CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General Comments: Biology Section

All but two of the questions in the biology section of the paper fell within the scope of at least half of the candidates. Some areas of the syllabus were shown to be well understood by the majority of candidates.

Comments on specific questions

Question 1

A significant number of candidates incorrectly chose option **D**, overlooking the fact that the vacuole is space (and it is the cell sap that has mass). The same proportion of candidates incorrectly option **C**, the nucleus.

Question 2

Candidates have had difficulty with the term 'assimilation'. Candidates who did not recognise the process as diffusion, often opted for assimilation (option **A**).

Question 7

This question required two thought processes to arrive at the correct answer and was the most difficult question in the biology section. The first was to realise that milk contains no fibre and the second was then to appreciate that fibre is essential for successful movement of gut contents by peristalsis.

Question 10

Although this proved to be one of the easiest questions in the biology section of the paper, most correctly chose the key **D**. A significant number of the least able thought that the process involved was fertilisation.

Question 12

Candidates should be reminded that it is the Sun that *makes* energy. All other organisms make use of that energy for various processes. A significant number incorrectly chose option **A**, which suggested that the pant *made* energy. Candidates should be reminded to read the whole question before selecting their response.

General Comments: Chemistry Section

Overall the examination performed well with candidates well distributed across the range.

Questions 17, **18**, **24** and **26** proved to be easiest being answered correctly by almost all of candidates.

Question 23 was the most difficult.

Comments on specific questions

Question 14

Candidates realised that distillation was the appropriate method but not that a thermometer was necessary for fractional distillation and incorrectly chose option **C**.

Question 16

Candidates incorrectly chose option **B**. The question required the name of the element at the negative electrode (in this case lead), as well as the term 'cathode'.

Question 17

A few candidates incorrectly chose option **D** as they knew about acid rain, but not that 'exothermic' means that the fuel releases energy.

Question 21

Candidates knew it was a transition metal but not that its oxide was basic and incorrectly chose option **A**.

Question 23

All responses had an approximately equal number of candidates choosing them indicating a large proportion of guesses. Candidates would benefit with a greater understanding of alloys.

Question 27

Candidates were not entirely secure in their knowledge of the fractions obtained from petroleum and a few incorrectly chose option **C**.

General Comments: Physics Section

On this paper the best-answered questions were **Questions 29** and **30**.

Candidates found **Questions 34** and **35** particularly difficult.

Comments on specific questions

Question 28

Here candidates were asked to identify a distance / time graph for an object travelling at constant speed. A common mistake was to choose option **D**, which showed constant distance (i.e. zero speed). Candidates should be advised to look carefully at axis labels before drawing any conclusion from the shape of a graph.

Question 29

This question involved calculation of density, and was very well answered.

Question 30

Similarly, little difficulty was experienced with this simple recall question about non-renewable energy resources.

Question 34

Candidates were asked to identify the focal length of a converging lens, and about one third correctly chose the key **B**. A roughly equal number incorrectly chose either option **A** or option **D**.

Question 35

Only about one third of candidates knew that all electromagnetic waves travel at the same speed.

Question 37

The most common mistake in this otherwise quite well-answered question was to believe that ammeter S carried less current than ammeter P, implying that some current had been 'used up' by the resistors.

Question 38

This question about voltmeters was quite well answered, but candidates incorrectly choosing option **C** may believe that two different meters must be needed to measure an e.m.f. and a potential difference.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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

General Comments: Biology Section

Candidates in general, performed well in the biology section. Only one or two questions caused any difficulty.

Comments on specific questions

Question 3

A significant number of candidates incorrectly chose option **D**, overlooking the fact that the vacuole is space (and it is the cell sap that has mass).

Question 8

This question required two thought processes to arrive at the correct answer and was the most difficult question in the biology section. The first was to realise that milk contains no fibre and the second was then to appreciate that fibre is essential for successful movement of gut contents by peristalsis.

Question 11

Although this proved to be one of the easiest questions in the biology section of the paper, most correctly chose the key **D**. A significant number of the least able thought that the process involved was fertilisation.

Question 13

Candidates should be reminded that it is the Sun that *makes* energy. All other organisms make use of that energy for various processes. A significant number incorrectly chose option **A**, which suggested that the pant *made* energy. Candidates should be reminded to read the whole question before selecting their response.

General Comments: Chemistry Section

Candidates in general, performed well in the chemistry section.

Question 27 proved to be easiest being answered correctly by almost all of candidates.

Question 21 was the most difficult.

Comments on specific questions

Question 15

Candidates realised that distillation was the appropriate method but not that a thermometer was necessary for fractional distillation and incorrectly chose option **C**.

Question 20

Some candidates incorrectly chose option **D** as they knew about acid rain, but not that 'exothermic' means that the fuel releases energy.

Question 21

All responses had an approximately equal number of candidates choosing them indicating a large proportion of guesses. Candidates would benefit with a greater understanding of alloys.

Question 23

Candidates knew it was a transition metal but not that its oxide was basic and incorrectly chose option **A**.

Question 25

Candidates were not entirely secure in their knowledge of the fractions obtained from petroleum and a few incorrectly chose option **C**.

General Comments: Physics Section

Questions 28 and **32** were the best-answered questions on this paper.

Candidates had difficulty with **Questions 33**, **35** and **37**.

Comments on specific questions

Question 28

This question involved calculation of density, and was very well answered.

Question 29

Here candidates were asked to identify a distance / time graph for an object travelling at constant speed. A common mistake was to choose option **D**, which showed constant distance (i.e. zero speed). Candidates should be advised to look carefully at axis labels before drawing any conclusion from the shape of a graph.

Question 32

Little difficulty was experienced with this simple recall question about non-renewable energy resources.

Question 33

Only about one third of candidates knew that all electromagnetic waves travel at the same speed.

Question 35

Candidates were asked to identify the focal length of a converging lens, and about one third correctly chose the key **B**. A roughly equal number incorrectly chose either option **A** or option **D**.

Question 37

This question about voltmeters was found difficult by many candidates. Candidates incorrectly choosing option **C** may believe that two different meters must be needed to measure an e.m.f. and a potential difference.

Question 38

The most common mistake in this otherwise quite well-answered question was to believe that ammeter S carried less current than ammeter P, implying that some current had been 'used up' by the resistors.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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

General Comments: Biology Section

The questions in the biology section fell well within the scope of the candidates taking the paper. Indeed, one or two questions did not really prove sufficiently demanding to make a meaningful contribution to the test as a whole.

Comments on specific questions

Question 2

Candidates have had difficulty with the term ‘assimilation’. Candidates who did not recognise the process as diffusion, often opted for assimilation (option **A**).

Question 7

Knowledge from everyday life would have helped candidates in this question, and almost all selected the correct response.

Question 10

The concept of the relative size of the listed structures exposed a very insecure area of knowledge. This was the most difficult question in the biology section of the paper. Only around a third of the candidates chose the correct sequence, but as all of the incorrect options being equally chosen this shows widespread guessing.

Question 12

Food chains are usually well understood and this proved to be one of the easiest questions in the section. A very insignificant minority of candidates were tempted by the first link in a food chain being photosynthesis..

General Comments: Chemistry Section

Questions 15, 18, 23, 24, 26 and **27** proved to be easiest being answered correctly by the majority of candidates.

Overall the examination performed well with candidates well distributed across the range.

Comments on specific questions

Question 14

Candidates realised that distillation was the appropriate method but not that a thermometer was necessary for fractional distillation and incorrectly chose option **C**.

Question 17

A significant number of candidates incorrectly chose option **B**, confusing the heating of the limestone with the notion of an exothermic reaction.

Question 21 Response A

Candidates knew it was a transition metal but not that its oxide was basic and incorrectly chose option **A**.

General Comments: Physics Section

Question 31 was the best-answered question on this paper.

Candidates found **Questions 32**, **33**, **34**, **35** and **37** particularly difficult.

Comments on specific questions

Question 28

Here candidates were asked to identify a distance / time graph for an object travelling at constant speed. A common mistake was to choose option **D**, which showed constant distance (i.e. zero speed). Candidates should be advised to look carefully at axis labels before drawing any conclusion from the shape of a graph.

Question 31

Little difficulty was experienced with this question on kinetic theory of gases.

Question 32

The topic here was change of state. Many incorrectly chose option **A**, believing that liquids only start to evaporate once they have reached their boiling point, whilst most others thought that the temperature of a liquid would fall whilst it solidified.

Question 33

This question concerned frequency and wavelength, and just over half the candidates incorrectly chose option **A**, not realising that one wave produced every 0.5 s meant a frequency of 2.0 Hz.

Question 34

Candidates were asked to identify the focal length of a converging lens, and about one third correctly chose the key **B**. A roughly equal number incorrectly chose either option **A** or option **D**.

Question 35

Only about one third of candidates knew that all electromagnetic waves travel at the same speed.

Question 37

In this question on resistors in parallel, about one third of the candidates correctly chose the key. More than half the candidates incorrectly chose option **B**, not appreciating that the total resistance of two resistors in parallel will be lower than either one on its own.

CO-ORDINATED SCIENCES

Paper 0654/21

Core Theory

Key Messages

Candidates need to write answers that add information that is not provided in the stem of a question. Candidates are advised to read through the question after writing their answer, to ensure that the question set has been answered.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae of a mixture of words, symbols and/or units should not be used.

General comments

Most candidates were able to attempt most questions and generally were awarded credit.

Performance depends not only on scientific knowledge but on the ability of the candidates to understand the question or to interpret data.

There was little evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

This question was answered quite well. Some parts of the question proved difficult to different candidates.

(a) Electron and insulator were well known. However there was confusion between ammeter and voltmeter and between volt, ohm and watt.

(b) (i) Many candidates knew that the second lamp would go out, although a number of candidates thought that the second lamp would be brighter. Few candidates were able to explain why the second lamp went out.

(ii) Many candidates used their answer to part **(i)** to explain that in a parallel circuit if one lamp failed the others would still operate. Few referred to being able to switch the lamps on and off individually.

(iii) This calculation was completed well by most candidates. A few attempted to calculate the combined resistance of the lamps connected in parallel.

Question 2

This question was well answered by the more able candidates.

(a) (i) Many candidates correctly identified **A** as photosynthesis, but the three stages which represented respiration was less well known.

(ii) Most candidates correctly identified a carbon-containing compound found in plants.

(iii) The percentage of carbon dioxide in the atmosphere was not well known. Very few candidates knew that it was a very small percentage.

(b) Very few candidates referred to *egest* as the elimination of undigested food.

(c) (i) Many candidates explained that there was an optimum frequency for the earthworms to respond to and were able to estimate this optimum frequency gaining credit.

(ii) A number of candidates correctly referred to the effect on food chains. A number also referred to earthworms improving the fertility of the soil.

(iii) A significant number of candidates attempted to answer this question, about natural selection, by referring to dominant and recessive genes.

Question 3

(a) (i) Most candidates gained some credit, usually for knowing that pure water has a pH of 7.

(ii) Most candidates were able to give a suitable advantage of using a digital pH meter.

(iii) The test for sulfate ions was not well known. Many candidates assumed that the two acids could be identified by their pH.

(b) (i) There was a large number of different metals suggested. Few candidates were able to explain why the metal should not be added to the acid.

(ii) Many candidates knew that the gas released would give a popping sound, with a lighted splint, but many failed to state that the gas released was hydrogen.

(iii) This was well answered by many candidates. Some candidates did not state what happened to the magnesium and the copper when they were added to the acid.

Question 4

(a) A large number of candidates did not mention any forms of energy in their answer. Many thought that gravitational potential energy increased as the athlete fell back to the ground.

(b) Gravity was well known as the force, but many candidates thought that the source of gravity was the atmosphere.

