.

Question 15

Candidates understood well enough how to relate the formula of the compound to the numbers of atoms of metals and of non-metals.

Question 16

The incorrect **C** was chosen more often than the correct answer, **A**. Candidates did not know the cathode product of the electrolysis of concentrated aqueous sodium chloride. They did not understand the effect of chlorine on the pH of the electrolyte.

Question 20

The three incorrect answers were each chosen more often than the correct answer, **A**. Candidates did not understand well enough the method of making an insoluble salt by precipitation from two soluble salt solutions.

Question 22

Candidates knew well the physical properties of nickel as a transition metal.

Question 23

Candidates did not know well enough the simple chemical tests for water and the results of these tests. Some candidates knew the correct colours associated with the use of anhydrous cobalt(II) chloride in the test for water, but they did not know the colour change well enough.

General comments: Physics

In the physics section **Question 35** was very well answered, with **Question 31** and, particularly, **Question 39** being found difficult by many candidates.

Comments on individual questions

Question 28

In this question on a speed-time graph, weaker candidates often chose option **D**, found by multiplying the maximum speed by the total time.

Question 30

Although generally quite well answered, in this question on extension of a spring, a common mistake was to multiply the new length by the spring constant, rather than the extension by the spring constant.

Question 31

There was much uncertainty here over the energy source that powers the Sun.

Question 33

Considering energy transferred thermally, a significant proportion candidates chose convection as the process in action, probably caused by not looking carefully at the diagram.

Question 37

In this electrical question a large number of candidates understood the meaning of current, but several confused e.m.f. with p.d.

Question 38

A quarter of able candidates, whilst being able to determine the overall resistance of the circuit, believed that there was a greater current in one branch (P) than in the wire connecting the resistor combination to the battery (Q).

Question 39

Candidates were very uncertain about the deflection of a current-carrying wire in a magnetic field, with most believing that the direction was either into or out of the page.

CO-ORDINATED SCIENCES

Paper 0654/31
Theory (Core)

Key messages

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

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

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered most of the questions well. There was a good range of marks on every question. Candidates generally scored on all questions. Few gained no marks on any question but very few gained full marks on any question. Performance depended not only on scientific knowledge but also on the ability of the candidates to understand the question and express themselves clearly.

Some candidates only gained some of the marks available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

Learning the definitions specified in the syllabus earns marks directly as well as being an aid to language used in explanations.

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

A number of candidates used the chemical formula of a substance rather than the words for a substance in their answers. For example CO rather than carbon monoxide.

A number of candidates seemed to doubt their original answers and ended up crossing out a correct answer and replacing it with an incorrect answer.

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

Comments on specific questions

Question 1

(a) (i) Many candidates gained all three marks here. Candidates should ensure that label lines touch the object being identified.

(a) (ii) Plant cells having chloroplasts, cell walls and vacuoles were all well known.

(b) (i) Few candidates were able to identify both of the reactants required for respiration.

(b) (ii) Few candidates were able to state both uses for the energy released from respiration. The only answers commonly given were growth and muscle contraction. Some candidates confused these uses with the characteristics of life. A number of candidates attempted to give answers relating to plants.

Question 2

(a) (i) Conduction was quite well known as the thermal energy transfer process.

(a) (ii) Some candidates gave good answers to this question. Candidates were expected to identify convection as the process and to describe convection. Candidates did not need to explain convection in terms of density changes. Some candidates made reference to hot air rising in the kettle.

(a) (iii) There were some good answers to this question. The most common answer was that plastic was a good thermal insulator.

(b) (i) A number of candidates simply referred to energy being lost or wasted. Some candidates were able to gain marks by referring to thermal energy being lost or energy being lost to the surroundings. A number of candidates wrongly suggested that the energy evaporated.

(b) (ii) A qualitative description of efficiency was given by a number of candidates.

(c) Many candidates were able to identify the electrical hazard and explain why it was dangerous.

(d) (i) Some candidates tried to describe evaporation or to define melting point. A correct answer needed to include the word temperature.

(d) (ii) Most candidates were able to identify **B** as the liquid and **C** as the gas. Many were able to explain why **C** was the gas but fewer were able to explain why **B** was the liquid.

Question 3

(a) Candidates needed to quote the percentages given in the syllabus. i.e. nitrogen 78 per cent and oxygen 21 per cent.

(b) (i) Candidates needed to refer to the incomplete combustion of a fuel, rather than vaguely refer to cars.

(b) (ii) The toxic effect on humans of carbon monoxide was well described by a number of candidates. Other candidates wrongly mentioned acid rain and global warming as harmful effects of carbon monoxide.

(c) Many candidates knew that nitrogen dioxide dissolved in water to produce an acidic solution. Very few candidates were able to correctly state the colour change of the full-range indicator.

(d) (i) Many candidates were able to do this. The mark was not given if the formula was given in an incorrect format. The symbols for hydrogen and nitrogen needed to be upper case and the number 3 needed to be subscript. N_2H_6 was a common wrong answer.

(d) (ii) Few candidates referred to atoms at all in their answers. Few candidates referred to the examples in Fig. 3.2 in their answers. There was a great deal of confusion about elements, molecules and atoms.

Question 4

(a) (i) Many candidates gained at least two marks.

(a) (ii) The oviduct was not well known as the part of the female reproductive system where fertilisation occurs. The commonest answer was the uterus.

(a) (iii) Very few candidates referred to nuclei in their descriptions of fertilisation. Most candidates correctly identified the sperm and egg as being involved but fewer were able to describe the fusion of the sperm and egg.

(b) Many candidates correctly identified two differences between asexual reproduction and sexual reproduction. Usually this was the number of parents required and whether there was variation or not.

Question 5

(a) Many candidates gained full marks. Pasta was a common wrong answer for both protein and vitamin C.

(b) (i) Growth and repair was well known. Many correctly referred to muscle growth in particular.

(b) (ii) Candidates found this difficult. Many candidates named one, two or three of the possible elements. Few correctly identified carbon, hydrogen, oxygen and nitrogen. A few candidates also suggested sulfur. This was accepted. Some candidates wrongly suggested amino acids.

(b) (iii) Some candidates correctly identified amino acids. Many suggested protease.

(c) (i) & (ii)
Many candidates were able to explain the differences in energy requirements. The most popular answers in **(i)** were that the 14 year old male was still growing and more active than the male office worker. The most popular answers in **(ii)** were that the male athlete was usually bigger than the female athlete.

Question 6

(a)(i) Many candidates were able to draw a methane molecule correctly. A number of candidates drew an ethane molecule. A number drew a structure where the central carbon atom had been replaced with the letter M.

(a)(ii) Carbon dioxide and water were not well known as the two compounds produced by the complete combustion of methane. Many candidates suggested hydrogen or carbon.

(b) (i) Many candidates knew that the process was distillation. Fewer knew that it was fractional distillation.

(b) (ii) Candidates found it difficult to find a similarity between liquid **W** and liquid **Z**. Suitable answers were that both liquids were mixtures or contained hydrocarbons. Candidates found it easier to find a difference between liquid **W** and liquid **Z**. The most popular answer was difference in colour.

(c) (i) Some candidates identified bromine as element **J**. Many different elements and compounds were wrongly suggested.

(c) (ii) Few candidates realised that bromine would not react with a saturated hydrocarbon and described the result for an unsaturated hydrocarbon.

(c) (iii) Ethene was not well known as the unsaturated hydrocarbon that contains two carbon atoms in each of its molecules.

Question 7

(a) (i) Many candidates were able to identify a time when the car was not moving. A common wrong answer was 10 seconds when the car was reaching maximum speed.

(a) (ii) Most candidates were able to use the graph to determine that the maximum speed reached by the car was 4 m/s.

(a) (iii) Most candidates used the correct formula to determine the distance travelled by the car.

(b) A reference to friction or electron transfer was required. A number of candidates wrongly referred to positive electrons.

(c) This was well done by many candidates who managed to complete the path of the ray of light.

(d) (i) Many candidates were able to state that the molecules would move faster.

(d) (ii) Few candidates were able to explain that the particles collided more frequently with the tyre wall.

Question 8

(a) It was important to show one arrow pointing into the roots and one arrow pointing out of the leaf. Some candidates drew arrows going the wrong way. Many candidates drew long continuous arrows going all the way through the plant.

(b) Xylem was well known. Common wrong answers were stem and root.

(c) Most candidates were able to name one other requirement for photosynthesis apart from water. Light was the most popular answer.

(d) The environmental conditions given needed to be those that increased the rate of transpiration. For example higher temperature rather than high temperature was needed.

Question 9

(a) (i) Few candidates gained full marks here but many gained at least one mark. Twenty six was a common wrong answer to all three answers.

(a) (ii) Eight was the correct and commonest answer.

(b) (i) The gas produced was commonly identified as hydrogen. However a number of candidates wrongly suggested magnesium chloride.

(b) (ii) Candidates frequently stated that the pH increased but then explained wrongly that the reacting mixture became more acidic. A number of candidates thought that an increase in temperature caused the pH to increase.

(b) (iii) This part was well answered with many of the candidates identifying the rise in temperature as a reason for the reaction being exothermic rather than endothermic.

(c) The reaction conditions given needed to be those that increased the speed at which the gas filled the measuring cylinder. For example increased temperature rather than temperature was required. A common error was the idea that using magnesium powder would decrease the surface area.

Question 10

(a) The description of a food chain as a flow of energy from one organism to another was not well known. Many candidates described a food chain as showing what eats what.

(b) (i) Many candidates did not follow the instructions and drew food chains containing organisms not shown in Fig. 10.1.

(b) (ii) Many candidates confused the carnivore with the herbivore.

(c) Many candidates gave an excellent explanation. A number failed to understand the food web and described foxes eating hawks and hawks eating foxes. A number wrongly assumed that the foxes would get the same disease as the hawks.

Question 11

(a) Chemical, water and turbine were all given by many candidates.

(b) (i) To get full marks, candidates needed to refer correctly to the penetration properties of gamma radiation and to describe how this would be measured.

(b) (ii) Cancer or cell mutation were commonly known as ways in which the scientist could be harmed by the radiation. A number of candidates attempted to explain why the scientist had been harmed describing a lack of protective equipment.

(c) (i) Resistance increasing was the correct answer. Many candidates suggested that the resistance would decrease and a number of candidates attempted to describe what happened to the electrical power being transmitted to the town.

(c) (ii) This was quite well answered. Many candidates suggested that the length of the cable could be changed or that the metal used in the cable could be changed.

(d) This question was not well understood. Most candidates wrongly suggested that the cables were hung loosely between the pylons during hot weather so that cables did not snap when the cables expanded during the hot weather. Candidates needed to state that the cables would contract during cold weather and that therefore if the cables had been hung loosely they would be able to contract without snapping the cables or damaging the pylons.

Question 12

(a) (i) Some candidates went into great detail as to how they knew that element **S** was a non-metal and a liquid at 20 °C. A common reason was that **S** was an insulator and therefore not a metal. Explanations about why **S** was a liquid at 20 °C were often confused.

(a) (ii) Malleable was the most popular correct answer. This question was not well answered. Many candidates attempted to give an extra column heading such as thermal conductor or insulator, without stating whether element **P** would be a good thermal conductor or not.

