CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General comments

A good spread of marks was obtained well distributed across the range.

Biology

Comments on specific questions

Question 1 This proved to be one of the more challenging questions, and revealed a misunderstanding of what information the binomial system provides. Some good candidates felt that the names show that the two animals could interbreed, whilst others thought that they would be genetically identical. Many of the less able candidates mistook genus for species.

Question 4 The majority of the candidates seemed to be unclear about the reasons for the stages in the starch test.

Question 5 This was the most challenging of the biology questions. Many of the candidates appeared to have guessed the answer. Although xylem was not specifically mentioned in the question, it was a lack of knowledge of exactly what job the xylem performs that proved to be the obstacle.

Question 8 Even amongst some of the more able candidates, there was evidence of confusion between the iris muscles and the ciliary muscles and their action.

Question 9 A number of candidates did not realise that the umbilical cord will be carrying both oxygenated as well as deoxygenated blood.

Question 10 Some candidates were not confident with the topic of seed structure as there was evidence of guessing as the answers were fairly equally spread across the options.

Question 11 A number of candidates incorrectly chose option **A**, that an allele is a pair of identical genes, revealing a common misunderstanding.

Question 13 This proved to be the easiest question in the biology section. Although this is traditionally an area of the syllabus that is generally well understood, it was pleasing to see so many choosing the correct answer.

Chemistry

Comments on specific questions

Questions 17, **18**, **24** and **26** proved to be easiest and were answered correctly by a large majority of candidates. **Question 27** was the most challenging.

Question 15 A number of candidates chose option **D**, clearly assuming that reactivity increased down both groups and not realising that the reverse happened in Group VII.

Question 19 Option **C** was chosen by some candidates, who appeared not to have read the question properly and assumed that the contents of the dish burned / were oxidised.

Question 20 Some candidates knew the word electrolyte but confused anode and cathode not taking account of the + and – signs, and hence chose option **B**.

Question 21 Candidates who incorrectly chose option **B** had confused the test for chloride ions with the test for sulfate ions.

Question 22 A number of candidates did not know that neutralisation is exothermic and incorrectly chose option **A**.

Question 27 Option **B** proved to be more popular than the correct answer. Candidates who made this choice did not realise that sharing electrons means a covalent bond, and thus a compound between two non-metals.

Physics

General comments

Physics questions which proved to be particularly challenging were **29** and **35**. Candidates also found **31**, **32**, **36**, **37** and **39** difficult.

Comments on specific questions

Question 28 The majority of candidates were familiar with the unit of density.

Question 29 This question caused much difficulty, with more than half the candidates believing that there would be an unbalanced force acting downhill, and failing to notice that the car was travelling at constant speed.

Question 30 Although this was generally well answered, the most common mistake was to calculate work done by multiplying the distance moved by the mass, rather than by the force.

Question 31 A significant number of candidates chose option **C**, probably mistakenly calculating charge by multiplying current by voltage.

Question 32 A number of candidates chose option **D**, presumably believing that use of a thinner wire would increase the current.

Question 33 This question on electromagnetic waves was answered quite well.

Question 34 Momentum was a much more secure concept.

Question 35 This proved to be the most challenging question. Reference in the question to 'the first few seconds' was included to avoid any confusion over whether the sky-diver had reached terminal velocity, but some candidates may have taken this to imply that no significant air resistance was acting, leading to option **A**. However, zero air resistance would not be referred to as being 'constant'.

Question 36 A significant number of candidates thought that a hot filament would emit alpha particles.

Question 37 Most of the candidates chose the correct particles, (electrons), however some then chose the wrong direction.

Question 38 Few problems were encountered in this question on efficiency.

Question 39 Many candidates believed that energy from the power station would be transmitted at low voltage.

Question 40 This question involved use of the power equation which was quite well known.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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

General comments

A good spread of marks was obtained well distributed across the range.

Biology

Comments on specific questions

Question 2 This proved to be one of the more challenging questions, and revealed a misunderstanding of what information the binomial system provides. Some good candidates felt that the names show that the two animals could interbreed, whilst others thought that they would be genetically identical. Many of the less able candidates mistook genus for species.

Question 5 Some of the candidates seemed to be unclear about the reasons for the stages in the starch test.