(c) (i) Many candidates gained partial credit, although only a few candidates explained what was happening to the particles.

(ii) Very few candidates were able to explain why evaporation has a cooling effect.

Question 5

(a) (i) Few candidates gained full credit although glucose, oxygen, carbon dioxide and water where written somewhere in their equation.

(ii) Water was well known but only the most able candidates suggested warmth or a suitable temperature.

(b) (i) The idea of a control was not well known.

(ii) Most candidates were able to describe the effect of temperature on the rate of respiration. Few were able to give a quantitative answer.

(iii) A number of candidates correctly predicted that a high temperature would denature enzymes and that therefore the rate of respiration would be zero.

Question 6

(a) (i) Many candidates were able to identify two forms of energy released and gained full credit.

(ii) Many candidates knew that the rate of reaction would increase.

(b) (i) Many candidates correctly explained why **B** was an atom of aluminium.

(ii) Few candidates realised that the particles were **ions** of aluminium and oxygen. Most candidates chose *atoms* of aluminium and oxygen.

(c) (i) Oxygen was well known.

(ii) Few candidates were able to explain that the oxygen would be released from the potassium perchlorate and that oxygen was needed for the firework mixture to burn.

Question 7

(a) Most candidates gained some credit for their answers. The most common error was suggesting that ultraviolet radiation could be felt as heat.

(b) (i) Very few candidates knew that the nucleus would split during nuclear fission.

(ii) This was well known.

(iii) Many candidates knew one way in which the workers could be protected from the radiation but few were able to describe two ways.

Question 8

(a) (i) The scrotum and urethra were fairly well known.

(ii) The function of parts **A** and **B** were quite well known.

(iii) The place where the gametes were made was well known.

(b) (i) The nucleus was correctly named by many candidates as the part of the cell where the X and Y chromosomes were found.

(ii) Only the most able candidates stated that male was XY and female was XX. Many candidates referred to dominant and recessive genes.

(c) Most candidates gained partial credit.

Question 9

(a) (i) This part was not well answered. Many candidates attempted to describe the differences between mixtures and compounds without mentioning chorine or referred to 'substances' rather than atoms or elements.

(ii) This was well known, however a number of candidates described how chlorine could be produced safely as so were unable to be awarded credit.

(b) (i) Few candidates gained full credit.

(ii) Only the most able candidates mentioned that the chlorine reacted with the sodium bromide, or that bromine was orange.

Question 10

(a) There were some very good answers to this question. However a few candidates were careless in drawing their diagrams or labelling so could not be awarded credited.

(b) (i) Some candidates were unable to be awarded credit as they wrote a vague statement that the 'sound was louder' but had not stated which wave was louder.

(ii) Some candidates were unable to be awarded credit as they wrote a vague statement that the 'pitch being higher' but again had not stated which wave had the higher pitch. Many candidates incorrectly thought that a difference in pitch would change how long the sound could be heard for or how far the wave would travel.

(c) Radiation was well known, although the explanation was less well known.

(d) (i) A number of candidates did not label the principal focus clearly and were unable to be awarded credit. Writing the letter **P** somewhere near the principal focus was not creditworthy.

(ii) Few candidates measured this accurately.

(iii) Few candidates knew what a real image was.

(e) Most candidates correctly carried out the calculation. The commonest error was to use an incorrect formula.

(f) The lines needed to be straight, the ray needed to emerge from the fibre and the reflected angles needed to appear to be approximately equal for each reflection to be awarded full credit.

Question 11

(a) (i) Many candidates understood this and gained credit. A few candidates chose two of the 'lettered' foods rather two of the nutrients.

(ii) Protein was well known.

(iii) Few candidates were able to identify both of the foods **A** and **C**.

(iv) Foods **A** and **C** were often correctly identified as those containing protein but not starch.

(b) (i) Rickets and weak bones were correctly identified as the symptoms, gaining credit.

(ii) Tiredness and anaemia were correctly identified as the symptoms, gaining credit.

(c) Many candidates did not mention bacteria or suggest that it acid dissolves tooth enamel in their answer and were unable to gain full credit.

Question 12

(a) Many candidates gained partial credit. The meanings of catalytic cracking and petroleum were not well known.

(b) (i) Many candidates knew that it was an '–OH' group on the end of the molecule. However, a significant number drew the atoms the wrong way round (–HO).

(ii) Few candidates were able to use the information given and therefore work out that a molecule of water vapour / steam was required to complete the word chemical equation.

(c) (i) The idea that the type of hydrocarbon produced was unsaturated was not well known.

(ii) Few candidates were able to explain that the aluminium oxide was a catalyst and so was not a reactant in the reaction and that therefore aluminium would not be present in any of the products of the reaction.

(d) Polythene and polymerisation were not known to many of the candidates. Only the most able realised that the white solid was a polymer.

CO-ORDINATED SCIENCES

Paper 0654/22

Core Theory

Key Messages

Candidates need to write answers that add information that is not provided in the stem of a question. Candidates are advised to read through the question after writing their answer, to ensure that the question set has been answered.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae of a mixture of words, symbols and/or units should not be used.

General comments

Most candidates were able to attempt most questions and generally were awarded credit.

Performance depends not only on scientific knowledge but on the ability of the candidates to understand the question or to interpret data.

There was little evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

This question was answered quite well. Some parts of the question proved difficult to different candidates.

(a) Electron and insulator were well known. However there was confusion between ammeter and voltmeter and between volt, ohm and watt.

(b) (i) Many candidates knew that the second lamp would go out, although a number of candidates thought that the second lamp would be brighter. Few candidates were able to explain why the second lamp went out.

(ii) Many candidates used their answer to part **(i)** to explain that in a parallel circuit if one lamp failed the others would still operate. Few referred to being able to switch the lamps on and off individually.

(iii) This calculation was completed well by most candidates. A few attempted to calculate the combined resistance of the lamps connected in parallel.

Question 2

This question was well answered by the more able candidates.

(a) (i) Many candidates correctly identified **A** as photosynthesis, but the three stages which represented respiration was less well known.

(ii) Most candidates correctly identified a carbon-containing compound found in plants.

(iii) The percentage of carbon dioxide in the atmosphere was not well known. Very few candidates knew that it was a very small percentage.

(b) Very few candidates referred to *egest* as the elimination of undigested food.

(c) (i) Many candidates explained that there was an optimum frequency for the earthworms to respond to and were able to estimate this optimum frequency gaining credit.

(ii) A number of candidates correctly referred to the effect on food chains. A number also referred to earthworms improving the fertility of the soil.

(iii) A significant number of candidates attempted to answer this question, about natural selection, by referring to dominant and recessive genes.

Question 3

(a) (i) Most candidates gained some credit, usually for knowing that pure water has a pH of 7.

(ii) Most candidates were able to give a suitable advantage of using a digital pH meter.

(iii) The test for sulfate ions was not well known. Many candidates assumed that the two acids could be identified by their pH.

(b) (i) There was a large number of different metals suggested. Few candidates were able to explain why the metal should not be added to the acid.

(ii) Many candidates knew that the gas released would give a popping sound, with a lighted splint, but many failed to state that the gas released was hydrogen.

(iii) This was well answered by many candidates. Some candidates did not state what happened to the magnesium and the copper when they were added to the acid.

Question 4

(a) A large number of candidates did not mention any forms of energy in their answer. Many thought that gravitational potential energy increased as the athlete fell back to the ground.

(b) Gravity was well known as the force, but many candidates thought that the source of gravity was the atmosphere.

(c) (i) Many candidates gained partial credit, although only a few candidates explained what was happening to the particles.

(ii) Very few candidates were able to explain why evaporation has a cooling effect.

Question 5

(a) (i) Few candidates gained full credit although glucose, oxygen, carbon dioxide and water where written somewhere in their equation.

(ii) Water was well known but only the most able candidates suggested warmth or a suitable temperature.

(b) (i) The idea of a control was not well known.

(ii) Most candidates were able to describe the effect of temperature on the rate of respiration. Few were able to give a quantitative answer.

(iii) A number of candidates correctly predicted that a high temperature would denature enzymes and that therefore the rate of respiration would be zero.

Question 6

(a) (i) Many candidates were able to identify two forms of energy released and gained full credit.

(ii) Many candidates knew that the rate of reaction would increase.

(b) (i) Many candidates correctly explained why **B** was an atom of aluminium.

(ii) Few candidates realised that the particles were **ions** of aluminium and oxygen. Most candidates chose *atoms* of aluminium and oxygen.

(c) (i) Oxygen was well known.

(ii) Few candidates were able to explain that the oxygen would be released from the potassium perchlorate and that oxygen was needed for the firework mixture to burn.

Question 7

(a) Most candidates gained some credit for their answers. The most common error was suggesting that ultraviolet radiation could be felt as heat.

(b) (i) Very few candidates knew that the nucleus would split during nuclear fission.

(ii) This was well known.

(iii) Many candidates knew one way in which the workers could be protected from the radiation but few were able to describe two ways.

Question 8

(a) (i) The scrotum and urethra were fairly well known.

(ii) The function of parts **A** and **B** were quite well known.

(iii) The place where the gametes were made was well known.

(b) (i) The nucleus was correctly named by many candidates as the part of the cell where the X and Y chromosomes were found.

(ii) Only the most able candidates stated that male was XY and female was XX. Many candidates referred to dominant and recessive genes.

(c) Most candidates gained partial credit.

Question 9

(a) (i) This part was not well answered. Many candidates attempted to describe the differences between mixtures and compounds without mentioning chorine or referred to 'substances' rather than atoms or elements.

(ii) This was well known, however a number of candidates described how chlorine could be produced safely as so were unable to be awarded credit.

(b) (i) Few candidates gained full credit.

(ii) Only the most able candidates mentioned that the chlorine reacted with the sodium bromide, or that bromine was orange.

Question 10

(a) There were some very good answers to this question. However a few candidates were careless in drawing their diagrams or labelling so could not be awarded credited.

(b) (i) Some candidates were unable to be awarded credit as they wrote a vague statement that the 'sound was louder' but had not stated which wave was louder.

(ii) Some candidates were unable to be awarded credit as they wrote a vague statement that the 'pitch being higher' but again had not stated which wave had the higher pitch. Many candidates incorrectly thought that a difference in pitch would change how long the sound could be heard for or how far the wave would travel.

(c) Radiation was well known, although the explanation was less well known.

(d) (i) A number of candidates did not label the principal focus clearly and were unable to be awarded credit. Writing the letter **P** somewhere near the principal focus was not creditworthy.

(ii) Few candidates measured this accurately.

(iii) Few candidates knew what a real image was.

(e) Most candidates correctly carried out the calculation. The commonest error was to use an incorrect formula.

(f) The lines needed to be straight, the ray needed to emerge from the fibre and the reflected angles needed to appear to be approximately equal for each reflection to be awarded full credit.

Question 11

(a) (i) Many candidates understood this and gained credit. A few candidates chose two of the 'lettered' foods rather two of the nutrients.

(ii) Protein was well known.

(iii) Few candidates were able to identify both of the foods **A** and **C**.

(iv) Foods **A** and **C** were often correctly identified as those containing protein but not starch.

(b) (i) Rickets and weak bones were correctly identified as the symptoms, gaining credit.

(ii) Tiredness and anaemia were correctly identified as the symptoms, gaining credit.

(c) Many candidates did not mention bacteria or suggest that it acid dissolves tooth enamel in their answer and were unable to gain full credit.

Question 12

(a) Many candidates gained partial credit. The meanings of catalytic cracking and petroleum were not well known.

(b) (i) Many candidates knew that it was an '–OH' group on the end of the molecule. However, a significant number drew the atoms the wrong way round (–HO).

(ii) Few candidates were able to use the information given and therefore work out that a molecule of water vapour / steam was required to complete the word chemical equation.