(b) (i) Many candidates were able to identify sodium chloride as the ionic compound.

(b) (ii) The loss of an electron was not well known as the description of what happens when a sodium atom changes into a sodium ion.

(b) (iii) Opposite charges attracting was the answer. Opposites attracting was not sufficient.

(c) (i) Electrolysis was well known as the process.

(c) (ii) Electrode **Y** was the anode and electrode **Z** was the cathode. Many candidates got the names the wrong way round.

Question 13

(a) Gravitational (potential) energy was well known.

(b) Many candidates described the time needing to be measured. Many candidates suggested using the formula speed = distance/time. Some candidates correctly suggested that either the distance needed to be doubled or that the time measured needed to be halved to take into account that it was an echo covering twice the measured distance.

(c) Infra-red needed to be placed to the right of visible light and ultraviolet to the left of visible light.

(d) (i) & (ii)
The continuation of the two rays in **(i)** was quite well done. However even the candidates who managed this found locating the image difficult in **(ii)**.

(d) (iii) Focal point was quite well known.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key messages

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

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

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered most of the questions well. There was a good range of marks on every question. Candidates generally scored on all questions. Few gained no marks on any question but very few gained full marks on any question. Performance depended not only on scientific knowledge but also on the ability of the candidates to understand the question and express themselves clearly.

Some candidates only gained some of the marks available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

Learning the definitions specified in the syllabus earns marks directly as well as being an aid to language used in explanations.

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

A number of candidates seemed to doubt their original answers and ended up crossing out a correct answer and replacing it with an incorrect answer. There was no evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

(a) (i) Stomach and large intestine were very well known.

(ii) D and F were commonly identified as the places where food is absorbed and where egestion occurs.

(b) Many candidates confused ingestion with digestion, indigestion or egestion.

(c) Many candidates gained full marks. Many more only gained one mark for identifying one enzyme/substrate/product link.

Question 2

(a) (i) The nucleus was well known.

(ii) Protons and neutrons were well known, but electrons were frequently mentioned.

(iii) Atomic number was well known. Proton number was accepted but not electron number.

(iv) Nitrogen was the correct and very popular answer. A number of candidates suggested lithium and a few suggested boron.

(b) (i) Many candidates were able to do this. The mark was not given if the formula was given in an incorrect format. The symbols for hydrogen and oxygen needed to be upper case and each2 needed to be subscript.

(ii) Very few candidates knew either of the chemical tests for water. Universal indicator was often suggested as was measuring the boiling point of the liquid

(c) Few candidates gained full marks. Many either knew that chlorine killed harmful microorganisms or that the process made the water safe to drink.

Question 3

(a) (i), (ii), (iii) and (iv) These parts were all well answered.

(b) Some candidates tried to describe evaporation or to define melting point. A correct answer needed to include the word temperature.

(c) (i) This was not well answered. Few candidates were able to suggest either of the two marking points.

(ii) Force and area were not well known. Mass was a common wrong answer.

Question 4

(a) (i) Sweating, vasodilation and hairs lying flat were all well-known responses when the body gets too hot.

(ii) Vasoconstriction and hairs standing on end were also well known responses when the body gets too cold. Shivering was also allowed.

(b) (i) Enzymes being used as catalysts to speed up reactions was not well known.

(ii) Few candidates suggested pH. Many candidates suggested temperature but this was already given in the question.

(c) Candidates found this difficult. Many candidates named one, two or three of the possible elements. Few correctly identified carbon, hydrogen, oxygen and nitrogen. A few candidates also suggested sulfur. This was accepted.

Question 5

(a) (i) Many candidates gained full marks. Common errors were to mix up the stigma and anther or the stigma and sepal.

(ii) The ovary was not well known as the producer of ovules or female sex cells. The function of the petals to attract insect was commonly known. Few candidates knew that the sepal's function was to protect the flower.

(b) Few candidates gained full marks. Anther and stigma were frequently reversed.

(c) Many candidates correctly identified an insect. A few candidates misunderstood the question and suggested the wind.

Question 6

(a) All four possible answers were frequently given, although methane and hydrocarbon were slightly more popular.

(b) Carbon monoxide and carbon dioxide were not well known. The health hazards associated with these gases were not well known. Candidates who correctly identified carbon monoxide often suggested that the health hazard was global warming or acid rain.

(c) (i) Cracking was a popular correct answer.

(ii) Some candidates were able to describe the ethene molecules joining together.

(iii) Many candidates seemed to misunderstand the question and described the positive test for an unsaturated hydrocarbon.

(d) (i) A large selection of metals were incorrectly chosen including copper, zinc, lead, magnesium and aluminium.

(ii) Oxygen and water were often given as correct answers.

(iii) Any reasonable source of damage/paint removal was accepted. For example: 'the paintwork being scratched'.

Question 7

(a) (i) It was expected that candidates would give a scientific definition of frequency and not a general definition.

(ii) The piano was commonly recognised as the instrument which produced the sound with the highest pitch and many candidates were also able to explain the connection between pitch and frequency.

(iii) 20 000 Hz and 20 Hz were well known as the highest and lowest frequencies. A small number of candidates reversed the values.

(b) The density calculation was well done. Many candidates showed good data handling skills. The correct units were less well known. There was a wide range of wrong units.

(c) (i) Most candidates correctly suggested light or water waves. Despite the wording of the question, a number of candidates incorrectly suggested sound.

(ii) Candidates found this very difficult. Very few candidates were able to describe the difference between transverse and longitudinal in terms of direction of oscillation and direction of energy transfer.

(d) (i) This calculation was also well done.

(ii) Most candidates appreciated that something needed to vibrate to produce a sound wave but few explained that ultimately it was the vibration of the air molecules that produced the sound wave.

(e) (i) Many candidates found it very difficult to label the angle of incidence. There needed to be some indication of where the angle started and finished.

(ii) 40° was the commonest answer, although 20° and 50° were also popular. Candidates who gave the correct angle usually managed to explain that the angle of incidence equalled the angle of reflection.

Question 8

(a) Most candidates suggested that carbon dioxide was formed and that this gas was responsible for limewater turning milky. Fewer candidates were able to explain the formation of carbon dioxide in terms of the reactivity series. A number described carbon as being more reactive than copper and displacing it from copper oxide. This idea was awarded a mark.

(b) (i) Only a few candidates gained full marks. Many gained one mark for correctly completing one row.

(ii) Magnesium chloride was frequently given but often the other product was water rather than hydrogen.

(iii) Candidates frequently stated that the pH increased but then explained wrongly that the reacting mixture became more acidic.

Question 9

(a) Few candidates were able to correctly convert 70 m/s into 252 km/h. There was no common error.

(b) (i) Many candidates drew a clear accurate diagonal line. A common error was to start the line from either 60 m/s or 80 m/s

(ii) (iii) and (iv) Gravitational potential energy, kinetic energy and chemical energy were all quite well known. Thermal energy was often seen as a wrong answer in all three parts.

Question 10

(a) The watt was well known as the unit with the symbol W.

(b) (i) Few candidates were able to describe how a fuse works. There was confusion about the fuse being used as a source of electricity for the television. Few realised that the fuse melts when too much current passes through it.

(ii) The answers of most candidates showed little understanding of the problem. Many candidates simply stated that a 5A fuse was not too small and not too big. One correct idea was that a 3A fuse could not be used because the usual current was 3A and so the fuse would melt under normal working conditions. Another correct idea was that a 13A fuse could not be used because too much current would be able to pass through before the fuse melted.

(c) (i) Many candidates gained both marks here for linking gamma radiation to radioactive medical tracers, microwaves to mobile phone communication and X-rays to airport security scanners.

(ii) Infra-red was well known as the electromagnetic wave used in a television remote control, although radio waves and microwaves were often incorrectly suggested.

(d) Most candidates were able to calculate the combined resistance as 16Ω. A few attempted to calculate the combined resistance of the two resistors connected in parallel.

Question 11

(a) (i) This was well answered with many candidates gaining both marks. Many candidates gave more information than required and explained why the increase and decrease in heart rate occurred.

(ii) and (iii) Good data handling skills were shown by most candidates. Ten minutes was a common wrong answer in **(iii)**.

(b) (i) Glucose was not well known as the other reactant required for respiration. Carbon dioxide and water were frequently suggested.

(ii) Red blood cell was well known.

(iii) White blood cells, platelets and plasma were all commonly given as correct answers.

Question 12

(a) (i) Some candidates knew that solutions containing ions are called electrolytes. A number of candidates thought that the answer was anions.

(ii) Cathode was well known as the negative electrode.

(b) (i) Many candidates correctly referred to copper as their explanation of the colour change for electrode L. Many others suggested that it was caused by the copper chloride.

(ii) Very few candidates identified chlorine as the gas given off at electrode M. Fewer still were able to state the correct chemical test for chlorine.

(c) (i) Bromine forming negative ions was quite well known. Many candidates were able to explain that bromine atoms would gain one electron.

(ii) Some candidates were able to suggest that there was only one electron difference between the bromine atom and bromide ion. A few candidates suggested that an electron had negligible mass. Many candidates referred to the particles as isotopes and therefore suggested that the number of neutrons differed.

Question 13

(a) (i), (ii) and (iii) Many candidates were able to use the information to identify the correct family member in all three parts.

(b) An allele as an alternative form of gene was not well known.

(c) Most candidates gained at least one mark. A number of candidates wrote genotypes in the parental gametes spaces. Many got the expected ratio correct even though they had the wrong genotypes.

CO-ORDINATED SCIENCES

Paper 0654/33
Theory (Core)

Key message

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

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

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Some candidates answered most of the questions well. There was a good range of marks on every question. Candidates generally scored on all questions. Few gained no marks on any question but very few gained full marks on any question. Performance depended not only on scientific knowledge but also on the ability of the candidates to understand the question and express themselves clearly.

Some candidates only gained some of the marks available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

Learning the definitions specified in the syllabus earns marks directly as well as being an aid to language used in explanations.

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

A number of candidates seemed to doubt their original answers and ended up crossing out a correct answer and replacing it with an incorrect answer.

There was no evidence of candidates running short of time to complete the examination but many candidates left a number of questions unanswered.

Comments on specific questions

Question 1

(a) (i) The alveoli, bronchiole and larynx were often correctly identified. Most candidates gained at least one mark and some gained all three.

(ii) The trachea was often labelled correctly. The commonest error was to place the label in a bronchus or bronchiole.

(b) Most candidates managed to correctly select at least one of the words and some scored full marks.

(c) (i) This question was not well answered. Few candidates were able to select one way in which expired air differed from inspired air. Care was needed to ensure that a comparative phrase was used. For example the word temperature alone was insufficient. Warmer or higher temperature should have been stated.

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(ii) Some candidates were able to describe one way in which the pattern of a person's breathing changes during vigorous exercise. Faster or more frequent was the popular correct answer.

Question 2

(a) (i) Number of protons was quite well known. Few candidates, however, made any reference to the fact that it was the number of protons in one atom of an element.

(ii) Water being a compound rather than an element was well known.

(iii) The number of electrons was better answered than the number of neutrons.

(iv) The source of argon gas was unknown to the candidates.

(v) Many candidates knew that argon was a noble gas and therefore unreactive.