Question 6 This was the most challenging of the biology questions. Many of the candidates appeared to have guessed the answer. Although xylem was not specifically mentioned in the question, it was a lack of knowledge of exactly what job the xylem performs that proved to be the obstacle.

Question 7 Some candidates were not confident with the topic of seed structure as there was evidence of guessing as the answers were fairly equally spread across the options.

Question 9 Even amongst some of the more able candidates, there was evidence of confusion between the iris muscles and the ciliary muscles and their action.

Question 10 A number of candidates did not realise that the umbilical cord will be carrying both oxygenated as well as deoxygenated blood.

Question 11 This proved to be the easiest question in the biology section. Although this is traditionally an area of the syllabus that is generally well understood, it was pleasing to see so many choosing the correct answer.

Question 12 A number of candidates incorrectly chose option **A**, that an allele is a pair of identical genes, revealing a common misunderstanding.

Chemistry

Comments on specific questions

Questions 17, **21**, **22** and **27** proved to be easiest being answered correctly by a large majority of candidates. **Question 25** was the most challenging.

Question 14 A number of candidates chose option **D**, clearly assuming that reactivity increased down both groups and not realising that the reverse happened in Group VII.

Question 18 Option **C** was chosen by some candidates, who appeared not to have read the question properly and assumed that the contents of the dish burned / were oxidised.

Question 19 Some candidates knew the word electrolyte but confused anode and cathode not taking account of the + and – signs, and hence chose option **B**.

Question 20 Candidates who incorrectly chose option **B** had confused the test for chloride ions with the test for sulfate ions.

Question 23 A number of candidates did not know that neutralisation is exothermic and incorrectly chose option **A**.

Question 25 Option **B** proved to be more popular than the correct answer. Candidates who made this choice did not realise that sharing electrons means a covalent bond, and thus a compound between two non-metals.

Physics

General comments

Physics questions which proved to be particularly challenging were **30**, **35** and **38**. Candidates also found **29**, **33**, **34**, **36**, **37**, and **39** difficult.

Comments on specific questions

Question 28 The majority of candidates were familiar with the unit of density.

Question 29 A significant number of candidates chose option **C**, probably mistakenly calculating charge by multiplying current by voltage.

Question 30 This question caused much difficulty, with more than half the candidates believing that there would be an unbalanced force acting downhill, and failing to notice that the car was travelling at constant speed.

Question 31 The most common mistake was to calculate work done by multiplying the distance moved by the mass, rather than by the force.

Question 32 Momentum was a much more secure concept.

Question 33 A number of candidates chose option **D**, presumably believing that use of a thinner wire would increase the current.

Question 34 This question on electromagnetic waves was answered quite well.

Question 35 This proved to be the most challenging question. Reference in the question to 'the first few seconds' was included to avoid any confusion over whether the sky-diver had reached terminal velocity, but some candidates may have taken this to imply that no significant air resistance was acting, leading to option **A**. However, zero air resistance would not be referred to as being 'constant'.

Question 36 A significant number of candidates thought that a hot filament would emit alpha particles.

Question 37 Almost Most of the candidates chose the correct particles, (electrons), however some then chose the wrong direction.

Question 38 Many candidates believed that energy from the power station would be transmitted at low voltage.

Question 39 This question involved use of the power equation which was quite well known.

Question 40 Few problems were encountered in this question on efficiency.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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

General comments

A good spread of marks was obtained well distributed across the range.

Biology

Comments on specific questions

Question 3 This proved to be one of the more challenging questions, and revealed a misunderstanding of what information the binomial system provides. Some good candidates felt that the names show that the two animals could interbreed, whilst others thought that they would be genetically identical. Many of the less able candidates mistook genus for species.

Question 4 This was the more challenging of the biology questions. Many of the candidates appeared to have guessed the answer. Although xylem was not specifically mentioned in the question, it was a lack of knowledge of exactly what job the xylem performs that proved to be the obstacle.

Question 6 Some of the candidates seemed to be unclear about the reasons for the stages in the starch test.

Question 7 Even amongst some of the more able candidates, there was evidence of confusion between the iris muscles and the ciliary muscles and their action.

Question 8 A number of candidates did not realise that the umbilical cord will be carrying both oxygenated as well as deoxygenated blood.