(c) (i) The idea that the type of hydrocarbon produced was unsaturated was not well known.

(ii) Few candidates were able to explain that the aluminium oxide was a catalyst and so was not a reactant in the reaction and that therefore aluminium would not be present in any of the products of the reaction.

(d) Polythene and polymerisation were not known to many of the candidates. Only the most able realised that the white solid was a polymer.

CO-ORDINATED SCIENCES

Paper 0654/23

Core Theory

Key Messages

Candidates need to write answers that add information that is not provided in the stem of a question. Candidates are advised to read through the question after writing their answer, to ensure that the question set has been answered.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae of a mixture of words, symbols and/or units should not be used.

General comments

Most candidates were able to attempt most questions and generally were awarded credit.

Performance depends not only on scientific knowledge but on the ability of the candidates to understand the question or to interpret data.

There was little evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

This question was answered quite well. Most candidates gained some credit.

(a) (i) Most candidates were able to identify at least one correct word. However the majority of candidates suggested that the offspring would be genetically identical, rather than genetically different.

(ii) Fertilisation was well known.

(b) (i) The anther and stigma were well known.

(ii) The anther and ovule were quite well known.

(c) (i) A number of candidates did not describe the light / no light conditions for any of the tubes and gained partial credit. Many candidates however were awarded full credit.

(ii) Candidates needed to state that both oxygen and water were required *and* that light was not essential to gain full credit.

Question 2

This question was well answered by the more able candidates. However, most candidates gained some credit.

(a) (i) Few candidates were able to state that the percentage of nitrogen in the air is 78%.

(ii) Most candidates did not use air and oxides of nitrogen as examples and were unable to be awarded credit. Many candidates tried to explain the difference between elements and compounds. Many candidates described a compound as a mixture and vice versa.

(iii) Carbon monoxide was well known as a poisonous gas found in exhaust gases.

(b) (i) The terms ionic bonding and covalent bonding were not well known. Candidates frequently placed the types of bonding the wrong way round.

(ii) Most candidates were unable to explain their answers to **(i)** in terms of two non-metal atoms bonding for covalent bonding and a metal atom and non-metal atom bonding for ionic bonding.

(iii) Most candidates knew what the formula meant but failed to gain credit because they referred to magnesium and nitrogen molecules.

(c) Many candidates correctly stated that the litmus paper would turn blue although some thought that this was due to the presence of sodium hydroxide. When referring to ammonia gas candidates need to be careful to use the word ammonia and not ammonium.

Question 3

In this question candidates were unable to gain credit as they had not used recognised symbols when quoting a formula.

(a) Many candidates correctly interpreted both graphs. A few candidates assumed that both graphs were distance / time graphs and not speed / time graphs.

(b) Most candidates were able to carry out the calculation successfully. A few candidates used the letters a.s. in their formula. Symbols such as this should be avoided.

(c) (i) Most candidates were able to carry out this calculation successfully. Again some candidates used incorrect symbols in their formula. The letter A is not a recognised symbol for current.

(ii) This calculation was also completed well.

Question 4

(a) (i) Few candidates were able to suggest a suitable frequency for ultrasound.

(ii) Longitudinal was not well known. The commonest incorrect answer given was transverse.

(b) (i) Most candidates gained some credit for stating that there were more drinking attempts from the smooth surface. A quantitative answer was rarely given.

(ii) Many candidates gained partial credit, however candidates' answers showed that few really understood how the bats detected water.

(c) (i) Ultrasound was not well known.

(ii) Many candidates were unable to identify the neurones.

(iii) Most candidates attempted to answer this question, about natural selection, by referring to dominant and recessive genes.

Question 5

This question was well answered by most candidates.

(a) Chlorination and filtration were well known as methods of water treatment. However many candidates were unable to explain why these processes were carried out. Crystallisation was a common incorrect method given.

(b) (i) Most candidates correctly the colour of the sweet as red. Few were able to explain that this was because the dye giving one spot on the chromatography paper matched the red dye in mixture **P**.

(ii) Almost all candidates correctly identified sweet **S** as the sweet which contained a dye which was not one of the dyes in mixture **P**.

(iii) Most candidates correctly suggested that the impurities might be hazardous to health. Few suggested that the impurities might give the sweet the wrong colour.

Question 6

(a) Most candidates gained partial credit.

(b) (i) Many candidates gained partial credit, although few candidates really explained what was happening to the particles.

(ii) Very few candidates were able to explain why evaporation has a cooling effect.

(c) Few candidates gained full credit. Candidates needed to draw at least twelve particles in each box. These particles needed to be of approximately equal size. For the solid the particles needed to be regularly arranged and touching. For the liquid, the arrangement of the particles should have been irregular, but most particles should have been touching others.

(d) It was not necessary to quote the equation for efficiency. A description relating to useful and wasted energy for a device was required to gain credit.

Question 7

(a) (i) Tooth **B** was usually identified as a molar or premolar. Tooth **A** was less often identified as an incisor or canine tooth.

(ii) Most candidates were able to suggest that the tooth **B** helped in digestion by crush or grinding the food or by breaking the food into smaller pieces. Few however gained further credit for suggesting that food would have a greater surface area or that enzymes would have better access to the food.

(b) Very few candidates gained full credit. Identifying digestion as the function for the stomach was the best known answer.

(c) (i) Amylase was quite well known as the enzyme that breaks down starch molecules.

(ii) The pancreas was the commonest correct location for amylase secretion.

(d) Few candidates showed that they knew what happened to glucose when it reached the liver. There were many references to diabetes.

Question 8

Few candidates answered this question well.

(a) (i) Many candidates gave any properties of metals rather than properties that make metals suitable for making electrical wires and were unable to be awarded full credit.

(ii) Some candidates were able to explain the meaning of the term alloy and some were able to give a difference in the physical properties of alloys compared to pure metals. Only a few candidates were awarded full credit.

(iii) Most candidates used the information given in the question to construct a word equation, but most did not realise that copper is also a product.

(b) (i) Very few candidates specified that electrolyte was a solution of copper chloride.

(ii) Most candidates realised that copper was one of the products but often placed it at the anode. Many candidates realised that chlorine would also be produced but often placed it at the cathode. Few candidates were able to give correct observations.

Question 9

(a) Very few candidates gained credit. The idea that ionising radiation causes atoms to become ions by the removal of electrons was not well known.

(b) The damage that can be caused by X-rays to the human body was well known. However few candidates knew that it was important to stand behind a screen to prevent exposure to X-rays.

(c) Most candidates gained credit for identifying one property correctly.

(d) This was well known by most candidates.

(e) Most candidates attempted to describe fractional distillation rather than describing the processes occurring in the power station. Very few named fossil fuel.

Question 10

(a) (i) Most candidates knew this. Candidates should be reminded that care should be taken when using label lines to ensure that the root is labelled and not merely an area underground.

(ii) Most candidates knew this although a few labelled a petal.

(iii) Xylem was quite well known. Some candidates wrote down both xylem and phloem and were not awarded credit.

(b) (i) The candidates found this difficult. A few suggested that the roots held the soil. Very few gained further credit for ideas such as the leaves reduced the impact of rain on the ground or that the trees acted as a windbreak.

(ii) Many candidates gained credit for suggesting that the trees took carbon dioxide from the air. A few mentioned photosynthesis.

Question 11

(a) Few candidates were able to use the data in question and the Periodic Table to correctly give the numbers of protons, neutrons and electrons in the isotope of carbon.

(b) (i) This was not well known. As the question asked for differences in properties the answer should have been comparative e.g. petroleum has a higher viscosity than gasoline. Many candidates did not make it clear which substance they were referring to, by stating, for example, 'that it has a higher viscosity' and were unable to be awarded credit.

(ii) Most candidates thought that it was a chemical change and the few candidates who said that it was a physical change were unable to explain why.

(iii) This was not well known.

(iv) Although most candidates had obviously seen this test, few realised that in this instance, there would be no reaction because the hydrocarbon was saturated.

(c) Some candidates appreciated that hydrogen would produce non-polluting water when it was burned, but few explained that burning gasoline in car engines produced carbon dioxide which is linked to the greenhouse effect. However, many candidates named a pollutant produced during the combustion of gasoline.

Question 12

(a) The symbol for the ammeter was well known. The symbol for the fuse was not known at all. The symbol for the variable resistor was frequently lacking an arrowhead on the line going through the resistor symbol.

(b) (i) Most candidates were able to use the information in the question to give the correct answer.

(ii) There were as many candidates who drew the voltmeter in parallel with the light bulb as there were candidates who drew the voltmeter in series with the light bulb.

(c) (i) Many candidates labelled the angles of incidence and reflection correctly. Many other labelled the two rays of light as the angles.

(ii) Even though all four angles were 45°, many candidates wrongly wrote down the value of the angle of reflection as 90°.

(d) This was not well known by most candidates. Few candidates drew a beam of light bending correctly at both surfaces. Few realised that the beam of light would show dispersion. Very few were able to show the colours of the dispersed light in the correct order.

CO-ORDINATED SCIENCES

Paper 0654/31
Extended Theory

Key message

Candidates need to write answers that add information that is not provided in the stem of a question. Candidates are advised to read through the question after writing their answer, to ensure that the question set has been answered.

Some candidates did not differentiate between the command words *describe* and *explain*.

General comments

There was no evidence that candidates were short of time and very few questions were not attempted.

The use of English was good, with ideas clearly expressed. The handwriting was usually good with very few scripts that were difficult to interpret and extended answers were generally well structured.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae of a mixture of words, symbols and/or units should not be used.

Mathematical operations were carried out accurately and working was well presented. Most candidates used an appropriate number of significant figures.

Comments on specific questions

Question 1

(a) Most candidates were able to correctly match the words to the statements. The most common incorrect match was the unit of electrical charge to ampere rather than to the word coulomb.

(b)(i) Most candidates were able to correctly explain why the lamp went out, referring to the circuit as being incomplete. Some candidates thought that the lamp would glow more brightly.

(ii) Most candidates were able to gain partial credit for explaining the advantages of a parallel circuit over a series circuit. A few candidates did not understand the differences between a series and a parallel circuit.

(iii) Where the appropriate formula was remembered, answers were usually correct. Some used an incorrect formula $R = 1/R_1 + 1/R_2$. or had difficulty rearranging the equation, which gave an incorrect answer of 1.67.

Question 2

(a)(i) Nearly all candidates correctly identified **A** as photosynthesis. In order to gain full credit for respiration, all three stages had to be identified.

(ii) Most candidates were able to name a correct compound.

(iii) Few candidates gave the correct percentage of carbon dioxide in air. Candidates needed to be able to state the composition and percentages of different gases in air.

(b) Most candidates gained partial credit and were able to describe decomposers feeding on dead material. There were some very good answers detailing respiration by decomposers and the return of carbon dioxide to the air.

(c)(i) General description of the effect of frequency of vibrations on earthworms was good. Some candidates needed to be more accurate when referring to data as many quoted the optimum frequency for emergence as 500 Hz or somewhere between 400 and 600 Hz. The optimum frequency for emergence of earthworms should have been stated as 480 Hz. Some candidates needed to remember to include the correct units when describing data.

(ii) This question was answered well. Many candidates were able to correctly describe the details of the process of natural selection in relation to response of earthworms. Some candidates described learnt behaviour or intent as opposed to inherited characteristics or traits.

Question 3

(a)(i) Most candidates were able to give a correct pH value for both liquids.

(ii) Most candidates were able to correctly identify an advantage of using a pH meter. Some candidates suggested disadvantages of litmus rather than advantages of a pH meter and were unable to gain credit.

(iii) The best candidates demonstrated good knowledge of the chemical tests that could be used and the expected result gaining full credit.