(b) (i) Many candidates were able to describe the trend as the higher the temperature the higher the solubility. The mathematical terms proportional and directly proportional should not have been used in the candidate's answer.

(ii) Many candidates gained one mark here. There were a number of incorrect references to the solubility of potassium.

Question 3

(a) (i) Many candidates gained full marks.

(ii) Many candidates knew that sperm were made in the testes and were able to show this on the diagram.

(b) (i) This was not well answered. Few candidates knew that an egg or ovum was the female gamete.

(ii) Fertilisation, as the process when the nuclei of the male and female gametes fuse, was better known.

(iii) Few candidates were able to identify the zygote as the cell produced during fertilisation.

Question 4

(a) Many candidates found the calculation easier because it had been split up into steps.

(b) Force and area were quite well known. Mass was a common wrong answer.

(c) (i) The correct frequency range from 20Hz to 20 000Hz was not well known.

(ii) Many candidates were able to place the frequency between the maximum frequency they had stated in **(i)** and 35 000Hz.

(d) This question was quite well answered. There was no popular electromagnetic wave quoted, nor any common wrong answer.

Question 5

(a) (i) Sulfur dioxide was well known but few candidates offered a suitable explanation. A number of candidates suggested sulfur.

(ii) A few candidates gained all three marks but many candidates found it difficult to gain one mark. None of the unknown reactants and products were commonly known.

(b) (i) Many candidates knew that pH of pure water was 7.

(ii) Few candidates were able to relate the pH of the solutions to rate of evolution of gas.

(iii) This part was well answered. Many candidates either knew that temperature affected the rate of reaction or were able to make a reference to fair testing.

Question 6

(a) (i) Many candidates showed good data handling skills to describe the changes in rate of water loss. A number of candidates also explained the reasons for the changes in rate of water loss.

(ii) Some of the candidates were able to explain why the rate of water was lowest at 24.00 hours. The absence of light was the most popular correct answer.

(iii) The difference in the rate of water loss was correctly determined by many candidates.

(b) (i) Many candidates were able to arrange the letters in the correct sequence to show the pathway of water through the plant.

(ii) Absorbing mineral ions was not well known as a function of root hair cells.

(iii) Some candidates were able to suggest one use for the water absorbed by the plant.

Question 7

(a) (i) Almost all the candidates determined that that the maximum speed of the truck was 8 m / s.

(ii) Most candidates were able to indicate the point when the truck stopped moving.

(b) Many candidates were able to state that the forces were in opposite directions. Fewer were able to work out that force **S** was greater than force **Q**. Many thought that either force **Q** was greater than force **S** or that force **Q** equalled force **S.**

(c) (i) Many candidates were able to state that the particles would move faster.

(ii) Very few candidates were able to explain that the particles collided more frequently with the tyre wall.

(d) A few candidates were able show the ray of light entering the prism without deviation. Very few candidates drew a ray that showed total internal reflection.

(e) (i) Many candidates correctly calculated the current in each lamp.

(ii) Many candidates were able to suggest a reason for the lamps being connected in parallel rather than in series. The most popular answer was that if one lamp fails, the other will still light up.

Question 8

(a) (i) Chromatography was well known as the process.

(ii) Few candidates were able to explain why the separation of the dyes in black ink was a physical change and not a chemical change. These candidates suggested that no new substances had been produced.

(b) Few candidates were able to identify more than one of the types of chemical reaction. This was usually polymerisation for the second reaction. The correct answer for the third reaction was reduction. Many candidates wrongly suggested oxidation or combustion.

(c) (i) Few candidates were able to do this. The cathode label needed to be to the cathode and not to the test tube covering the cathode or to the wire connected to the power supply.

(ii) This part was not well answered. A few candidates recognised oxygen as the gas released at the anode. Sulfur was a common wrong answer for both gas **P** and gas **Q**.

(d) The sulfate ion was unknown to the candidates. Most candidates gave no answer. A few candidates suggested sulfur.

Question 9

(a) Milk, butter and tuna were correctly identified by most candidates as the best sources of calcium, fat and protein respectively.

(b) (i) Many candidates knew that fat provided energy.

(ii) The three chemical elements contained in fat were largely unknown. A number of candidates were able to name one element but all three were required for the mark.

(iii) Fatty acids and glycerol were largely unknown as the basic units resulting from the digestion of fats and oils. Both answers were required for the mark.

(c) Many candidates showed a good understanding of the characteristics of living organisms and were able to suggest at least one characteristic. Respiration, reproduction, growth and excretion were all suggested frequently.

Question 10

(a) Most candidates were able to identify at least one process and some identified all three.

(b) (i) Many candidates were able to use the information shown in Fig. 10.1 to suggest at least one way in which humans could reduce the amount of carbon dioxide in the atmosphere. Popular answers were references to growing more trees or plants and reducing combustion of fossil fuels.

(ii) Global warming was well known as the process that increased atmospheric carbon dioxide is contributing to.

Question 11

(a) Many candidates were able to explain that one disadvantage of generating electricity from solar energy was that it did not work at night.

(b) Few candidates were able to identify convection as the thermal energy transfer process.

(c) (i) Some candidates were able to describe an isotope.

(ii) The composition of an alpha particle was unknown to the candidates. Most candidates did not attempt an answer to this question.

(iii) Most candidates gave vague answers about ionising radiation being dangerous to the human body.

(iv) Candidates were unable to explain that alpha particles posed little danger to people passing by the smoke detector because alpha particles would be absorbed by 5 cm of air.

(d) Many candidates were able to select at least one description of the image and gain one mark.

Question 12

(a) Candidates needed to describe the energy transfers involved in the wave-powered electrical generator. Candidates only needed to correctly describe two of the four possible energy transfers to gain full marks.

(b) Many candidates were able to state at least one advantage of using renewable energy resources to gain one mark.

(c) (i),(ii) Many candidates were able to correctly determine the amplitude of the wave in **(i)** and the wavelength of the wave in **(ii)**. The amplitude was more often correct than the wavelength.

(d) (i),(ii) Evaporation and freezing were commonly given as answers to **(i)** and **(ii)** respectively.

(iii) The volume was generally calculated correctly. This was a more difficult calculation involving rearranging the usual formula.

Question 13

(a) Many candidates were able to draw a molecule where either there was single carbon to carbon bond or draw a molecule showing an OH group. Few candidates managed to do both.

(b) (i) A number of candidates identified the process as fractional distillation.

(ii) The purpose of the condenser was not well known.

(iii) Many candidates correctly suggested that ethanol had a lower boiling point.

(c) (i) The test for hydrogen gas was not well known. Many candidates did not attempt to answer this question.

(ii) This was well answered. A number of candidates were able to describe one similarity between the reactions. Usually this was that both reactions produced hydrogen.

(iii) This was not well answered. Many candidates wrongly thought that the reaction speed would be higher in ethanol.

(d) Few candidates were able to follow the clues given in the question to identify the two combustion products of ethanol as carbon dioxide and water.

CO-ORDINATED SCIENCES

Paper 0654/41
Theory (Extended)

Key messages

Questions involving the recall, manipulation and application of formulae were generally answered very well. Where calculations are based on the application of scientific knowledge and data handling, it is important that candidates show the method used and the steps involved in their calculation. This not only facilitates logical progress through the problem for the candidate but allows the Examiner to give credit for method when errors are carried forward to a subsequent step. The syllabus requires that candidates understand significant figures and use them appropriately. To gain full marks in a calculation the answer should be rounded up or down to a sensible degree of precision. Recurring decimals should be indicated or the number rounded.

General comments

The standard of presentation of responses was very good. In general handwriting was legible, and the use of language was competent. Some candidates need to work on the spelling of scientific terms. Definitions of terms learned from the syllabus gain marks themselves but can also form the basis of explanation of phenomena. Diagrams were drawn with care. It was noticed that where an answer is to be given by annotating a diagram provided on the paper there is a relatively high rate of failure to make a response. Candidates should be aware that an action may still be required when an answer line is absent. They should use a technique to ensure that parts of questions are not missed.

Comments on specific questions

Question 1

(a) (i) Most candidates identified the umbilical cord and amniotic fluid. Some thought that **Z** was labelling the amniotic sac.

(ii) Most correctly stated that protection of the foetus was the function of the amniotic fluid and gave further detail as protection from mechanical shock, drying out or temperature fluctuation.

(iii) The role of the blood vessels in the umbilical cord was usually correctly given as supplying materials and removing waste from the fetus. Most candidates avoided incorrect terms such as food, air and faeces.

(b) (i) The correct position of the placenta during *placenta praevia* was usually shown as being above the cervix.

(ii) There were various ways used for describing blockage of passage of the baby. Haemorrhaging or damage to the placenta were mentioned less often.

Question 2

(a) (i) Many gained credit for the relationship between energy transfer and specific heat capacity and for stating the temperature change. Those who could rearrange the formula, and not get mislead into including time in their calculation, gained full marks.

(ii) Most realised that the efficiency was required in the form of a percentage. Complete answers quoted the formula as *useful energy output/energy input* rather than just *energy output/energy input*. They rounded their answer up to an appropriate number of significant figures or indicated a recurring decimal.

(b) The best answers stated succinctly that thermal energy was supplied during boiling to overcome intermolecular attractive forces. Few candidates used the term *latent heat of vaporisation* or discussed the increased potential energy of molecules. Some answers showed confusion between the processes of boiling and evaporation. Others ignored the instruction to explain in terms of molecules.

Question 3

(a) (i) To gain credit candidates had to suggest a situation where the temperature was sufficient for nitrogen and oxygen to combine to form nitrogen oxides. The internal combustion engine was acceptable, but suggesting that nitrogen dioxide was a product of burning fossil fuels was inaccurate. The effect of acid rain was well known, but a role in global warming was a fairly common misconception.

(ii) Most candidates knew that ammonia was produced by the Haber process.

(iii) The equation for formation of hydrogen was usually balanced correctly. State symbols were often omitted or water put in the liquid state, ignoring information in the question.

(b) (i) Bonding diagrams of the nitrogen molecule usually showed a full octet of electrons on each atom and some correctly included three pairs of bonding electrons.

(ii) The best suggestions for the reason why nitrogen had low reactivity included a description of the strong bond between atoms, rather than being incorrectly based on full electronic shells.

(c) (i) Most candidates could show that the relative molecular mass of hydrazine is 32.

(ii) There were some good calculations of the volume of ammonia produced. The hardest step proved to be the use of the equation to find the number of moles of ammonia formed.

Question 4

(a) (i) Almost all candidates used the graph to find the correct optimum pH for the enzyme.

(ii) Many knew that the enzyme was denatured at low pH and a few described changes to the active site. Others just stated that the enzyme did not work or that it was killed, both answers being unacceptable.

(iii) Temperature was usually correctly quoted as another factor affecting enzyme activity.

(b) The required definition of digestion was that supplied in the syllabus. Many candidates simply described the alimentary canal or referred to the action of acid in the stomach.

(c) The correct enzyme was usually identified as that which worked at a low pH. Other explanations inaccurately stated the enzyme was acidic.

Question 5

(a) Those who knew the formula for glucose usually gave a correctly balanced equation.

(b) Good answers recognised that nitrate deficiency led to stunted growth. Many confused nitrate deficiency with magnesium deficiency, suggesting yellowing of leaves and reduced ability to photosynthesise.

(c) (i) **Candidates providing** full answers described water and ion flow from the roots to the leaves, as required by the question. They described transpiration as the driving mechanism and did not confuse the roles of xylem and phloem. Others were unnecessarily concerned with movement of water into the roots by osmosis due to the concentration gradient. Only the best responses demonstrated understanding of water potential gradient along the stem.

(ii) A minority realised that increased humidity reduced transpiration, thus slowing the progress of water and ions through the plant. Many thought that leaves would absorb water from the air and some appeared to confuse humidity with air temperature.

(d) Most candidates gained some of the marks available for the eutrophication process. The best responses described the loss of oxygen due to respiration of increased bacteria feeding on dead plants which had died due to lack of sunlight. The role of algae was often omitted. Misconceptions included lack of sunlight or plants as the direct cause of fish deaths.

Question 6

(a) (i) The process was usually named accurately as fractional distillation.

(ii) This question required an explanation for the trend in boiling point rather than a description of the trend and its consequence for the order of distillation of fractions. Those who began their explanation with the trend in molecular size could show how that affected the energy required to separate molecules by overcoming increasing intermolecular force. Marks were often lost by a failure to clarify that bonds that were broken during boiling were *between* rather than *within* molecules.

(iii) Many candidates knew that a pure compound had a specific boiling point and that a mixture boiled over a range of temperature, although some had difficulty expressing this. Some suggested that pure compounds boiled at the same temperature, with 100 °C being specified.

(b) (i) The molecular structure of butane was usually drawn correctly.

(ii) Candidates suggesting that methane and hexane both had properties typical of saturated compounds were awarded the mark, but few cited the combustion products typical of hydrocarbons.

Question 7

To ensure credit in spite of a mathematical error, candidates are recommended to describe their method and show the steps in their calculation.

(a) (i) The maximum speed was read correctly from the graph by the vast majority of candidates.

(ii) Many attempted to measure the distance travelled by adding the areas under the graph.

(iii) Most could show how the value for acceleration was obtained.

(iv) The majority of candidates applied the formula $F = ma$ correctly.

(b) (i) Most identified the increase in the speed of particles as the air warmed rather than using vague terms such as increased motion.

(ii) Good explanations for pressure increase included the increase in rate of collision rather than more collisions and specified collision with the tyre wall. Fewer candidates went on to describe how this led to an increased force on the tyre wall.

(c) (i) There were some very precise descriptions of the working of an electromagnetic relay including how the current in the coil produced a magnetic field, causing the armature to turn on its pivot, causing the contacts to close. Some responses suggested that the contacts were attracted into the magnetic field while others attempted to describe the working of a transformer.

(ii) Most candidates realised that the function of this relay was to isolate the user from the high voltage circuit. Some confused the relay with an electromagnetic circuit breaker. Credit was not given for preventing electrocution.

Question 8

(a) (i) Most candidates found the format of this question easier to demonstrate their knowledge of the reflex action pathway.

(ii) Many answers explained why impulses travelled to the brain in terms of shorter distance rather than attempting a detailed description of the connection between eye and brain.

(b) (i) Candidates who described the changes to the pupil in bright light rather than going into normal conditions gained credit. The role of the radial muscles was not well understood.

(ii) The characteristics of reflex action were well known.

(c) Good suggestions for an adaptation of the eyes of nocturnal animals were provided.

Question 9

(a) (i) Most candidates stated that the nucleus of an atom of magnesium-26 contained 12 protons and 14 neutrons. The majority did not confuse the mass number of *this magnesium atom* provided in the question with the relative atomic mass of the element provided in the Periodic Table. Some candidates were penalised for locating electrons in the nucleus.

(ii) The electronic structure of magnesium was well known.

(b) (i) The gas released in the reaction was almost always correctly identified.

(ii) Those who understood the meaning of the term *composition* predicted changes in concentration of acid or magnesium chloride, or the decrease in mass of magnesium during the reaction.

(iii) Most candidates compared the kinetic energies at **A** and **B** correctly but lost the mark by just describing the increase and decrease between points **B** and **C**.

(c) (i) Candidates giving the best responses realised that the purpose of the water bath was to keep the temperature constant. Fewer explained its use due to the reaction being exothermic, or mentioned the effect of temperature on rate of reaction. Marks were not awarded for vague references to fair testing or the effect on results.

(ii) The relationship between acid concentration and rate of reaction was generally explained well, although there were some references to the number of collisions of particles rather than to the rate of collision.

Question 10

(a) Moisture was often correctly stated as a condition for germination but temperature was sometimes cited rather than a suitable temperature. The requirement for light was a common misconception.

(b) Glucose was usually named as a raw material required for germination, with carbon dioxide being sometimes incorrectly suggested.

(c) Comparative statements were generally used well to explain that the index moved further to the left because of increased respiration removing more oxygen.

(d) Most answers stated that there was no movement using seeds that had been boiled due to lack of respiration. A few candidates explained this in terms of denatured enzymes, but some incorrectly referred to denatured seeds. There was some confusion between the idea of respiration enzymes being denatured at 100 °C and that of warm seeds respiring more.

Question 11

(a) Most experiments involved placing materials between the source and a detector. The detector was not usually named. Candidates giving the best responses used a procedure based on a comparison of the penetration by radiation rather than the absorption of radiation. They realised that proof that γ-radiation was released was provided if the radiation was transmitted by a thick aluminium sheet, or a lead block. A common misconceived argument was that aluminium, unqualified, absorbed α and β completely and lead absorbed α, β and γcompletely.

Some candidates were given credit for knowing that γ-radiation was not deflected by a magnetic or electric field. Errors in describing the direction of the deflection of α and β-particles were not penalised.

(b) There were many correct nuclear equations. Some were spoiled by the correct daughter nuclide being given the symbol Pu instead of U. Some confused an α-particle with a hydrogen nucleus.

(c) The mathematical reasoning involved in the prediction of the resistance proved to be a challenge. Many were given some credit for thinking that resistance was inversely proportional to diameter obtaining an answer of 14 Ω. Very few deduced that resistance was inversely proportional to the square of the diameter to obtain 28 Ω.

(d) (i) Most candidates drew a reasonably accurate sinusoidal waveform with constant amplitude and frequency.

(ii) The mark was usually obtained for suggesting an increase in the strength of the magnet, the speed of rotation, or the number of turns on the coil.

(e) (i) The calculation of wavelength using the formula $v = f\lambda$ was done well.

(ii) A region of compression was usually labelled correctly.

(iii) Most knew that when the frequency increased the wavelength decreased causing the distance between two compressions to decrease.

Question 12

(a) (i) Most candidates stated that when sodium and chlorine combined, each sodium atom lost an electron and each chlorine atom gained an electron. Marks were lost by suggesting that electrons were transferred from chlorine to sodium or between ions. A substantial minority described covalent bonding.

(ii) Most arrangements of sodium ions and chloride ions in solid sodium chloride were correct.

(b) (i) The products of the electrolysis of molten sodium chloride were often shown correctly. Those of aqueous sodium chloride proved harder to predict.

(ii) The best responses stated that solid sodium chloride could not be used as an electrolyte because its ions were fixed. Few candidates explained that when an electrolyte conducts an electric current its mobile ions carried charge. A common error was to describe electric current in an electrolyte as the flow of electrons.

Question 13

(a) (i) Almost all candidates explained that lightning was seen before thunder was heard because the speed of sound was less than the speed of light.

(ii) Very few could state the meaning of the term *electric field* using the syllabus description as a region in which an electric charge experiences a force.

(iii) This question, which required the use of the formula $Q = It$ to calculate a current, was answered very well.

(b) (i)(ii) Successful candidates drew an accurate ray diagram knowing that:

- a ray passing through the optical centre of a lens was not deviated
- a ray passing through the principal focus was refracted parallel to the principal axis.

This facilitated the location of an image with its base on the axis and its point at the focus of the rays.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key message

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

Calculations were generally done well with working carefully shown. Candidates are expected to round their answers up or down to an appropriate number of significant figures.

It would be helpful for candidates to practise labelling and annotating diagrams and drawing graphs. Marks were often lost due to inaccuracies. Candidates should be reminded to use a sharp pencil and a ruler to draw label lines and, when appropriate, lines on graphs.

General comments

Some candidates only gained some of the marks available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

Candidates generally showed good use of English, expressing their ideas in continuous prose. Correct scientific terminology as stated in the syllabus should always be used. Inaccuracies in this area were particularly apparent in the responses to some of the questions on the biological content, which required candidates to state a specific scientific term or name. Learning the definitions specified in the syllabus earns marks directly as well as being an aid to language used in explanations.

Comments on specific questions

Question 1

(a) Candidates struggled to articulate their responses clearly, with few gaining both the available marks. Some candidates stated that blood flows through the heart twice but did not qualify this by saying this happens in one circuit. More candidates were able to identify the pulmonary and systemic circulations. Only the best candidates covered both points in their responses. There were many vague references to oxygenated and deoxygenated blood, which were ignored.

(b) Many good answers were seen, with many candidates gaining three marks. The area where glucose concentration is the highest was often given as **D** rather than the correct letter **F**.

(c) (i) Some candidates were not detailed enough in their responses and only gave the answer of arteries or blood vessels rather than the required response of **coronary** arteries. Incorrect responses of veins and capillaries were also seen.

(ii) This question was well answered with many candidates giving recommendations of eating less fat and taking some form of exercise. Incorrect responses included not exercising too hard and going to bed early.

Question 2

(a) (i) Several candidates gave only **A** or **B,** despite the question asking for elements. Most related conductivity to being metallic but fewer to **A** and **B** being in groups 1 and 2. Some thought **C** and **D** would be the best conductor(s) as they had most electrons in their outer shell.

(ii) The majority of candidates named **D** and stated that it had a full outer shell.

(iii) Some candidates stated the bonding type as covalent rather than ionic. Some candidates confused the two terms and gave a correct explanation of ionic bonding, which was credited. It was clear that some candidates did not read the question carefully and provided an explanation in terms of electron transfer, rather than referring to the types of element involved, as requested.

(b) It was clear that some candidates did not refer to the diagram provided in the question. Candidates should be reminded to use all the stimulus material to aid in their responses. Some candidates suggested that an alloy has combined properties of both metals without reference to the structure. Some thought there were stronger bonds between atoms in the alloy or that it was a compound. However, most candidates did make some attempt to explain it in terms of layers of atoms sliding over one another and irregularity of structure or different sized atoms.

Question 3

(a) (i) The majority of candidates were able to give the correct answer of iron.

(ii) The majority of candidates were able to give the correct answer of uranium. Lead was the most common incorrect response.

(iii) Fewer candidates gave the correct response of iron here. It may be that candidates did not want to use the same metal twice, despite being told this was acceptable in the question. The incorrect responses of copper and aluminium were frequently seen.

(b) (i) Candidates had to make some reference to temperature. Some responses where too vague, simply stating this is the point where something boils. There is still some confusion between evaporation and boiling. Some candidates muddled the state changes giving from solid to liquid, for example.

(ii) Only the more able candidates scored highly on this question by relating latent heat to energy being needed to break intermolecular bonds. There were many references to increased kinetic energy, leading to more collisions and some candidates seemed unable to distinguish between latent heat and boiling point. Very few candidates used the term *latent heat of vaporisation*.