(b)(i) Many candidates were able to describe magnesium as having lost electrons. Only a few went on to describe that hydrogen had gained electrons. Some candidates were able to identify magnesium as being oxidised. The best candidates linked together the ideas that magnesium has lost electrons, so is oxidised AND that hydrogen has gained electrons, so is reduced.

(ii) This question was answered well. Many candidates were able to describe the correct experiment to carry out. Some were also able to explain the reasons behind their methodology. A few candidates incorrectly referred to the heating of dilute hydrochloric acid.

Question 4

(a) Those candidates that used the correct formula were able to answer this question well. Some candidates incorrectly used mass of 60 kg rather than weight of 600 N. Some candidates completed the correct calculations but used incorrect units.

(b) Most candidates who answered **(a)** correctly also gained credit here. Some candidates answered part **(a)** for this question.

(c) Fewer candidates used the correct formula of power = work / time. Some candidates while using the correct formula did not use the correct units.

Question 5

(a)(i) Some candidates were able to correctly state the reactants and products for aerobic respiration. Candidates need to make sure that balanced equations contain balanced chemical formulae rather than words. Candidates should be reminded that energy is not a product of respiration.

(ii) Only the most able candidates described that the volume of carbon dioxide produced would equal the volume of oxygen being used. Candidates need to understand the process of respiration and, in particular that carbon dioxide is released and oxygen is taken in.

(b)(i) Many candidates identified set **D** as a control. Many candidates incorrectly suggested that **D** was used to check that dead seeds do not respire. Very few candidates were able to explain that set **D** was used to check that the movement of the red liquid was caused by germinating seeds.

(ii) A very few candidates suggested a change in temperature would affect the volume of gas. Some candidates suggested decomposition but needed to link this to microorganisms respiring to fully explain the change in carbon dioxide levels.

(iii) Many candidates were able to describe the effect of increasing temperature on rate of reaction. Some were able to analyse data further to show that a 10 °C rise in temperature doubled the rate of reaction.

(iv) Many candidates recognised that a high temperature would denature the enzymes involved in respiration and so result in no net movement. Some candidates did not make the link between high temperature and denaturation of enzymes and incorrectly used mathematical means to extrapolate the data.

Question 6

(a) This question was well answered with many candidates able to describe in detail the effect powder had on the rate of reaction.

(b)(i) Many candidates could correctly describe that three electrons are lost from the outer shell of magnesium. Fewer were able to explain that the +3 charge was a result of the imbalance of three more protons than electrons.

(ii) Most candidates gained at least partial credit for this answer. Almost all the candidates could identify the equation as not balanced. Most candidates recognised that there was an oxygen imbalance. Candidates gained further credit by explaining that a balanced equation has the same number of each type of atoms on both sides.

(c) Many candidates gained partial credit. Many candidates described potassium perchlorate as having produced oxygen. There was confusion about what this oxygen was used for. Many candidates incorrectly linked the production of oxygen to relighting the glowing splint in the firework.

Question 7

(a)(i) Many candidates correctly stated visible light.

(ii) Many candidates correctly stated infra-red.

(iii) Fewer candidates correctly stated microwaves with many stating ultraviolet or gamma rays.

(b) Many candidates answered this question very well, using labelled diagrams to support their answer. Some candidates were able to describe the charges and explain the path that they took through an electric field in detail. Some candidates incorrectly described the path of radiation through a magnetic field rather than an electric field. A few candidates described the path of radiation through paper, aluminium and lead and so were unable to gain credit.

(c)(i) Many candidates described atoms splitting. Candidates needed to give more detail in their answer and describe the nucleus as splitting.

(ii) This question was well answered.

(iii) Many candidates could correctly describe what precautions needed to be taken to protect workers from radiation. Most described various forms of protective clothing.

Question 8

(a)(i) Most candidates could describe the function of **A** as carrying sperm. Fewer candidates were able to describe the function of **B** as producing fluid for the sperm to swim in. Some candidates mistook **B** for the bladder and some mistook B for the prostate gland. Many candidates correctly described the function of **C**. Some candidates named the parts rather than stating their function.

(ii) Most candidates correctly labelled the testis. A few candidates incorrectly labelled the scrotum.

(b)(i) Candidates needed to provide comparative statements describing the differences between male and female gametes to gain full credit. Many were able to describe sperm as having a tail. Some described sperm as being small rather than being smaller than eggs and also referred to lots of sperm rather than sperm being greater in number.

(c) Few candidates gave a correct explanation with most stating that the gametes 'fusing together'. Candidates need to explain that haploid gametes enable a fertilised cell (zygote) to be produced with a diploid number of chromosomes.

(d) This question was answered well with many candidates able to simply describe how HIV affects the immune system. A few candidates were able to describe this in more detail referring to lymphocytes.

Question 9

(a) Most candidates gained partial credit for stating that 'the green gas could not be decomposed'. Fewer candidates gained full credit by providing a correct definition of an element.

(b)(i) Many candidates could correctly name hydrogen gas for substance **Y**. Fewer were able to correctly identify substances **X** and **Z**. A few candidates identified **X** as brine, only the correct name of sodium chloride was creditworthy.

(ii) Many diagrams were drawn correctly with the correct number of shared and outer shell electrons. Some candidates needed to draw a molecule of chlorine with two chlorine atoms rather than a single chlorine atom.

(c)(i) Some candidates were able to correctly calculate the number of moles. Some candidates did the correct calculation but did not correctly calculate the relative molecular mass.

(ii) Some candidates correctly calculated the volume with the majority using the correct units. Candidates should be reminded to set out their work carefully in order to fully show their working.

Question 10

(a) Few candidates gained full credit for this question. Candidates should remember to include labels and labelling lines when requested. Candidates should also take care to draw carefully to achieve the correct dimensions.

(b)(i) Many candidates correctly stated that **A** would be louder.

(ii) Many candidates correctly referred to **X** having a higher pitch. Some candidates stated that **X** would sound for longer.

(iii) Most candidates were able to state that the speed of sound in different media. The most common incorrect answer was to state that sound travels at 330 m/s through a solid and at 5000 m/s through a gas.

(iv) Many candidates drew diagrams which supported their written answers, thus gaining credit. Many were able to correctly describe compressions and rarefactions. Some were also able to explain compressions and rarefactions in terms of particles.

(c) Most candidates were able to correctly state the answer radiation. Candidates need to be specific and refer to radiation being able to travel through a vacuum rather than through space or through nothing.

(d)(i) Some candidates correctly labelled the focus. Candidates should include a labelling line when labelling diagrams.

(ii) Many candidates answered this correctly. The most common incorrect answer was 55 mm. Candidates should take care to measure accurately.

(iii) Many candidates described a real image as 'not being a reflection' rather than what a real image was.

Question 11

(a) Most candidates correctly stated two substances. A few candidates incorrectly stated minerals.

(b)(i) Most candidates were able to correctly describe the symptoms of rickets or weak bones.

(ii) Many candidates correctly described the symptoms of anaemia or fatigue. A few candidates described symptoms caused by other deficiencies.

(c) Few candidates could describe the use of bacteria in the manufacture of yoghurt. There was some confusion, with few candidates recognising that bacteria are a type of microorganism. Candidates needed to be able to describe the role of bacteria in changing lactose in milk to lactic acid to gain full credit.

Question 12

(a)(i) Most candidates correctly named carbon and hydrogen.

(ii) Many candidates were able to recognise the process of fractional distillation. The other reactions were less likely to be recognised. Candidates needed to be able to recognise the reaction that occurs in each process stated.

(b)(i) Many candidates specified that only alkenes could decolourise bromine solution. Fewer candidates could explain that decane was an alkane and so must have undergone a chemical reaction. Most candidates showed good understanding of this question but some did not give detailed enough answers to gain full credit.

(ii) Most candidates showed good understanding that the aluminium compounds acted as a catalyst and so therefore did not undergo chemical changes. The most common incorrect answer was candidates stating that aluminium compounds did not take part in the reaction.

(iii) Most candidates were able to answer this correctly with good knowledge of the effect of temperature on rate of reaction.

(c)(i) Some candidates correctly completed the diagram by adding single C-C bonds and 2 H atoms bonded to each C atom. Some candidates mistook the brackets around the repeating unit for bonds.

(ii) Very few candidates understood that the diagram in **(c)(i)** was a polymer and therefore the size of the molecule or chain length varied.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

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General comments

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The use of English was good, with ideas clearly expressed. The handwriting was usually good with very few scripts that were difficult to interpret and extended answers were generally well structured.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae of a mixture of words, symbols and/or units should not be used.

Mathematical operations were carried out accurately and working was well presented. Most candidates used an appropriate number of significant figures.

Comments on specific questions

Question 1

(a) (i) Nearly all candidates were able to identify the red protein in blood as haemoglobin.

(b) (i) Most candidates knew the function of a root hair cell although some referred to the absorption of minerals rather than mineral ions.

(ii) Many candidates gained full credit.

(c) (i) Many candidates were unable to correctly relate the effect on the cell to the medium in which it was placed. This caused them some difficulties in part **(ii)**.

(ii) Most candidates knew that this was osmosis but some referred to the sugar or cell contents moving through the membrane. Several candidates used the term concentration without making it clear that they were referring to water rather than the concentration of the solute.

Question 2

(a) (i) The majority of candidates answered this correctly but a few gave half the number of electrons or twice the number of shells.

(ii) Most candidates predicted that the element would be unreactive because it had a full outer shell with many adding that it would therefore not be likely to gain or lose electrons gaining credit. Candidates who predicted that it would be reactive either had reached the conclusion that it had 4 electrons in the outer shell or had confused the number of electron shells with the group number and that it was therefore a halogen.

(b) (i) Although many candidates did know that chlorine was more reactive than the other two halogens and would displace them, few knew the correct colours in solution and gave the colours of the elements. Often candidates did not distinguish between halogen and halide and some referred to the potassium reacting with the chlorine. A significant number of candidates gave two colours and then simply stated that the chlorine would react with the solution to give that colour.

(ii) Most candidates answered this well but a few suggested that elements in all groups became more reactive further down the group. Some did not take variation in reactivity into account and agreed with the candidate's prediction as both elements needed to gain or lose only one electron to achieve a full outer shell.

(c) Many candidates did not realise that the charges on the ions were given as a guide that the formula for potassium bromide was KBr and consequently used these for the reactants rather than K and Br_2. Most of those who had correct reactants were able to produce a fully balanced equation.

Question 3

(a) (i) Most candidates linked the transmission of the sound to vibrations of air particles although there was occasional reference to sound particles. Many went on to explain what was meant by compression and rarefaction in terms of the particles and related this to longitudinal waves, with or without the aid of a diagram. A few confused rarefaction with refraction and some diagrams referred to compression of waves.

(ii) Most candidates knew that this related to particles being closer together in water than in air but few explained why this increased the rate at which the energy was transferred. References to the greater density of water were usually too vague to gain credit and there was often reference to the speed of the particles.

(b) Although this was often well answered, many candidates drew a diagram for the same volume but a higher pitch.

(c) This was generally answered correctly although some missed off the units and a few used 'λ' as a unit.

(d) The main problem encountered by candidates was the conversion of the answer to megajoules which many ignored. Some candidates used temperature rather than change in temperature in the formula.

Question 4

(a) (i) Few candidates gained full credit by not distinguishing between an ecosystem and a food web, and not including a reference to the environment.

(ii) Although many candidates recognised that the arrows represented energy flow, a large proportion wrote that it was what was being consumed as food.

(iii) Most candidates recognised that the spiders were at the third level in the web or that they were secondary consumers.

(iv) Most candidates answered in terms of pollination and, although there were some thorough descriptions of the reproductive process, most simply referred to transfer of pollen. Some candidates confused this with seed dispersal.

(b) (i) Few candidates gained full credit. Most referred to the half-life of β and γ radiation rather than of the isotopes and the concept of half-life was not clearly understood with many stating that the caesium-137 would remain for 60 years. Many did not seem to realise that barium-137 had a short half-life and although they recognised that it was produced by the decay of caesium 137. It was also common to list the properties of β and γ radiation in terms of their penetrating or ionising power and use these as an explanation.

(ii) Most candidates were able to complete this equation. A number used an incorrect symbol for barium using Cs or Br.

(iii) Most candidates wrote much describing the pattern of results shown in the graph rather than giving reasons for it. The effects of ionising radiation were more often than not related to humans rather than spiders but most were aware of damage to DNA and mutation and that the effects of radiation could be fatal. Many then linked this to the effects it would have on the food chains and hence the spiders.

Question 5

(a) Almost without exception candidates knew that the limewater would turn milky but, only a few gained further credit by explaining that this is the formation of a precipitate (calcium carbonate).

(b) (i) Generally candidates gained credit by calculating the relative molar mass of calcium carbonate correctly. A few did not multiply the relative atomic mass of oxygen by 3. Other common errors were dividing the relative molar mass by the mass or multiplying them.

(ii) A significant number of candidates appeared to have misread the question and gave the answer for 1 mole of calcium carbonate rather than the amount in the antacid tablet.

(iii) Most candidates tried to explain this in terms of the number of moles in the equation, not realising that there were other carbonates in the tablet.

Question 6

(a) (i) Many candidates knew that there would be no change but quite a number thought that the reading would reverse and a few suggested it would increase or decrease.

(ii) Although the majority gave good answers there were a number who seemed to confuse this with an electromagnet or motor and suggested increased current or voltage. There were also a number who thought that thinner or thicker wire would suffice.

(b) Many candidates did not refer to voltage at all but to changing high to low power. A number of candidates answered this from the point of view of stepping up voltage onto transmission cables as a means of reducing energy loss rather than why it should be reduced for use in the home.

Question 7

(a) Most candidates were able to label the appropriate parts of the eye correctly although in quite a few cases the label lines were not drawn accurately enough. This was particularly the case with labelling the iris. Some tried to fit the names to the labels **A**, **B** and **C**.

(b) Only the best candidates were able to explain how the labelled structures allowed the eye to focus on a nearby object. Some candidates gave good explanations for a 'distant object' and while their answers have been correct, credit was unable to be awarded.

(c) (i) Most candidates gave creditworthy responses, some referred to receptor cells, e.g. rods and cones, rather than the retina.

(ii) Although many candidates did give a good account of how information was transmitted from receptor cells to muscles, there were many references to messages rather than electrical impulses. In many cases the central nervous system was given as controlling this rather than the brain. It was rare to see transmission through the neurones rather than just 'send'.

Question 8

(a) (i) There were a number of incorrect answers given including carbon, hydrogen, unspecified hydrocarbons and carbon dioxide. Those who identified the gas as methane usually gave a correct word equation.

(ii) Few candidates gave creditworthy answers to this question. Most candidates did not cover the fact that fuels, and therefore the sulfur in them, are burnt when used thus giving rise to oxides of sulfur in the atmosphere. Those who had some idea of acid rain suggested that it was formed by sulfur reacting with water in the air but many simply had the sulfur reacting with the water in the lakes and rivers. A high proportion of the candidates attributed eutrophication to the presence of sulfur.

(b) (i) Many candidates were able to draw a creditworthy 'dot and cross' diagram with the majority getting the two bonding pairs.

(ii) Most candidates knew that sulfuric acid was the product of the Contact Process.

Question 9

(a) Most candidates were able to perform this calculation and use the correct units for energy gaining full credit. A few converted the mass to grams or had 'rounding errors'.

(b) There were some good explanations of the origins of electrostatic charges with most relating this to friction and transfer of electrons. Some referred to the plastic surface or the wheels of the car being already charged and this attracting the opposite charge. A few referred to transfer of positive charge or positive electrons.

(c) (i) Most candidates recognised the horizontal section of the graph as representing constant speed and correctly read the value from the graph.

(ii) Most candidates knew that the distance travelled was represented by the area under the graph even though many did not state it. A significant number made mistakes in the calculations of area or multiplied speed by distance.

Question 10

(a) (i) The majority of candidates knew where the reaction took place but a number incorrectly wrote liver or pancreas.

(ii) Although the majority of candidates knew that bile emulsified the fats, many confused it with lipase and thought that it was a catalyst for chemical breakdown rather than a reduction in physical size of the particles. Some used terms such as 'pieces' which suggested a solid.

(b) (i) Many candidates were unable to relate the colour change (to yellow) as being due to the production of acid in the reaction.

(ii) In many cases the candidates simply described data from the table rather than giving an explanation. Candidates who linked rise in temperature to an increased reaction rate, did not gain further credit for then relating this to the increased energy of the particles.

(iii) Most candidates were able to answer this correctly with just a few having colours such as green or orange.

(c) (i) Most candidates gave creditworthy answers with most referring to insulation. Some referred to fat producing energy rather than storing it.

(ii) Most candidates were well aware of the dangers to the heart of consuming too much fat although some referred to blocking of blood vessels other than arteries.

Question 11

(a) (i) There was a range of values given for the percentage of oxygen in the air from 0.04 to 88%.

(ii) A few candidates tried explain the term element by using the word element, e.g. 'oxygen is an element because it only contains one element', but many candidates were awarded full credit.

(b) (i) A significant number of candidates incorrectly chose calcium oxide. Of those who chose phosphorus oxide, many needed to include, in their explanation, that the acidity of the oxide is because phosphorus is a non-metal to gain full credit.

(ii) Many candidates wrote that reduction is loss of electrons. Some candidates tried to explain oxygen being reduced in terms of losing oxygen.

(c) Many candidates attempted only to explain the difference in the arrangement of particles in a solid and a liquid. Many did know that silicon(IV) oxide had a giant structure and referred to forces between ions. Some simply drew 'dot and cross' diagrams or tried to explain it in terms of relative numbers of oxygen atoms.

Question 12

(a) Most candidates knew that a circuit breaker was a safety device but many did not distinguish it from a fuse. Those who gained credit had a good idea of how it worked. A common incorrect answer was to state that 'it would detect and operate when the *voltage* exceeded a set value'.

(b) (i) The majority of candidates had correct numerical answers to this but quite a number did not include units or incorrectly used A (as the symbol for current) in their equation. A few misread the scale of the graph.

(ii) Candidates had difficulty in expressing what happened to the current with many stating that it decreased or slowed down.

(iii) Only a few candidates realised that their calculations in part **(i)** gave a clue to increased resistance and very few that this was caused by increasing temperature of the filament. Although the better candidates did know that Ohm's Law was no longer obeyed, many insisted that the current was proportional to the voltage.

(c)(i) A number of candidates labelled the angle of reflection as that between the incident and reflected rays as 90°. A few labelled the rays rather than the angles and some the angle between the rays and the mirror.

(ii) Most candidates gained credit for the angle of reflection.

CO-ORDINATED SCIENCES

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The use of English was good, with ideas clearly expressed. The handwriting was usually good with very few scripts that were difficult to interpret and extended answers were generally well structured.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae of a mixture of words, symbols and/or units should not be used.

Mathematical operations were carried out accurately and working was well presented. Most candidates used an appropriate number of significant figures.

Comments on specific questions

Question 1

(a) (i) Many candidates knew that the term diploid referred to the presence of a complete set of chromosomes. A full answer needed to recognise that this was made up of sets of chromosomes from each of the two fused haploid nuclei. A minority restated the information in the question.

(ii) Fertilisation was usually correctly given as the term for the fusion of two haploid nuclei. Meiosis was sometimes suggested.

(b) (i) Parts of the flower were correctly identified by most candidates.

(ii) Most responses correctly recognised that the presence of petals indicated insect pollination. Imprecise statements, describing the stigma and anthers as inside the flower rather than inside the petals, were common. Candidates had difficulty in expressing the idea that the incidental collection and depositing of pollen by insects was caused by the structure of the flower, rather than by the intention of the insect.

(c) Many good descriptions of fruit dispersal were seen, although some candidates had not named a specific fruit or identified the feature that aided dispersion and so were unable to be awarded full credit.

Question 2

(a) (i) Only a minority of candidates stated the percentage of nitrogen in the air.

(ii) The importance of different boiling points in the process of fractional distillation was well understood. The general term evaporation was often used in place of boiling when describing the separation of the fractions. Some candidates confused the fractional distillation of crude oil with this question on nitrogen.

(b) (i) Most candidates correctly described iron and nickel as transition elements.

(ii) The majority of candidates suggested that the catalyst was used in small pieces in order to increase its surface area and so increase the rate of reaction gaining credit.

(iii) and **(iv)** Hydrogen and nitrogen were usually identified correctly as having been re-cycled due to incomplete reaction.

(c) (i) A few excellent answers were seen. In these, energy requirement for bond breaking was explained in terms of work done in separating particles against the force of attraction between positively charged nuclei and negatively charged electrons. Many responses repeated information in the question, or anticipated the next part by stating that a large amount of energy was required to break a strong covalent bond.

(ii) The majority of candidates demonstrated the misconception that the cause of stability of an atom of a noble gas was the same as that for the lack of reactivity of a covalent compound. They developed an argument based on the low tendency to gain or lose electrons in a full outer shell. A few did use the model of bond breaking and bond making in a chemical reaction, and explained the lack of reactivity as due to the large amount of energy needed to break the strong bond caused by the high force of attraction between the nuclei and a large negative charge.

Question 3

(a) This question on speed/time graphs was answered well.

(b) There were many responses where the calculation of work done was set out logically with statements of the formulae used, working shown and the correct units included.

(c) (i) The acceleration was usually calculated correctly with candidates remembering to quote the formula as **change in** speed/time. The units were sometimes given as m/s or m/s^{-2}.

(ii) The force calculation was usually done well.

(iii) Most candidates described the resistive forces acting on the car, and recognised that the speed became constant when they become equal to the driving force. The term used for driving force was sometimes vague, such as the force of the car. Some responses equated different quantities like force and acceleration.

Question 4

(a) (i) The frequency of ultrasound emitted by bats was usually correctly suggested to be above the human range of hearing.

(ii) Some confusion about the nature of ultrasound waves.

(b) (i) Most candidates made an observation from the data which supported a generalised comparison of the results for rough and smooth materials and gained credit.

(ii) Most candidates recognised that the smooth surface modelled that of water, and that it was detected when less sound wave energy was received by the bat. Although the term scattering was not often used for the reflection of waves from the rough surface, a good description of the reflection in many directions was common. Other candidates just made an observation of the disorder of waves from a rough surface or assumed that the bat could detect the direction of travel of reflected waves.

(c) (i) Candidates who answered this question well applied the principles of natural selection, rather than learned behaviour, to explain the evolution of the moths' behaviour. They described the likelihood that moths with the behaviour would survive, and that they would be more likely to reproduce, passing on the genes to their offspring. They recognised that over many generations most, rather than all, moths would have the genes.

(ii) Some candidates described nerve impulses travelling along the sensory neurone to the central nervous system and through the motor neurone to the muscle. Some treated the neurones purely as receptors and effectors, neglecting their transmission role.

Question 5

(a) (i) Most candidates showed ions separated and randomly spread throughout the solution. A few showed ions in pairs, or ions separated but maintaining the lattice arrangement.

(ii) This question was answered well, with the electrical charge on the ions being explained by the loss of electrons from metal atoms and the comparison of resultant numbers of protons and electrons.

(b) (i) and **(ii)** Those candidates who understood the principle of the mole, and could deduce the molar ratio from the equation, obtained the correct result to the calculation.