(c) A lot of information was given in the stem of this question, which some candidates seemed to miss. A number had an equation with no zinc isotope. ^{64}Cu and $_{29}Zn$ were often seen and many candidates could not correctly formulate a β-particle.

(d) (i) Most candidates could easily access this question, with only the occasional use of an incorrect formula such as mass multiplied by the volume.

(ii) The most common issue was not converting grams to kilograms, with many incorrect responses of 448 N seen.

(iii) Candidates had to use their response for part **(ii)** in this calculation and allowance was made for an error carried forward from one step to the next. This meant that many candidates scored highly here, gaining full credit by calculating the pressure with their answer from part **(ii)**. A small number of incorrect formulas of pressure = weight × area were seen.

Question 4

(a) The majority of candidates scored well here. The gametes were most frequently incorrect with some candidates using **X** and **Y** and some giving two alleles in each circle. There was some confusion between the meaning of the words genotype and phenotype.

(b) (i) Most candidates were able to define the term *mutation*.

(ii) Most candidates had the idea of better chances of survival through camouflage but often struggled to express it. There was some confusion evident between predators and prey in some responses. The idea of survivors mating and reproducing seemed to be well understood. Few candidates named the process as natural selection with many using the term *survival of the fittest*, which only partially explains the example given in the question.

Question 5

(a) (i) Too many candidates missed this question or chose not to answer it. Those that did frequently shaded only the tip of the shoot. Only the better candidates attempted this and shaded the correct side.

(ii) Most candidates gave the correct answer of phototropism, with a small number giving incorrect answers such as photosynthesis and geotropism.

(b) The mechanism of auxin control of differential growth was poorly understood. Few candidates could explain how auxins controlled growth. Some incorrectly referred to auxins weighing the plant down, causing bending. Some candidates misinterpreted the question and gave an explanation of why plants grow towards the light. Few referred to changes to cells caused by auxins.

(c) The equation for photosynthesis was well known, with only a few candidates giving the respiration equation. A few candidates struggled to balance the equation, with some forgetting the formula for glucose and resorting to using the word.

(d) Definitions are quoted in the syllabus using the terminology that examiners expect to see. Many candidates had learnt the definition for growth and answered this question using appropriate terminology. Some candidates gave vague answers often referring to getting bigger or maturing, which were not credited.

(e) The process of translocation seems less well known among candidates. Many candidates could state that phloem is the vessel that transports sugars. Fewer were able to give the correct sugar as sucrose or describe the process using the term translocation. A minority of candidates confused xylem and phloem.

Question 6

(a) (i) The majority of candidates were able to name the correct processes. Occasional incorrect processes were named such as polymerisation and hydrolysis.

(ii) Again, the majority of candidates were able to give the correct conditions. A few candidates were not specific enough and referred to heat and pressure rather than **high** temperature and **high** pressure.

(iii) Most candidates attempted this question with some success. Common errors included drawing a molecule of butane and adding double bonds.

(b) (i) This question was well answered with many candidates being able to explain how rusting occurs. Some candidates referred to a reaction with air rather than oxygen.

(ii) Fewer candidates were successful here, with only the most able candidates referring to sacrificial protection. Many gave vague answers of 'it lasting longer' or 'being cheaper'.

Question 7

(a) (i) The majority of candidates correctly identified the piano and a good number also gave the correct explanation of the highest frequency. A small number of incorrect answers such as violin were seen.

(ii) Again, it seemed that candidates were reluctant to use the same answer twice. The piano also had the lowest frequency but a number of candidates opted for cymbals. Some of those who stated piano referred to the largest frequency range rather than the lowest frequency.

(b) (i) Most candidates calculated the correct answer of 7.5 Ω. The most common incorrect answer was 30 Ω

(ii) Many candidates were confused here and did not seem to realise that the heat sink needed to take heat away from the amplifier **and** the heat sink so there was much reference to absorption of heat, especially by the black fins. Many gained credit for referring to metals being good conductors of heat.

Question 8

(a) (i) Most candidates were able to correctly name the labelled parts of the flower. Occasionally other incorrect responses were seen or the names were reversed.

(ii) Some candidates gave answers referring to wind-pollination rather than insect-pollination as instructed. However, these were given credit if wind-pollination was specified.

(b) Many incorrect responses were seen including ovulation and pollination. Although, it was pleasing to see that many avoided the incorrect answer of mitosis, which is easily confused with meiosis.

(c) Most candidates were able to state an advantage and disadvantage of sexual reproduction. Some responses vaguely referred to differences between offspring and parents. The best responses referred to genetic variety of offspring.

(d) It was clear that there was some confusion between pollination and seed dispersal. Dispersal by attachment to fur or ingestion and excretion were often seen. Candidates were given credit if they gave other correct methods of seed dispersal by animals.

Question 9

(a) Most candidates knew that carbon dioxide turned limewater milky, although some who chose **Q** suggested that other gases were responsible. More chose **P** and usually then explained that carbon displaced copper forming carbon dioxide. Only the more thorough candidates added that carbon would not displace magnesium.

(b) (i) Many candidates scored all three marks. A surprising number of candidates thought that a gas was released with no reaction taking place.

(ii) A number of candidates scored well here with most getting copper chloride and either water or carbon dioxide. Hydrogen, carbon and copper also appeared as products with a few more unlikely ones such as magnesium. The majority of candidates stated copper chloride rather than copper chlorine, which has been a common error in the past.

(c) (i) The vast majority of candidates correctly calculated the mass.

(ii) Many candidates got this correct. A few candidates multiplied when they should have divided. Some got 0.15 for the 2nd answer by taking Cl_2.

(iii) The question asked candidates to use their answers from part **(ii)**. Despite this many candidates that gained marks in part **(ii)** did not apply their answers to part **(iii)**. Also, many candidates managed to get the correct answer despite getting part **(ii)** wrong.

Question 10

(a) Not many candidates answered this correctly.. Many answered in terms of electrolytes needing to be liquid, which aqueous solution was and crystal was not. Very few answered in terms of conduction, usually referring to electrons being able to move or not, rather than ions.

(b) Many candidates correctly identified the products at the cathode and anode. A common error was to suggest sulfur formed at the anode.

(c) (i) Most candidates realised the difference was 1 electron, which had little mass. There was some confusion with isotopes. Many stated that they had the same number of protons but did not refer to the number of neutrons. Some used a similar wording to the question of nearly the same number of electrons.

(ii) Particle **M** was mostly identified as having a negative charge and so attracted to the positive electrode. Some candidates incorrectly referred to particle **M** as chlorine rather than a chloride ion.

(iii) Some candidates did not read the question fully and drew a chloride ion or a chlorine atom rather than a molecule of chlorine as instructed.

Question 11

(a) (i) The vast majority of candidates scored both marks available. A minority drew horizontal lines or ended the line at (35, 0).

(ii) A number of candidates got the correct answer but lost marks for incorrect rounding of figures.

(iii) A number of candidates tried to use acceleration rather than velocity in this calculation. Credit was given if the correct formula was stated.

(b) This calculation was often completed correctly with many candidates gaining at least partial credit. Almost all knew the formula for calculating distance. Many candidates lost a mark by forgetting to divide by 2, because the radar pulse made a double journey.

Question 12

(a) (i) Almost all candidates could use the graph to predict a correct volume. Candidates were more likely to give a figure that was too high such as 71 or 72 cm^3 than one that was too low.

(ii) Many candidates provided good suggestions of enzymes being denatured. There was some confusion between enzymes and yeast being denatured and killed.

(iii) Increased concentration of sugar and/or yeast was frequently seen. Some candidates were not precise enough and simply referred to changing the amount, which was not credited. Some gave suggestions such as adding a catalyst, which was not appropriate.

(b) A minority of candidates confused anaerobic and aerobic respiration. Many candidates knew that lactic acid was produced in animals and ethanol in yeast.

(c) The vast majority gave the correct answer of producing some form of alcoholic drink. The most common incorrect answer was yoghurt. Although this is produced by fermentation it is with the use of bacteria rather than yeast.

Question 13

(a) (i) Most candidates gained credit with a minority using the incorrect formula $V = IR$.

(ii) Although many candidates understood the principles of choosing a suitable value for a fuse, in many cases they could not express clearly the consequences of using the wrong one. Some candidates seemed to think the fuse actually determined the current flowing.

(b) Most candidates could explain this in a satisfactory manner and often it was clearly and concisely expressed. Common errors included the magnetism of the solenoid attracting the contacts and repulsion of the pivoted soft iron. Some candidates tried to explain why a relay was used instead of a switch in the high voltage circuit.

(c) (i)(ii) Most candidates achieved some of the marks available. A common error was to be imprecise with labelling. Wavelengths were often too short or too long. Compressions and rarefactions covered too large a range using brackets rather than labelling a point where a compression or rarefaction was. Very occasionally the labelling for the compression and rarefaction was reversed.

CO-ORDINATED SCIENCES

Paper 0654/43
Theory (Extended)

Key message

It is necessary that candidates learn the formulae listed in the syllabus. They stand to lose all the marks for a calculation if they begin with an incorrect formula. Where calculations are based on the application of scientific knowledge and data handling, it is important that candidates show the method used and the steps involved in their calculation. This not only facilitates logical progress through the problem for the student but allows the examiner to give credit for method when errors are carried forward to a subsequent step.

General comments

The standard of presentation of responses was good. In general handwriting was legible, and the use of language was competent. Candidates should check their working in calculations as the final answer often counts for a large proportion of the marks for a question.

Candidates should ensure that their answers add information to what is supplied by the questions rather than simply rephrasing what is supplied. Those who showed evidence of having practiced logical explanation of key phenomena were the most successful in responding to questions requiring longer answers. There were signs that many candidates understood the processes in all three branches of the subject but lost marks through lack of precision in their answers. Examples included the discussion of more particle collisions instead of the greater rate of collision causing increased rate of chemical reaction, and particles at a water surface gaining energy from the Sun instead of particles gaining sufficient energy to escape from the surface during evaporation.

Comments on specific questions

Question 1

(a) Most candidates accurately labelled the liver and the pancreas.

(b) A few responses correctly described the primary function of bile as the emulsification of fat in order to present a greater surface area for the action of digestive enzymes, rather than simply breaking down food.

(c) Insulin was often mentioned in descriptions of the reduction of blood glucose concentration. The role of the pancreas in producing insulin when it detected high glucose concentration was less common. Many candidates knew that glucose was converted to glycogen for storage, although there was some confusion with glucagon. Candidates were less clear that insulin caused the liver to carry out that function.

(d) (i) There were some good explanations of the meaning of the term *negative feedback* as a response to a change from a set point that returned the system back to the set point.

(ii) The most common example of negative feedback was temperature control. Some candidates lost the mark by describing the response to a change, e.g. sweating, rather than stating the variable which was being controlled, temperature.

Question 2

(a) The table of information about atoms of the elements was usually completed correctly.

(b) (i) Most candidates identified the argon atom.

(ii) Many candidates explained the representation of the argon atom in terms of its low reactivity but fewer mentioned the role of electronic structure.

(iii) This question was well answered with most knowing that iron was a catalyst that increased the rate of reaction or enabled the reaction.