Question 6

(a) (i) Most candidates knew that a.c. stood for alternating current, but often did not explain the meaning of frequency.

(ii) The formula for calculating current from power was usually used correctly. Some candidates neglected to convert kilowatts to watts.

(b) (i) Many responses described the separation of particles when a liquid evaporates. The best candidates recognised that the particles escaped when they had sufficient energy to overcome the attractive forces of other particles.

(ii) Most candidates described metals as heat conductors and expressed sound ideas about energy being passed from particle to particle. There was some confusion between thermal and electrical conduction.

(c) A minority of diagrams showed carefully drawn circles of consistent size. The solid was usually represented by particles touching in a regular arrangement. For the liquid few candidates drew most of the particles in contact and in a random arrangement.

(d) The formula for the energy transfer was well known and **change in** temperature was usually used in the calculation.

Question 7

(a) (i) and **(ii)** Most candidates knew that amylase, secreted by the salivary glands or pancreas, was the enzyme that broke down starch, gaining credit.

(b)(i) Most candidates implied that nutrients were carried by the blood in capillaries in the villus, without going on to describe their solution in blood plasma. Some wrote that glucose was absorbed, but the absorption of amino acids was rarely mentioned.

(ii) The absorption of fats, fatty acids or glycerol was the primary role of the lacteals that was required. The most common suggestion was that the lacteals provided structural support for the villus.

(iii) The function of the microvilli was usually correctly stated as increasing the surface area allowing increased rate of absorption. A minority confused microvilli with cilia in the trachea.

(c) This question was generally answered well. Most responses related the conversion of glucose to glycogen which could be stored. That this occurred in liver cells was rarely mentioned. The role of insulin was often included, although it was unnecessary in this question, and the involvement of glucagon was sometimes described incorrectly.

Question 8

Candidates found this part of the syllabus difficult.

(a) A minority of candidates drew a careful diagram of the structure of a substitutional alloy with copper atoms of consistent size in a close packed regular arrangement. They added a few zinc atoms drawn slightly larger than copper, disrupting the pattern. More often the structure of an interstitial alloy was drawn with much smaller 'zinc' atoms. The effect of the zinc atoms in making it more difficult for atoms to move past each other was well known, but relating this to the question by mentioning the force required to bring this about was rare.

(b) Many wrote the chemical equation correctly, the most common mistake was to write Cu_2 instead of 2Cu.

(c) (i) A few candidates knew that copper sulfate was the electrolyte used in the cell.

(ii) Most candidates did not explain the results of the electrolysis, they described the changes in mass. A minority knew that copper was deposited on the cathode or that copper from the anode dissolved in the electrolyte. More common was a vague description of the migration of copper or its ions towards the cathode. Ionic equations were not generally used.

(iii) A few candidates could show how the electrolysis was used to purify copper. They suggested using impure copper as the anode and that impurities were left behind in the cell. The most able candidates explained that **only** copper atoms were deposited on the cathode.

Question 9

(a) A minority of candidates explained the meaning of ionisation as the conversion of atoms or molecules into ions, with many repeating the term ionising or ionises from the question. Some knew that there was a change in the number of electrons in the particle, with few specifying their loss.

(b) This question was generally answered well. Most responses implied that the screen stopped X-rays passing through and the potential danger of exposure causing cell damage was well known.

(c) Most candidates knew that γ-rays travelled at the same speed as X-rays. A common explanation was that they both travelled at the speed of light rather than that all electromagnetic waves travelled at the same speed.

(d) About a third of candidates correctly matched the radiations to their properties.

Question 10

(a) The water pathway was correctly described by most candidates as involving root hairs and the xylem. Further detail about transport across the cortex, position of the xylem or the destination in leaf cells was rarely offered. Detail about the mechanism of transport in the xylem, when included, was usually confused.

(b) (i) Many responses suggested that nitrate ions were required for the growth of plants. Some explained that this was due to the production of proteins, and only a few stated that proteins were formed from amino acids.

(ii) Some candidates correctly explained that too much fertiliser in the soil prevented osmosis, due to reversal of the water concentration gradient. Few made the connection between water concentration and water potential. Common incorrect responses included explanation in terms of blockage of root hair cells and bonding between nitrate ions and water.

(iii) There were some very good explanations of how leaching of fertiliser into rivers caused fish to die. Most candidates knew that the fertiliser could cause algal bloom and that fish would die due to lack of oxygen. Some candidates went on to explain that the algae would shade other plants causing their death and decomposition by bacteria which respired aerobically using up oxygen. Some incorrectly stated that respiration or even photosynthesis of the living plant caused excessive oxygen depletion.

Question 11

(a) Most candidates drew a good diagram of the atomic structure of the carbon isotope.

(b) Some candidates demonstrated a sound understanding of the reasons for the different properties of the allotropes of carbon. They were able to compare the macromolecular structures and the bonding within them. Some diagrams lacked the precision required to help in the explanation and gain credit. There was some confusion between the terms intramolecular and intermolecular.

(c) (i) Most candidates named the alkane series and explained it by recognising saturation or application of the general formula.

(ii) The best responses were based on the fact that water was the product of the combustion of hydrogen. Many candidates were under the impression that hydrogen was a constituent of the atmosphere and hence its leakage would be harmless. Some candidates linked the production of carbon dioxide to the greenhouse effect while others thought that it was the cause of damage to the ozone layer. Carbon monoxide and sulfur dioxide were usually suggested as other pollutants.

Question 12

(a) There were many succinct answers involving heat energy producing steam which was used to turn a turbine. There was some use of the word evaporation when boiling would have been more appropriate.

(b) Some candidates identified the slip rings, while others were confused by split rings and commutators. Candidates selected a use from not reversing coil connections, reversing current direction, avoiding twisting of wires and maintaining, rather than making, connection. Some correctly suggested rotating with the coil while others stated that they caused rotation of the coil, confusing the dynamo and motor effects.

(c) (i) The transformer formula was well known, but a number of candidates used non-standard symbols.

(ii) The reason for the power station output being a.c. was often stated as being due to transformers not working on d.c. Some candidates gave the reasons why voltage is stepped up from the power station output, which was not creditworthy as it does not address the question.

CO-ORDINATED SCIENCES

Paper 0654/04
Coursework

(a) Nature of tasks set by Centres.

The standard of candidates work was comparable with previous years with candidates covering the whole mark range.

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

(b) Teacher's application of assessment criteria.

Centres had a good understanding of the assessment criteria and applied them well for all of their activities.

Skill C1, following instructions and skill C4, planning, are mutually exclusive, but a Centre indicated on their summary form that these skills were be tested within the same experiment.

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

The use of annotation on candidates scripts to indicate where the marks are awarded and/or to justify credit are helpful.

(d) Good practice.

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

CO-ORDINATED SCIENCES

Paper 0654/51

Practical Test

Key message

It is important for candidates to refer to their observations and/or results when instructions specifically ask for an explanation using observations and/or results.

General comments

Candidates organised themselves to complete this paper in the time available and the majority of candidates carried out the practical work well.

Comments on specific questions

Question 1

In part **(a)** where the seeds had been prepared according to the Confidential Instructions, most candidates gained credit.

Candidates who used their results from part **(a)** were often awarded full credit in part **(b)**. Some however treated this as a theory question and did not refer to their results whilst others were vague, often giving answers that could not be credited.

Most candidates gave creditworthy answers for parts **(c)** and **(d)**.

In part **(e)** many candidates obtained a positive test for the radicle with Benedict's, with the most common colour being green. Fewer candidates obtained a positive test for the seed with iodine solution; in many cases dark brown was recorded instead of the expected blue/black. This obviously had an effect on a candidate's ability to answer part **(f)**. Some candidates did not make it clear which part of the germinating seeds they were referring to because they simply referred to **R1**, **R2**, **S1** and **S2**.

The name of an enzyme for part **(g)** was not well known.

Question 2

The experiment was usually carried out well and consequently useful sets of results were obtained. Candidates should present their results to the same accuracy throughout a column in the table. Values to the nearest centimetre were allowed because this was adequate for graph plotting and values to the nearest millimetre were allowed since this was the accuracy of the rule provided.

In part **(b)(i)** candidates were expected to calculate $1/m$ and round the answer appropriately. For this reason answers of 0.016, 0.0142 and 0.012 were not creditworthy. A significant number of candidates recorded 1/60 as 0.016 recurring, which also was not credited, however most of these candidates went on to plot this as 0.016.

Candidates needed to take more care in drawing the graph in part **(b)(ii)**. Common errors were not giving the units with the label for the vertical axis; poor plotting of the points caused by difficulties in reading the horizontal scale; not drawing a straight line as instructed; and not drawing the best straight line. For a best fit straight line there should be a fairly equal spread of points above and below the line unless they all happen to lie on the line. It is still acceptable to ignore points that are clearly anomalous when drawing the best fit line.

Finding the gradient in part **(b)(iii)**, candidates had to use a triangle with a vertical distance of at least 4 cm (or a distance representing a change in *d* of at least 10 cm). Candidates should be encouraged to use large triangles when finding gradients. The most common mistake was not reading the coordinates correctly. A number of candidates incorrectly used the data from the table to calculate the gradient.

Part **(b)(iv)** was well done despite some incorrect gradients resulting in values for the mass of the rule close to 300 g.

The calculations generally were awarded credit for part **(c)** when candidates followed the instructions given.

In part **(d)** very few candidates appreciated the advantage of plotting a graph over using the average *md* value.

Question 3

A large variation in the volumes of unused soil washings was seen, reflecting the difficulty of carrying out a titration with a dropping pipette. Despite this, many candidates were able to obtain two readings within 0.4 cm^3. Candidates should be reminded that when recording values to 1 decimal place 3 cm^3 should be recorded as 3.0 cm^3.

Those candidates who used all 10 cm^3 of soil washings each time, when no such problem was reported by the Supervisor, were unable to gain full credit in parts **(a)(i)** and **(ii)**.

Parts **(a)(iii)** and **(iv)** did not cause any difficulties for the majority of candidates.

Most candidates were able to perform the calculation in **(a)(v)**. Only the weakest candidates were unable to rearrange the equation. Most candidates correctly rounded their values.

Parts **(b)** and **(c)** gave fairly consistent results provided the instructions had been followed carefully. Allowances were made for unusual colours when these were also recorded by the Supervisor. Some candidates gave a pH range and were only awarded credit if the extent of their stated range matched the mark scheme.

A wide range of answers was seen for part **(d)** varying from excellent use of the results from parts **(b)** and **(c)**, as instructed, to wrongly treating this part as a theory question quite separate from the practical work.

CO-ORDINATED SCIENCES

Paper 0654/52

Practical Test

Key messages

If an extended line of a graph goes off the grid for a required intercept, it is important to extend the relevant axis or grid line accurately and to measure the extension of the axis or grid line carefully to work out the value of the intercept.

Candidates should be reminded that results can be negative or positive and that a negative result can be useful in eliminating potential (incorrect) answers. This is particularly relevant to the tests carried out in chemistry.

General comments

Candidates organised themselves to complete this paper in the time available and very few misunderstood the practical instructions.

Comments on specific questions

Question 1

Most candidates described bubbles or the absence of bubbles in part **(a)(i)** but, whereas the leaves in dish **A** usually behaved as expected, a wide variety of observations were seen for the monocotyledonous leaves in dish **B** which caused problems when answering part **(a)(vi)**.

Many candidates were able to relate carbon dioxide to the air in the leaves. Fewer could name the structures in part **(a)(iii)** which then affected their ability to gain further credit.

Part **(a)(iv)** depended on the candidate having a reasonable set of results and knowing the structures in the surface of the leaf. Some candidates were not specific enough and simply referred to cuticles.

Generally there was a better understanding of loss of water in part **(a)(v)** although exposure to sun or heat was not always mentioned.