(c) (i) The trend in solubility shown by the graph was described well.

(ii) Most candidates quoted 68 g as the mass dissolving in 100 cm^3 of water. Some misread the solubility as 64 g per 100 cm^3. Using the molar volume in step 3 posed few problems. A small number of candidates were successful in finding the relative molecular mass of ammonia and using it to find the number of moles in the solution.

Question 3

(a) (i) Candidates found it difficult to describe the advantage of thin walls in a gas exchange surface without simply repeating the question. Where they acknowledged that gases travelled across a shorter distance they seldom referred to diffusion.

(ii) Successful responses usually referred to the large area of gas exchange surfaces, and sometimes to their moistness or good blood supply, as ways in which they were adapted to their function.

(b) (i) Most marks were scored here when the functions of mucus and cilia were described separately, with the mucus rather than the cilia trapping particles, and the cilia moving the mucus away from the lungs.

(ii) Some candidates knew the effect of smoking on health in the short term, but they were only likely to refer to cilia being unable to remove mucus if they could answer part **(i)**.

(c) Few candidates referred to the carcinogenic effect of tar in cigarette smoke.

Question 4

(a) (i) Many attempted to measure the distance travelled by adding the areas under the graph. Those who found the areas of both triangles usually obtained the right answer. Candidates who showed the method used and the steps involved in their calculation clearly gained credit for the method even when the answer was incorrect.

(ii) Those who knew that the gradient of the graph could be used to find the acceleration usually obtained the correct answer.

(iii) The maximum speed was generally read correctly from the graph. When the kinetic energy formula was stated as ½mv^2 rather than ½mv and the candidate remembered to square the speed, the correct answer was usually reached.

(b) Where the formula was known and all four feet were taken into account, the pressure exerted by the bear was often correct.

(c) (i) This question was answered well with many candidates suggesting a frequency for the device between the upper limits of hearing for humans and polar bears.

(ii) Many candidates described one difference between a compression and a rarefaction in terms of either density or pressure, obtaining only one of the marks by referring to compression for answer 1 and rarefaction for answer 2. Some descriptions referred to the lines on the diagram as waves, suggesting that there was a difference in frequency or wavelength.

(d) Suggestions for low frequency radiation were split between microwaves or radio waves and radiation with frequency higher than that of the infra-red.

Question 5

(a) (i) Carbon dioxide was usually suggested as a contributor to global warming with carbon monoxide being a popular but incorrect choice.

(ii) Many realised that carbon monoxide is produced by internal combustion engines but few named the type of fuel or included the role of incomplete combustion.

(b) Many drew a correct dot-and-cross diagram to show the bonding in a carbon dioxide molecule.

(c) Candidates found the context of this question challenging. Those that regarded the liquids as containing different concentrations of acid often went on to state the relationship between concentration and rate of reaction caused by different rates of collision of reacting particles. Marks were sometimes lost by explanations referring to particles colliding more rather than colliding more often.

Question 6

(a) The parts of the seed were not well known.

(b) Many candidates knew that water and a suitable temperature were conditions necessary for germination, but oxygen was rarely included.

(c) (i) A few answers referred to transport of material through the phloem, but the term translocation was rarely used. There was no reference to conversion of food stores in the cotyledon into sucrose.

(ii) A few candidates realised that a seedling, planted too deeply, uses up its food store before reaching the surface.

(d) (i)(ii) The questions on the adaptation of seeds for dispersal by animals were answered well.

Question 7

(a) Most candidates knew the charge formula and could perform the substitution. Those who gained full marks converted milliseconds to seconds and were familiar with the coulomb as the unit of charge.

(b) Many knew the formula relating thermal energy transfer with specific heat capacity. Common errors were to use the initial or final temperature rather than the temperature change, and to quote the answer to the wrong power of 10.

Question 8

(a) (i) There were many good suggestions for the reason why some dyes did not move recognising the presence of dyes which were insoluble in water.

(ii) Most explanations for the ink containing more dyes referred to the presence of more than one insoluble dye. Few candidates mentioned the possibility of dyes moving at the same speed.

(iii) In order not to simply repeat the question, candidates needed to recognise that no new substances were formed or that existing substances were being separated. Reference to the lack of chemical reaction and the difficulty in reversing the process were not adequate answers.

(b) Some identified the cracking reaction but hydrolysis was rarely named.

(c) (i) The best responses stated that when magnesium and chlorine combined, each magnesium atom lost two electrons and each chlorine atom gained an electron. Some good answers were provided in the form of a diagram showing the transfer of electrons between the outer shells of atoms. Marks were lost by not referring to atoms or by suggesting that electrons were transferred from chlorine to magnesium or between ions. A substantial minority described covalent bonding.

(ii) Those who showed understanding of the bonding between magnesium and chlorine often gave the correct formula, $MgCl_2$. $MgCl$ was a common answer.

(d) (i) There were a wide range of gases named as products of the electrolysis. Where hydrogen and chlorine were named they were often reversed or chloride written instead of chlorine.

(ii) Some candidates correctly suggested that molten magnesium chloride was used as the electrolyte in the industrial production of magnesium. Many were distracted by the reference to an industrial process and answered in terms of the scale of production.

Question 9

(a) Most candidates used the graph to describe the general relationship between pH and number of fish species. There were some useful comments about the significance of neutral and alkaline environments.

(b) (i) The correct name of a gas causing acid rain was often given. To gain the marks it was necessary to suggest a source of this gas and to describe the interaction between the gas and water in the atmosphere.

(ii) More candidates could describe at least one effect of acid rain. The best responses included a specific example, such as damage to trees in forests or leaching minerals from soil, rather than a general statement such as killing plants or crops.

(iii) A practical way to reduce the incidence of acid rain was required. Answers such as ‘reduce the burning of fossil fuels’ was better than ‘stop emitting sulfur dioxide’.

Question 10

(a) (i) Most candidates interpolated the data and correctly predicted the change in mass of the potato. Marks were lost for omitting the negative sign.

(ii) This question requiring an explanation of which salt solution had the same water potential as the potato was well answered.

(b) Most candidates explained that entry of water into the potato caused the increase in mass but few explained this in terms of osmosis driven by a water potential gradient.

Question 11

(a) Marks were obtained by explaining that the house was cool during the day due to the reflection or lack of absorption of heat radiation from the Sun. The effect on light or sunlight was not acceptable. Explanations for the house staying warm at night were less successful. Many candidates had the misconception that radiation was reflected back into the house rather than the white surface being a poor radiator or emitter of heat radiation.

(b) (i) Most candidates drew the image at the correct height but on the surface of the mirror.

(ii) The drawing showed that the ray from the bottom of the mirror was reflected well above the head of the woman, if care was taken so that the angle of incidence equalled the angle of reflection.

(iii) The explanation of why the woman could not see the reflection had to recognise that light was not reflected into her eyes. Answers such as ‘the mirror was too high’ were common.

(c) (i) The correct symbol for a voltmeter was usually used and many candidates did connect it across the output terminals.

(ii) Some good sketches of a sinusoidal voltage waveform were seen. More common were traces showing a constant direct voltage or a ramp voltage.

(iii) A small number of candidates were able to explain the production of an alternating current by the generator. They described how rotation of the coil cutting the magnetic field or experiencing a changing magnetic field induced an e.m.f. They showed that this e.m.f. reversed every half turn. They described how the slip rings conducted current to and from the coil preventing the tangling of wires.

Question 12

(a) Most candidates described the transformation of kinetic energy to electrical energy by the generator or by the overall system. Fewer included the transfer of kinetic energy from waves to air to turbine.

(b) Those who knew the formula $v=f\lambda$ usually applied it successfully.

(c) Good descriptions of evaporation referred to the most energetic molecules leaving the surface, while others simply stated that the Sun caused surface molecules to escape. Forces or bonds between molecules were often mentioned although descriptions in terms of molecules having sufficient energy to overcome those forces were less common.

Question 13

(a) The molecular structure of ethanol was often drawn correctly. A common error was to reverse the oxygen and hydrogen symbols.

(b) (i) The chemical test for water was not well known. Alternative tests were often confused with each other or a physical test suggested.

(ii) Some candidates could state the energy transformation that occurred when ethanol burned. Some knew that chemical and thermal energy was involved but reversed the order of transformation. Some responses involved kinetic energy.

(iii) The equation for the combustion of ethanol proved to be a challenge for many candidates. They needed to know that ethanol reacted with oxygen to form carbon dioxide as well as water and then write the correct symbols in the appropriate spaces. Those who achieved that usually gained the balancing mark.

(c) Many candidates explained that ethanol was collected first because it had the lower boiling point. Some referred to intermolecular forces or the energy that was required to overcome those forces without comparing ethanol and water.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

Key Message

The triangle used for calculating the gradient of a line should be based on at least half the length of the line to reduce errors of reading the scales on the *x* and *y* axes.

General Comment

The Chemistry question proved to be the most challenging question, probably because it approached analysis in a slightly different way.

Comments on Specific Questions

Question 1

Most candidates knew that Benedict's test needs heating. There are still a significant number of candidates who believe that this test is for any sugar or carbohydrate. Glucose was accepted as an alternative response to reducing sugars.

In **part (b)** it was clear that nutrients in chickpea varied according to the source. Allowance was made for this if the supervisor's report included a set of results as requested. Generally the expected results were seen for banana and egg white. Candidates should place a record of what they saw in the table.

The conclusions in **part (c)** had to be consistent with the observations recorded in **(b)** rather than the expected nutrients.

A large range of responses was seen for **(d)**. Most candidates realised that the amount of sample needed to be kept constant. They were often less specific about the volume of Benedict's solution. Heating to the same temperature for the same time was required for further credit and was often omitted. Although the range of colours observed in the Benedict's test was well known some candidates did not link the colour to the concentration and referred to the darkness of colours instead.

Knowledge of the test for fats was reasonably well known. Some candidates proposed the use of ethanol without water but were still credited for ethanol. The idea of an emulsion being formed in the presence of a fat was required for the further credit; mention of a precipitate only gained no credit.

Question 2

This question required candidates to identify pairs of compounds and later identify two compounds. Candidates needed to be able to use the Notes for Qualitative Analysis on the back page of the question paper and to know about alkalis. In **(a)** candidates were expected were able to identify H as being a neutral solution, hence the two salts silver nitrate and barium nitrate, and J as being an alkali, ammonia or sodium hydroxide. Some candidates gave one compound for H and one compound for J at this point.

Candidates found **part (b)(i)** challenging. Some went into the theory of the reaction. Very few used excess copper oxide followed by filtration.

Part (b)(ii) can be quite tricky to carry out but candidates did this well and described the residue accurately. Some did not appreciate that they were adding copper sulfate to ammonia rather than the more usual ammonia to copper sulfate and wrongly quoted the observations from the Notes for Qualitative Analysis.

A good number of candidates were able to identify J as ammonia in **(b)(iii)**. Fewer were able to identify H as barium nitrate, perhaps because they did not isolate the white precipitate of barium sulfate in the previous part.

The last part required a lot of thought and many candidates realised that iron (III) sulfate would not distinguish between the two alkalis because the observation would be the same in both cases. Fewer were able to deduce that the sulfate ion would be able to distinguish between silver nitrate and barium nitrate in the same way that copper sulfate had.

Question 3

This experiment worked well and most candidates generated a good set of results. Common errors were recording the meter readings in milliamps and millivolts and recording the current to only one decimal place. Resistance values were generally well calculated. Some candidates incorrectly recorded their resistance values to an inconsistent number of significant figures. Correct rounding should be carried out rather than leaving an unrounded number with the recurring symbol. Similarly if three significant figures are chosen as the appropriate accuracy then a value of 8.00 would be more appropriate than 8.

Graph plotting skills were good. Common errors were not starting the scales at the origin, non-linear scales, difficult scales, this sometimes resulted in candidates making mistakes in the plotting of points, and poor best-fit straight lines. Often the non-linear scale was between zero and 20 cm so the candidate was able to gain the plotting, line and gradient credit. Non-linear scales throughout the *y*-axis resulted in no credit for the graph, extrapolation and gradient. Consequently construction of linear scales is an essential skill.

Many candidates did not construct a scale to include l = 110 cm, probably because they had not read ahead of **part (b)**. These candidates were still able to access the mark in **(c)(i)** if they extended their line beyond the grid and accurately measured the value of R for l = 110 cm.

The relationship in **(c)(ii)** was well understood and clearly stated in most cases.

The gradient in **part (d)** was attempted on most scripts. Common errors were the use of too small a triangle (less than half of the best-fit line) and the use of the number of small squares in the calculation rather than the lengths on the scales.

In **(d)(ii)** candidates were expected to multiply the gradient (Ω / cm) by the number of centimetres (3.4 m × 100). Some candidates made this question part more difficult by using a reading off the graph, such as the resistance for 1 m, and multiplying this by an appropriate distance, such as 3.4 for 1 m. Many of these candidates either used points not on the best-fit line or did not carry out the calculation correctly.

Answers to **part (e)** needed to be both clearly expressed and clear about the source of inaccuracy being discussed. If a reading was chosen it was necessary to specify the measuring instrument or what was being measured, for example the length of the wire. Most candidates chose to discuss the measurement of the wire in some way, including the problems associated with keeping the wire straight. The heating effect in the wire was rarely discussed.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

Key Message

There is no need to include the origin when plotting a graph unless candidates are instructed to include the origin or the origin is clearly a point.

General Comments

There was a good balance of credit between Biology, Chemistry and Physics questions.

Comments on Specific Questions

Question 1

The drawings of a flower were generally well done and were rarely too small or too large for the box. Some drawings did not depict the ovary. Labelling needed care. Candidates sometimes confused anthers and stigmas. Most knew the position of the stamen but labelled only the filament.

In **part (b)**, candidates were asked to draw a straight line across their drawing from one edge to the other. It was anticipated that this would be from left to right across the widest part. Some candidates did not draw the line but carried out the measurements. Other candidates drew vertical lines or lines across narrow parts of the drawing. These variations were all allowed. Lengths of the line were well measured. A small number of candidates recorded the lengths in centimetres rather than millimetres. Many candidates processed the measurements incorrectly to obtain reciprocals of the magnification. Some candidates gave the magnification as a ratio or as a percentage. This was accepted if some mathematical processing had been carried out.

Candidates had to circle the stigma in **part (c)**. This was usually done correctly even if the stigma had been wrongly labelled.

Benedict's solution was well known as the reagent required in **part (d)**. Most knew that heat was required. Some candidates wrongly proposed heating the flower before testing with Benedict's solution. Candidates needed to link the colour to the amount of reducing sugar present. Some just discussed the identification of reducing sugars. Others discussed darkness of the mixture with no reference to specified colours.

Question 2

It is important to check that the chemicals listed in the Confidential Instructions react in the usual way. The results of some centres were unexpectedly low. This was caused by the reduced activity of certain batches of marble chips.

Most candidates carried out **parts (a)(i)** and **(a)(ii)** correctly. A small number confused the columns in the recording of V1 and V2. In **part (a)(iii)** the recording of temperature to the nearest 0.5 °C was tested. Technically readings should have ended in .0 or .5. Whole numbers were accepted in this case. Some candidates recorded volumes lower than in **parts (i)** and **(ii)**, suggesting that too much air was allowed into the measuring cylinder in these earlier parts.

Most candidates calculated the volume of gas collected correctly. A small but significant number added V1 and V2.

A large number of candidates included the origin, (0,0) on their graph in **part (b)**. Better use of the grid was achieved by not including the origin. As there were only four points it was often more difficult to decide whether a straight line or a curve was more appropriate. Both were accepted.

In **part (c)** candidates were instructed to use their graph to describe the relationship between temperature and rate. This was generally done well. Some candidates gave the expected relationship when their graph suggested an alternative relationship.

Answers to **part (d)(i)** varied considerably and responses other than the list in the mark scheme were accepted if valid.

The same method for **part (d)(ii)** was proposed by a number of candidates and consequently their answers were not credited. All three methods in the mark scheme were seen and a small number of candidates proposed the equally acceptable timing of limewater to go milky. Candidates should ensure that in addition to a description of the apparatus, the details of the measurements made are included.

Question 3

Generally the first three measurements in **part (a)** were recorded correctly to an appropriate accuracy. The units for density were fairly well known and most were able to record the density to two or three significant figures and with correct rounding.

Many candidates were able to discuss how the reading of the measuring cylinder could be carried out as accurately as possible. Answers concerning reading at eye level were more common than reading to the bottom of the meniscus.

Parts (b)(i), **(ii)** and **(iii)** caused few problems. Many candidates gained full credit in **part (b)(iv)**.

Relatively few candidates provided an acceptable source of inaccuracy in **part (c)** although more were able to describe the effect on density and error carried forward was often applied. Few realised that, in **part (c)(iii)**, carrying out the experiments in reverse order would result in a wet measuring cylinder for method 1.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental technique, to have carried out experiments similar to the ones shown in the paper and be able to draw apparatus. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates should have performed identification tests on the range of substances detailed in the syllabus.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard and food tests were well known. The standard of graph drawing was generally high although candidates need to remember that axes need to be linear and covering at least half of the grid and to draw smooth curves with a single line. Candidates must read the questions carefully so that they answer what is being asked by the question. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results. Knowledge of identification tests for ions was limited and many found drawing diagrams of apparatus very difficult.

Comments on specific questions

Question 1 – Food Tests

(a) About half of the candidates gained credit and although all reagents were seen biuret was the most common incorrect response.

(b) Many candidates gained partial credit with some gaining full credit. Many candidates gave remains the same or doesn't change for the negative tests, or omitted the tests for the negative results, none of which gained credit as the question asked for colours. Common incorrect responses included: colour of the biuret solution itself to be purple and colour of iodine in starch to be blue.

(c) Many candidates gave the method from the stem of the question and so did not gain credit. Control of the amount of the two solutions was seen from more able candidates. Many thought that either the degree of redness or the speed that the solution changed to red indicated the amount of sugar content.

(d) The addition of alcohol was well known but the subsequent addition of water was seen rarely. A significant number of candidates gave the result as suspension or precipitate rather than emulsion.

Question 2 – Identification of Solutions

(a) Some candidates gained credit for **H** but fewer appreciated that **J** was alkaline. Often candidates gave one of the correct substances and gave an acid for the other in each pair.

(b) (i) Candidates found this very difficult and a significant number omitted the question. Many added copper oxide to sulfuric acid and crystallised. Many used electrolysis and some fractional distillation.

(ii) More able candidates identified **J** but far fewer identified **H**.

(c) Candidates found this very difficult with few gaining any credit. Some discussed the relative reactivity of copper and iron, some thought that because iron(III) would not give a blue colour then it would not be useful and others discussed displacement reactions.

Question 3 – Resistance of a Wire

(a) The vast majority of candidates read the voltage correctly. A few candidates gave 0.37.

(b) (i) While most candidates performed both calculations correctly many didn't follow the pattern of data in the table and only gave the answer 2 to one sig.fig., hence gaining credit for the second calculation only.

(ii) Whilst generally the graph was done well, there were still a large number of candidates who had non-linear axes mainly the x-axis.

(c) (i) Many candidates gained credit. The most common error was attempting to read a value from a non-linear scale.

(ii) The relationship was well described by many. The most common error was to describe the relationship as proportional when their line of best-fit didn't pass through the origin.

(d) Candidates found this very difficult. Common non-creditworthy responses included: varying thickness of the wire, voltmeter broken, not increasing the length in regular amounts. Those that gave an inaccuracy often didn't give a correct associated precaution.

Question 4 – Blood

(a) The majority of candidates gained credit.

(b) (i) The majority of candidates correctly labelled the red blood cell but a significant number did not gain credit for the platelets.

(ii) The quality of the drawings varied enormously. Many candidates drew an enlarged cell but some had difficulty with the three lobed nucleus. A significant number ignored the white cell in the diagram and drew from memory either an animal cell or a plant cell with all of their associated features. Many didn't label the cell. Common incorrect labels included: the nucleus labelled as an antibody and the outer membrane labelled as the cell wall.

(c) (i) Whilst many candidates measured the cell correctly, a large number then recorded the measurement in cm or gave 80 or 90 mm.

(ii) Most candidates did not give the measurement to the nearest 0.5 mm and gave an integer value.

(iii) Most candidates calculated the magnification correctly but a large number then did not give the answer to the nearest whole number. A small number inverted the division.

Question 5 – Rate of Reaction

(a) Candidates found this difficult and quite a large number omitted this question. More able candidates gained credit usually for a syringe and its label. Many candidates attached a sealed test-tube to the delivery tube or collected over water into a test-tube with no graduations or into a beaker. A few collected into a balloon.

(b) The majority of candidates calculated the values correctly.

(c) Whilst many candidates chose 2.5 many gave the reason that higher concentration leads to a faster reaction with no reference to the data. Some cited 65 cm^3 of gas given off without an interpretation of this being the largest. A small number chose 0.2.

(d) (i) More able candidates gained credit. A wide variety of equipment was named but pipette, burette, syringe and measuring cylinder were the most common.

(ii) More able candidates gained credit. Measuring cylinder was a common incorrect response.

(e) (i) More able candidates gained credit. Mass or amount of calcium carbonate was the most common incorrect response and volume of acid was seen often.

(ii) Many candidates gained credit. Fair testing and correct result were non-creditworthy responses seen quite often.

(f) Many candidates gained full credit here. However almost as many candidates thought the gas given off was hydrogen and of these many gave the test using glowing splint. Chlorine, oxygen and ammonia were also seen quite often.

Question 6 – Heat transfer

(a) Quite a few candidates gained credit. Common incorrect responses included: clasp, holder, tongs, stand and claw.

(b) Candidates found this difficult. Common non-creditworthy responses included not using mercury thermometers, goggles, lab coat, tying hair back.

(c) (i) Most candidates plotted the two points correctly.

(ii) Many candidates gained partial credit for the smooth 'reverse s' shaped curve but many either drew the curve through the anomalous point or shifted the curve a long way towards it. A small number drew a straight line.

(iii) Many candidates estimated the temperature correctly but of these many did not show on the graph how they had reached this estimate.

(iv) Many candidates correctly described the relationship although some did not use the variables identified in the question. Few candidates appreciated that the decrease was non-linear or that the temperature was becoming constant.