Few candidates were able to compare their results to gain credit for part **(a)(vi)**.

The drawing in part **(b)(i)** was generally well done and of a sensible size. Details of the veins and stalk were not always included.

For parts **(b)(ii)** and **(iii)** the measurement of the width was not always done as accurately as possible and a significant number of candidates measured the length of the leaf. Many candidates were able to calculate the magnification of their drawing although some wrongly used an inverted fraction for their calculation.

Part **(b)(iv)** was generally well answered. Common mistakes were to describe features that are invisible or features that have nothing to do with photosynthesis. Some candidates identified the correct features but did not explain how they help the leaf to photosynthesise efficiently so were unable to be awarded full credit.

Question 2

This experiment can be tricky to carry out well because of the friction between the thread and the rods. Despite this many candidates obtained good sets of results. Many candidates gained credit in part **(a)** and very few candidates read the scale with the higher numbers on the protractor. Full credit for part **(a)(ii)** was obtained only by those candidates who carried out the experiment very carefully.

A number of candidates recorded angles which only corresponded to angles in Table 2.2 rather than actual angles shown on the protractor. This may have been coincidence, misunderstanding or rounding angles up or down for the convenience of working out sine values. In most cases the sine values were worked out correctly. A number of candidates rounded sine values inappropriately whilst others worked out the sine values of mass *m* by mistake.

The graph in part **(b)(i)** was often well drawn. It is important to write the physical quantity and its unit when labelling an axis. Some candidates used an awkward scale, despite the grid being suitable for 0.1 per cm for the sine and 10 g per cm for the mass. Credit was awarded for a different scale if this had been done to accommodate the extension of the line to a sine θ value of 1.0. Candidates were awarded credit for a best-fit line through the origin. The origin is considered to be the most accurate point in this experiment.

In part **(b)(ii)** the candidate had to extend the line and read the value of mass *m* which corresponded with the sine θ value of 1.0 to within half a small square on the grid. This was done quite well but many candidates had to extend their line off the grid and this was generally carried out poorly. If an extended line of a graph went off the grid, it was important to extend the relevant grid line (sine θ value of 1.0 in this case) accurately to meet the line and to measure the extension of the grid line carefully to work out the value of the mass *m*.

The most common answer to part **(b)(iii)** was 'gravity' which was not accepted unless it was made clear that gravity was acting on the thread or hanger. 'Friction' was a creditworthy answer.

Question 3

The 'pop' or 'explosion' was nearly always recorded in part **(a)(i)**. The presence of bubbles did not always accompany this observation and 'colourless solution' was rarely recorded, emphasising the need to record all observations to gain full credit.

For part **(a)(ii)** most candidates gained credit for deducing that the gas was hydrogen.

In part **(a)(iii)** only the most able candidates suggested an acceptable identity for **A**. Common incorrect responses were Group 1 metals and unreactive metals such as copper.

Part **(b)** did not cause any problems but the reduction of **B** using **A** in part **(c)** varied in how far the reaction proceeded, depending on how much **A** was added.

A variety of colours was accepted for part **(c)(i)** but wrongly coloured precipitates were not credited. For most candidates enough reaction had taken place in **(c)(i)** to give a green precipitate (although grey or black was credited) in **(c)(ii)** due to the presence of iron(II).

For part **(c)(iii)** if a green precipitate had been recorded most candidates went on to gain credit for writing iron(II). 'Iron' on its own was not awarded credit.

Many candidates observed the darkening in part **(d)**. However many wrote the same colour as in part **(c)(ii)** and were not awarded credit; as there had to be a clear difference between the two. Relatively few candidates realised that the iron(III) had been reduced to iron(II), or were able to explain their observations.

In part **(f) (i)** it was common to see a white precipitate recorded despite this being impossible as there was no sulfate ion present. As in previous papers, some candidates wrongly assumed that all tests would be positive.

Part **(g)** did not cause any problems to candidates and was well answered.

CO-ORDINATED SCIENCES

Paper 0654/53

Practical Test

Key messages

If an extended line of a graph goes off the grid for a required intercept, it is important to extend the relevant axis or grid line accurately and to measure the extension of the axis or grid line carefully to work out the value of the intercept.

Candidates should be reminded that results can be negative or positive and that a negative result can be useful in eliminating potential (incorrect) answers. This is particularly relevant to the tests carried out in chemistry.

General comments

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Comments on specific questions

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Part **(a)(iv)** depended on the candidate having a reasonable set of results and knowing the structures in the surface of the leaf. Some candidates were not specific enough and simply referred to cuticles.

Generally there was a better understanding of loss of water in part **(a)(v)** although exposure to sun or heat was not always mentioned.

Few candidates were able to compare their results to gain credit for part **(a)(vi)**.

The drawing in part **(b)(i)** was generally well done and of a sensible size. Details of the veins and stalk were not always included.

For parts **(b)(ii)** and **(iii)** the measurement of the width was not always done as accurately as possible and a significant number of candidates measured the length of the leaf. Many candidates were able to calculate the magnification of their drawing although some wrongly used an inverted fraction for their calculation.

Part **(b)(iv)** was generally well answered. Common mistakes were to describe features that are invisible or features that have nothing to do with photosynthesis. Some candidates identified the correct features but did not explain how they help the leaf to photosynthesise efficiently so were unable to be awarded full credit.

Question 2

This experiment can be tricky to carry out well because of the friction between the thread and the rods. Despite this many candidates obtained good sets of results. Many candidates gained credit in part **(a)** and very few candidates read the scale with the higher numbers on the protractor. Full credit for part **(a)(ii)** was obtained only by those candidates who carried out the experiment very carefully.

A number of candidates recorded angles which only corresponded to angles in Table 2.2 rather than actual angles shown on the protractor. This may have been coincidence, misunderstanding or rounding angles up or down for the convenience of working out sine values. In most cases the sine values were worked out correctly. A number of candidates rounded sine values inappropriately whilst others worked out the sine values of mass *m* by mistake.

The graph in part **(b)(i)** was often well drawn. It is important to write the physical quantity and its unit when labelling an axis. Some candidates used an awkward scale, despite the grid being suitable for 0.1 per cm for the sine and 10 g per cm for the mass. Credit was awarded for a different scale if this had been done to accommodate the extension of the line to a sine θ value of 1.0. Candidates were awarded credit for a best-fit line through the origin. The origin is considered to be the most accurate point in this experiment.

In part **(b)(ii)** the candidate had to extend the line and read the value of mass *m* which corresponded with the sine θ value of 1.0 to within half a small square on the grid. This was done quite well but many candidates had to extend their line off the grid and this was generally carried out poorly. If an extended line of a graph went off the grid, it was important to extend the relevant grid line (sine θ value of 1.0 in this case) accurately to meet the line and to measure the extension of the grid line carefully to work out the value of the mass *m*.

The most common answer to part **(b)(iii)** was 'gravity' which was not accepted unless it was made clear that gravity was acting on the thread or hanger. 'Friction' was a creditworthy answer.

Question 3

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Many candidates observed the darkening in part **(d)**. However many wrote the same colour as in part **(c)(ii)** and were not awarded credit; as there had to be a clear difference between the two. Relatively few candidates realised that the iron(III) had been reduced to iron(II), or were able to explain their observations.

In part **(f) (i)** it was common to see a white precipitate recorded despite this being impossible as there was no sulfate ion present. As in previous papers, some candidates wrongly assumed that all tests would be positive.

Part **(g)** did not cause any problems to candidates and was well answered.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key Message

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

General comments

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

Comments on specific questions

Question 1

This question investigated some of the conditions required for seed germination.

(a) For full credit candidates had to notice that one seed had not geminated in dish **B**.

(b) Some candidates did not use the results from part **(a)** and were unable to be awarded full credit.

(c) Only a few candidates appreciated that with biological samples individual variation can occur and that some seeds could be dead or damaged. Answers with just 'get an average' were not creditworthy.

(d) Many candidates gave 'moisture', which was not credited as it was in the question. Answers such as temperature, concentration of oxygen and pH gained credit.

(e) Knowledge of the starch test, with iodine and the Benedict's test for reducing sugar were required for this part. Many candidates were unable to do this.

(f) The expected answer was amylase although the enzymes carbohydrase and diastase were credited.

Question 2

In this question candidates are using moments to calculate the mass of a metre rule.

(a) Many candidates did not read the question properly and tried to find *d* straight away. This and the fact that many candidates read the scales incorrectly meant that few candidates gained full credit. As candidates were instructed to record their values to three decimal places, other values were not credited.

(b) Most candidates plotted their points accurately and draw good straight lines. Some candidates plotted their incorrect readings from part **(a)** and joined the points with straight lines from point to point making it look like a mountain range. Candidates are instructed to show clearly on the graph how they obtained the values that they used when finding a gradient - a tiny pencil dot or two is not 'clearly'. Examiners are expecting a triangle below the line showing the horizontal and vertical values chosen.

(c) A correct calculation using the candidates own value for the gradient was credited. A value in the region of 110 g was expected.

Question 3

The pretext of a farmer's crop being poor was just a setting for some neutralisation experiments.

(a) Examiners were expecting references to the same mass of soil or the same volume of water used, instead candidates tended to discuss practical details picked out from information already given in the question for instance the fact they were all washed or all filtered, and were not credited.

(b) The expected answer, blue to red, was often reversed.

(c) A significant number of candidates were unable to read off the values from the measuring cylinders. Large number of candidates were unable to calculate the volumes used in the experiment, i.e. subtracting their value from 10. A number of candidates were unable to calculate the average.

(d) This was done reasonably well by those candidates who had followed the instructions to part **(c)** correctly.

(e) Few candidates realised that the ions form insoluble hydroxides in alkaline solution.

Question 4

Transpiration rates from upper and lower surfaces of leaves were investigated in this question.

(a) Few candidates followed the instruction to take the reading from the **left hand side** of the bubble. Candidates should be encouraged to check their calculations and appreciate that the average distance moved per minute must be in the range of the individual distances moved.

(b) A correct calculation using their average value was fully credited. When correctly calculated, candidates should have found that 75% of the water loss was from the lower surface. A method to confirm that the other 25% was lost from the upper surface would be to repeat the experiment with the lower surfaces of the leaves covered with grease.

(c) The majority of candidates gained partial credit. Suggestions such as temperature, air speed (wind), humidity or light were all seen and credited.

(d) Only a few candidates were able explain that the reason the leafy shoot was cut under water before putting in the apparatus, was to prevent air bubbles entering the shoot. For part **(ii)** many answers were too vague, creditworthy answers included it is used in photosynthesis; used to maintain cell turgor or some was produced by respiration.

Question 5

A candidate was given five solutions of sodium compounds and by using four tests was able to identify them. This question was set showing the candidates plan with some answers missing.

(a) Almost all candidates gained full credit for knowing that Universal Indicator turns green in a neutral solution and a purple / blue colour in alkaline solution.

(b) The sodium sulfate solution could be identified as on addition of aqueous barium chloride to one of the neutral solutions, a white precipitate was formed.

(c) The two remaining neutral solutions were tested with aqueous silver nitrate, the one forming a white precipitate was the chloride and the one without the precipitate was the nitrate.

(d) This part identified the hydroxide and carbonate. As dilute hydrochloride was added, the litmus in both solutions turned red, but the carbonate would also produce bubbles.

(e) Candidates had to name the precipitate formed in test two: barium sulfate, and explain what a precipitate was. There are many ways of defining a precipitate; the Examiners credited the idea that a solid was being formed in or from a solution. An answer of 'an insoluble solid' was also creditworthy.

Question 6

This question covered some aspects of electricity using a 240 V filament lamp.

(a) Most candidates were able to complete the energy change from electrical energy to heat and light. Fewer could name the gas inside the lamp that prevents the filament burning out, with a significant number of candidates incorrectly naming 'oxygen'. Any of the inert gases were credited or the group name.