(v) Generally well answered but lamp too far away was seen quite often with no reference to the temperature.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard, calculations were done well and food tests were well quite known. The standard of graph drawing was generally high although candidates need to remember to include quantities and units on the axes and to draw smooth curves with a single line. Candidates must read the questions carefully so that they answer what is being asked by the question. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1 – Flowers

(a) (i) This was well answered with almost all candidates gaining some credit and some full credit. Some candidates drew feathery outlines rather than clear solid lines or drew very small flowers. A significant number drew a flower from memory rather than the one in the photograph and so drew many petals rather than just the two. Most candidates included the internal flower parts.

(ii) Both structures were well known but there was sometimes ambiguity in where the label lines ended. Common errors included labelling the filament as the anther, and reversing the labels.

(b) (i) A significant number omitted to draw the line or measured in cm.

(ii) Calculation of magnification was well answered although a significant number inverted the division.

(c) Many candidates drew the circle on their drawing rather than on the photograph but if correct these were credited. Common errors: circling the whole structure or the anther.

Question 2 – Reaction Rate

(a) (i) Almost all candidates calculated the values correctly.

(ii) Generally the graphs were quite drawn well. However, axes were sometimes unlabelled and of those that were labelled the units were often omitted. A significant number chose a scale which did not extend over at least half of the grid. Candidates often plotted the points correctly but then opted to draw a straight line rather than a curve. There were a small number of feathery or multiple lines drawn. A significant number of candidates plotted the values for V_2.

(iii) The relationship was described well although a number of candidates discussed the volume of gas rather than the rate.

(b) (i) Few candidates gained credit. Many thought that the reaction would be faster in the second minute or that the gas needed time to travel into the measuring cylinder.

(ii) Few candidates gained credit. The most common responses were that the marble chips had already been used up or that the experiment would not have been fair.

(iii) More able candidates gained credit, usually for the syringe, with the most able gaining full credit for appreciating that the measurements needed to include timing. Many candidates redrew the diagram from the question stem which was not creditworthy.

Question 3 – Density of Water

(a) (i) The majority of candidates gained credit but a significant number gave 51.27.

(ii) Most candidates read the volume correctly.

(iii) More able candidates gained credit. Common non-creditworthy responses included allowing the water to settle, using a more precise measuring cylinder or getting someone else to check the results.

(iv) The majority of candidates calculated the value correctly but fewer gave the correct unit. Common incorrect units included g, kg, cm^3.

(b) (i) The majority of candidates calculated the volume correctly.

(ii) The majority of candidates calculated the value correctly but fewer considered the number of significant figures appropriate and so gave the answer 1.

(c) (i) Few candidates gained credit. Common non-creditworthy responses included: reliability, to get an average, test-tube not vertical.

(ii) Few candidates gained credit. Many thought that the experiment was being repeated for reliability or accuracy or for checking the answer rather than considering the order of the processes.

Question 4 – Sugar and Starch content of Plants

(a) Many candidates gained partial credit but many of these did not include a time factor. A significant number thought the plant should be boiled in alcohol to destarch it.

(b) (i) Most candidates gained partial credit usually for iodine and sometimes for the correct colour. Few candidates appreciated the need to remove the chlorophyll by warming in alcohol. Many colours were seen for iodine including orange, brown, blue and dark blue.

(ii) Many candidates gained credit for the reagent and correct colour change but few remembered that heating is required.

(iii) Whilst most candidates gave a safety precaution, few explained why that precaution should be taken and so did not gain credit.

(c) More able candidates gained credit. Many cited either' light' or 'carbon dioxide' rather than both. A significant number only repeated the results from the Table.

Question 5 – Salt Preparation

(a) (i) Only the more able candidates appreciated that an observation was needed in order to gain credit. The most common non-creditworthy responses were that the copper sulfate was no longer dissolving and a blue solution was forming.

(ii) Most able candidates gained credit. Incorrect responses included: to form crystals, to complete the reaction and to concentrate the solution.

(iii) Filtration was well known. Common incorrect responses included heating and distilling.

(b) (i) Very few candidates gained credit, many thought the copper sulfate was burnt since it was black. Many thought that the copper had reacted with oxygen.

(ii) More able candidates appreciated that the solution needed to be heated but few gained further credit. Many candidates repeated the initial stem describing the formation of the copper sulfate solution.

(c) Many candidates knew the sulfate test but many used silver nitrate and a significant number omitted the question.

(d) Many candidates gained at least partial credit with many gaining full credit. The most common incorrect response was zinc and chlorine.

Question 6 – Evaporation and Temperature

(a) (i) Many candidates gained credit but several used a measuring cylinder. A teat pipette or dropping pipette should not simply be called a dropper. Many described how the cotton wool should be held, for example with tongs.

(ii) More able candidates gained credit. Many thought incorrectly that this was needed for the cotton wool to absorb the same amount of alcohol.

(b) (i) Most candidates read the thermometers correctly.

(ii) Whilst most candidates calculated the value correctly many did not follow the pattern of data in the question with regards to decimal places and so gave a value of 9.

(c) (i) Many candidates gained credit. Common incorrect responses included 120 s and 150 s.

(ii) Candidates found this quite difficult. Many discussed changes in the room temperature, or the student touching the thermometer or errors in timing.

(d) More able candidates gained credit. Common incorrect responses included: the end of the reaction, it has reached its lowest temperature and the alcohol is evaporating.

(e) Candidates found this very difficult. More able candidates appreciated that the temperature was decreasing but didn't appreciate that the rate of decrease was decreasing and so gave a straight line.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques, to have carried out experiments similar to the ones shown in the paper and be able to draw apparatus. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates should have performed identification tests on the range of substances detailed in the syllabus.

General comments

Candidates from some Centres demonstrated good understanding of practical knowledge. The reading of the instruments was of an excellent standard. The standard of graph drawing was generally high although candidates need to remember to draw straight lines with a ruler. Undertaking practical work helps the candidates to state observation and to interpret and evaluate experimental methods, techniques and results. Knowledge of identification tests for ions was limited and many found drawing diagrams of apparatus difficult.

Comments on specific questions

Question 1 – Respiration in Yeast

(a) The majority of candidates read the volumes correctly. 16.2 was seen a number of times.

(b) Generally the graphs were well drawn, linear axes and plotting of the points scoring most highly. Common errors included: not labelling the axes or labelling the axes and either omitting the units or giving the unit of time as m, drawing a straight line which ignored many of the points, drawing a dot-to-dot line or a feathery line.

(c) (i) Many candidates gained credit. Common incorrect responses included: oxygen, hydrogen, ammonia, and sulfate.

(ii) Candidates found this more difficult with quite a large number omitting the question. Common incorrect responses included: evaporation and oxidation.

(d) (i) The majority of candidates gained credit but a significant number either drew a line totally or partially above the original line.

(ii) Quite well answered but the most common incorrect response was time.

Question 2 – Identification of Ions

(a) (i) Candidates found this difficult. Most connected a delivery tube between the two test-tubes but many had a bung in the tube containing the limewater or did not have the delivery tube dipping into the limewater. Many did not label the delivery tube.

(ii) Few candidates gained credit. Answers included: to stop explosions, to stop the reaction, so that only the gas goes into the limewater, to absorb all the gas and to stop the gas escaping.

(iii) Few candidates gained credit. The most common incorrect responses were it contains or is carbon dioxide. A significant number described the colour change.

(b) A small number gained partial credit, usually for copper sulfate and even fewer gained full credit. Many substances were given including iron(II), sodium sulfate, carbon sulfate. Many omitted either one or both substances.

(c) Candidates found this difficult and many omitted the question. Answers seen were varied and showed no pattern.

(d) Few candidates could recall this test and those that did often did not include the confirmatory result. Many omitted the question. A wide variety of responses were given including Universal Indicator, silver nitrate and colour changes.

(e) (i) A small number of candidates gained credit. Many omitted this question. Answers seen were varied and showed no pattern.

(ii) Few candidates gained credit and many omitted this question. Some thought the residue had already been filtered out but other answers seen were varied and showed no pattern.

Question 3 – Focal Length of a Convex Lens

(a) (i) Many candidates measured this correctly. Common incorrect responses included 15, 25, 35 and most commonly 37.5.

(ii) Those candidates that answered **(a)(i)** correctly usually answered this part correctly. Few candidates gained credit as error carried forward from **(a)(i)**.

(iii) Whilst many candidates calculated the two values correctly many did not gain credit as they did not follow the pattern of data in the table and gave the answer as 40 rather than 40.0.

(b) Few candidates gained credit. Common non-creditworthy responses included: make accurate measurements and repeat.

(c) (i) Generally the graph was drawn well but often the line was drawn without a ruler or was a dot-to-dot line.

(ii) Many candidates gave a correct intercept for their line but some candidates did not extend their line to the y-axis and often guessed at an intercept value or omitted this question.

(iii) Those candidates who gave an intercept value in **(c)(ii)** usually calculated the value correctly and often it was within the limits of accuracy.

Question 4 – Effect of Temperature on Germinated Seed Growth

(a) Most candidates gained partial credit, usually for water and some gained full credit. Many candidates thought light was required and a significant number thought nutrients were needed.

(b) Many candidates gained credit. Tying the shoots to a stick was the most common non-creditworthy response.

(c) Most candidates gained full credit and the rest gained partial credit.

(d) A significant number of candidates omitted this question. Many of the remainder recalled Benedict's although iodine and biuret were seen quite frequently. The confirmatory colours were quite well known but heating was not seen often.

(e) A significant number of candidates gained credit but many thought it to be for either better or more accurate results or to compare between dishes.

Question 5 – Rate Of Reaction

(a) Some candidates appreciated that the volume of gas needed to be measured although many discussed amount of gas or movement of the syringe. Few candidates appreciated the need for a time measurement.

(b) (i) Candidates found this very difficult and few gave an observation; most said the reaction would be faster or more gas would be made. Whilst some candidates appreciated that the measurement of gas would be larger, few included a time reference and so did not gain credit.

(ii) Many candidates gained partial credit for trials with more surface area or repeats and a few gained full credit. Using a different metal was seen quite often.

(iii) Many candidates gained partial credit, often for temperature, and some gained full credit. Common incorrect responses included time, amount of magnesium and same apparatus.

(c) Some candidates knew the gas given off and gave the correct test. Several tested with a glowing splint or just referred to the squeaky pop test, neither of which gained credit. Common incorrect responses included oxygen, carbon dioxide and magnesium oxide.

Question 6 – Energy Transfer

(a) Most candidates read the distance correctly. 44 was seen a few times.

(b) (i) The plotting of the point was quite accurate but some misread the scale and placed the point too high. The drawing of the line proved difficult with many drawing a curve including the anomalous point or a straight line.

(ii) Many candidates described the basic relationship but almost no-one appreciated that the increase in distance was deceasing.

(c) More able candidates increased the angle but few specified a range or a high enough number of values. Many thought the mass of the ball bearing should be constant despite the size changing.

(d) (i) The energy change was quite well known but thermal and chemical energy were seen quite often and the energy change was sometimes reversed. A significant number omitted the question.

(ii) More able candidates gained credit. Many candidates just wrote the word friction with no explanation and a few thought it would avoid damage to the bench or would keep the ball in place. A significant number omitted the question.