(b) This part was omitted by a number of candidates. It may have been that candidates did not 'see' the mark allocation.

(c) Most candidates read the dials correctly and completed the table. However some candidates read 0.6 as 0.52 and 12 as 10.2. Candidates need to be reminded to carefully check dial scales.

(d) The calculation caused few problems.

(e) Few candidates realised it was the large amount of heat energy wasted by this type of bulb and that this requires an increase in electricity generated (often by the combustion of fossil fuels), that contributes to global warming.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key Message

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

General comments

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

Comments on specific questions

Question 1

This question compared transpiration rates from both surfaces of a holly leaf and a grass leaf.

(a) While the majority of candidates followed the instructions there was a significant number who did not measure just the leaf or did not have a ruler. The most able candidates correctly calculated the magnification.

For part **(ii)** many candidates said the holly leaf was larger despite being asked for differences other than size and so were unable to gain credit. A number of candidates stated one (leaf) was a monocotyledon and the other a dicotyledon; this was not awarded credit as this is not a **visible difference**.

(b) For part **(i)** an answer of 'carbon dioxide present' gained credit, but a significant number of candidates mentioned of oxygen, so were unable to be awarded any credit.

Many candidates did not mention stomata and few had any idea of why there are more on the lower surface than the upper. Candidates then needed to relate the structure of the leaf to their function using the information given, but only the most able candidates gained credit for their answers.

In part **(iv)** candidates were asked to compare the results of the two leaves and suggest a reason for this, again only the most able candidates gave creditworthy answers.

Question 2

In this question candidates investigated forces acting at various angles.

(a) Most candidates were able to read the angles correctly, but were then unable to convert this to a sine value, despite the values being presented in the table.

(b) Candidates had to plot a graph of the sine value against mass, five points. However a number of candidates plotted the values from an incorrect table (and thus plotted many more points which produced a curve). Candidates should check that they following the instructions. The best straight line had to be drawn, extended to the value of sine =1.0. Most candidates suggested friction for part **(iii)** gaining credit.

(c) Candidates were asked to suggest how the results would be different if the experiment was carried out on the moon. Only the most able candidates realised that there would be no difference to the results as the reduced force of gravity still exerts an equal force on all the masses.

Question 3

In the practical examination, solid **A** and solution **B** were analysed. The same tests are used in this question. Candidates must complete the descriptions of the test, results and conclusions. Candidates should be able to recall the standard tests for cations and anions and be able to deduce the composition of a mixture of ions using these logical steps.

Generally candidates who had experience of these analytical tests scored well, but a significant number gained little or no credit.

(a) When a metal reacts with a dilute acid effervescence occurs and the gas evolved, hydrogen pops with a lighted splint.

(b) The cation in solution **B** is iron(III), therefore on addition of aqueous sodium hydroxide a red/brown precipitate should be formed.

(c) The addition of metal **A** to solution **B** changed the iron(III) to iron(II), therefore a green precipitate of iron(II) hydroxide is formed.

(d) A chloride is detected by the use of silver nitrate in the presence of nitric acid, a white precipitate being produced.

(e) The metal in solid **A** could be magnesium or zinc.

(f) The formula of the compound in solution **B** is $FeCl_3$.

Question 4

This question was about the amount of reducing sugar in different flowers.

(a) Candidates were shown diagrams of four flowers and a colour chart to show the relative concentration of reducing sugar shown by the Benedict's test. For both parts candidates were able to gain credit for clearly expressing their ideas.

(b) Practical knowledge of the Benedict's was required to answer part **(i)**. Few candidates answered this well. Three steps were required, firstly the grinding up of the flower sample in a solvent, secondly separation by filtering or decanting before finally heating with the Benedict's solution.

For part **(ii)** only a few candidates gave two things that should be done to ensure a fair comparison and gained full credit. Some made references to the volume of Benedict's solution without stating it should be the same volume used each time.

Candidates were then given a results table showing the colour of the Benedict's solution for each of the four flowers and had to list the flowers in order of increasing amount of reducing sugar. Some candidates put two letters on one line and others listed colours rather than flowers.

(c) Candidates were shown diagrams of pollen grains under the microscope. A significant number of candidates were unable to answer this 'comparative' question.

Question 5

This question examined the effect that changing the temperature had on the rate of reaction between marble chips and dilute hydrochloric acid.

(a) Candidates had to count the number of marks made, representing bubbles seen, at various temperatures. A significant number of candidates were unable to count the number correctly.

(b) The graph was usually plotted correctly, but some candidates did not label the axes or state the units used and thus unable to gain full credit.

(c) Although many candidates realised that the rate of reaction would increase further if a higher temperature was used few suggested why this would prove difficult in this experiment.

For part **(ii)** Examiners awarded credit for comments such as 'the particles gain more energy' or 'move faster resulting in more frequent collisions'.

(d) Candidates were asked to construct a word equation for the reaction between carbon dioxide and limewater. Some tried to write a symbol equation. Few candidates knew the chemical name for limewater or that calcium carbonate was formed. Fewer still could say that the limewater turned milky due to insolubility of calcium carbonate.

Question 6

This question concerned the density of ice.

(a) Candidates were instructed to read the balance with the four ice cubes in the beaker. Some candidates did not read the question carefully and thought the balance reading was the mass of the ice alone, others had difficulty in reading the balance.

(b) The same four pieces of ice were placed in 50 cm^3 hexane in a measuring cylinder. This time candidates had to read the volume and calculate the volume of the ice. Even with a diagram of the ice and hexane in the cylinder some candidates again confused what had to be taken from what. Many candidates have trouble reading scales and a number read the scale as 90.5 instead of 91, despite being instructed to record the value to the nearest 1 cm^3.

(c) The density of the ice had to be calculated using the candidates' values of mass and volume. A correct calculation was awarded full credit. Partial credit was awarded if the correct values were used but the answer incorrect. Where a candidate divided volume by mass no credit was given.

(d) Candidates had to deduce two properties of hexane from the information provided in the question. Prior knowledge of hexane was not required to state that it is not as dense as ice, it has a melting / freezing point of less than –5 °C and it does not react or dissolve ice.

(e) Finally the properties of ice were linked to polar bears. For both parts, candidates the answers could be expressed in many ways, but a two part answer was expected. For example for part **(i)** the ice floats, so the animals have a dry habitat to live in and for part **(ii)** the ice will melt, destroying the habitat of the bears were creditworthy.

CO-ORDINATED SCIENCES

Paper 0654/63
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Key Message

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General comments

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

Comments on specific questions

Question 1

This was an investigation into water loss from a plant shoot.

(a) Experimental details of how the apparatus was set up were supplied. Candidates gained full credit for stating this was to allow the plant to settle or adjust to the conditions.

(b)(c) Candidates had to read off the position of the bubbles on scales and complete the table by calculating the distance moved and the average distance moved. The majority of candidates gained credit for these parts.

(d) The majority of candidates stated that the results showed that an increase in air movement brought about an increased water loss gaining credit.

(e) Candidates named a condition that needed to be kept constant during the experiment; any one of temperature, light intensity, humidity, air pressure and the plant was creditworthy.

(f) Most candidates knew the possibility of getting an anomalous result is lessened by conducting the experiment three times, or reliability is improved.

(g) Finally candidates were asked to suggest why the amount of water taken up by the shoot may not be exactly equal to the amount lost by transpiration. Many answers was too vague, creditworthy answers included it is used in photosynthesis; used to maintain cell turgor or some was produced by respiration.

Question 2

In this question, candidates were experimenting with samples of aluminium of different thickness.

(a) Candidates were told that aluminium is used to make containers for cooking food and to name two properties that made aluminium suitable for this use. The ability to conduct electricity or its low density are not creditworthy properties in this context.

(b) The ability to conduct electricity, however, can be used to prove that aluminium is a metal.

(c) Many candidates find drawing diagrams difficult. Perfection was not expected but a reasonable attempt was required to gain credit. Some candidates drew a test-tube and collected the gas by downward delivery; others had delivery tubes passing through the side of the trough.

Most candidates correctly read the values of the two measuring cylinders for part **(ii)**.

(d) A graph was provided that linked the volume of hydrogen evolved to the thickness of the foil. The first piece of aluminium foil evolved 20 cm^3 gas, which converted to a thickness of 0.06 mm. Candidates were instructed to do the same for the two other pieces of foil with many gaining full credit, however some did not follow the pattern shown, and were unable to be awarded credit.

Question 3

A trolley system was used to investigate the relationship between mass and time.

(a) Candidates named of a metal or plastic that could be used to make the trolley, with many gaining credit for aluminium or a plastic such as polystyrene.

(b) Two timers had to be read and the values entered in a table, only a few candidates were not awarded credit.

(c) Most candidates correctly plotted the points but a significant number did not label the axes or indicate the units used. Despite the instruction to draw a smooth curve a number tried to draw a straight line of best fit. Candidates were told that the curve would not pass (0,0) and many realised that the trolley or mass would still take time to travel the metre even if the mass was zero. This idea was explained in a number of creditworthy ways.

(d) Many candidates did not draw a curve which would be obtained if the mass of the weight was increased. A line drawn below the original line gained credit.

(e) Most candidates stated that the force was gravity and went on to explain that gravity acts on the weight. Where a candidate had answered 'tension in the string' for part **(i)** an answer of 'gravity acts on the weight so that the string pulls the trolley' was credited for part **(ii)**.

Question 4

This experiment studied the effect of pH on protease activity.

(a) The majority of candidates answered this correctly.

(b) Part **(i)** was carried out well by most candidates. A few did not measure accurately or did not use millimetres. Most candidates graphs were well drawn, however some did not label the axes and a number of curves were not smooth. The optimum pH value should be somewhere between 8.2 and 8.8. Most candidates thought that the point at 8.5 would be the maximum and were awarded credit.

For part **(iv)** candidates who suggested taking readings closer together, especially in the range pH 8 to 9 gained credit. Repeating the experiment at 0.5 pH intervals will not produce a more accurate value and so was not awarded credit.

(c) The protease enzyme is found in the small intestine, any reference to the stomach was not creditworthy.

Question 5

Five solutions had to be identified. The chemicals were known, but not which one was which. The question followed a candidates' notebook plan to identify them. Candidates should be able to recall the tests given in the syllabus for cations, anions and gases and use them to deduce the composition solutions.

Only the most able candidates gained credit for this question.

(a) By looking at the candidates plan the candidate should deduce that litmus turns red or pink if the solution was an acid, and blue if alkaline.

(b) For test 2 aqueous barium chloride was added to the three acids. Only the sulfuric acid produced a white precipitate.

(c) Test 3 used silver nitrate to distinguish between hydrochloric acid (white precipitate) and nitric acid.

(d) Test 4 used aqueous copper sulfate to distinguish between aqueous sodium hydroxide and aqueous ammonia. They both produce a blue precipitate which dissolves in excess to produce a dark blue solution with ammonia.

(e) Only the most able candidates were able to put together a plan to find which of hydrochloric acid and nitric acid was the more concentrated. Candidates need to be reminded that litmus is a qualitative indicator not a quantitative one and therefore cannot be used in isolation.

Question 6

A long shallow tank of water was used to investigate some properties of waves.

(a) Many candidates correctly calculated the wavelength, velocity and frequency of the waves by following the procedure. Candidates should be reminded that a mathematical error is only penalised once when an incorrect value is then used correctly in further calculations. However the Examiners were unable to work out how candidates arrived at some figures and so were unable to award credit.

(b) Few candidates realised that the waves would reflect in a similar manner to light with the reflected rays now parallel to the sides of the tank. Some had waves refracted behind the barrier.

(c) Most candidates knew the waves were transverse waves gaining credit.