Question 9 Some candidates were not confident with the topic of seed structure as there was evidence of guessing as the answers were fairly equally spread across the options.

Question 12 This proved to be the easiest question in the biology section. Although this is traditionally an area of the syllabus that is generally well understood, it was pleasing to see so many choosing the correct answer.

Question 13 A number of candidates incorrectly chose option **A**, that an allele is a pair of identical genes, revealing a common misunderstanding.

Chemistry

Comments on specific questions

Questions 16, 21, 23 and **25** proved to be easiest and were answered correctly by a large majority of candidates. **Question 26** was the most challenging.

Question 15 A number of candidates chose option **D**, clearly assuming that reactivity increased down both groups and not realising that the reverse happened in Group VII.

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Question 24 A number of candidates did not know that neutralisation is exothermic and incorrectly chose option **A**.

Question 26 Option **B** proved to be more popular than the correct answer. Candidates who made this choice did not realise that sharing electrons means a covalent bond, and thus a compound between two non-metals.

Physics

General comments

The only physics question which proved to be particularly challenging was **35**. Candidates also found **31**, **34**, **36**, **37** and **38** difficult. **Question 39** presented no problems to candidates, with almost all giving the correct answer.

Comments on specific questions

Question 28 The majority of candidates were familiar with the unit of density.

Question 29 Although this was generally well answered, the most common mistake was to calculate work done by multiplying the distance moved by the mass, rather than by the force.

Question 30 A significant number of candidates chose option **C**, probably mistakenly calculating charge by multiplying current by voltage.

Question 31 This question caused more difficulty, with almost half the candidates believing that there would be an unbalanced force acting downhill, and failing to notice that the car was travelling at constant speed.

Question 32 This question on electromagnetic waves was answered quite well.

Question 33 Momentum was a much more secure concept.

Question 34 A number of candidates chose option **D**, presumably believing that use of a thinner wire would increase the current.

Question 35 This proved to be the most challenging question. Reference in the question to 'the first few seconds' was included to avoid any confusion over whether the sky-diver had reached terminal velocity, but some candidates may have taken this to imply that no significant air resistance was acting, leading to option **A**. However, zero air resistance would not be referred to as being 'constant'.

Question 36 Most of the candidates chose the correct particles, (electrons), however some then chose the wrong direction.

Question 37 Some candidates thought that a hot filament would emit alpha particles.

Question 38 Many candidates believed that energy from the power station would be transmitted at low voltage.

Question 39 Few problems were encountered in this question on efficiency.

Question 40 This question involved use of the power equation which was quite well known.

Question 35 This proved to be the most challenging question. Reference in the question to 'the first few seconds' was included to avoid any confusion over whether the sky-diver had reached terminal velocity, but some candidates may have taken this to imply that no significant air resistance was acting, leading to option **A**. However, zero air resistance would not be referred to as being 'constant'.

Question 36 Almost half of the candidates chose the correct particles, (electrons), but the wrong direction.

Question 37 A significant number of candidates thought that a hot filament would emit alpha particles.

Question 38 Many believed that energy from the power station would be transmitted at low voltage.

Question 39 Very little difficulty was encountered in this question on efficiency.

Question 40 Most candidates could recall and use the power equation.

CO-ORDINATED SCIENCES

Paper 0654/21
Core Theory

Key Message

Candidates need to read questions carefully, taking note of the stimulus words (a glossary is provided at the back of the syllabus) and ensure that their answers address the questions asked.

General Comments

Most candidates attempted most questions. Although it appeared that candidates often knew the answers to the questions, their answers were often very vague. Performance depended not only on scientific knowledge but on the ability to understand the question.

It is clear that, when performing calculations, weaker candidates struggled to use the numbers in the correct way to achieve the correct answer. Quite often the candidates would make up a formula to confirm their answer. In some cases it was necessary to refer back to previous parts of a question to find the correct data. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of a mixture of words, symbols and units should be avoided. Similarly, formulae consisting only of units should be avoided.

Candidates need to be aware that their answers should be written in the designated area. Answers written elsewhere could well be missed.

Comments on Specific Questions

Question 1

(a)

(i) The retina was better recognised than the optic nerve.

(ii) Many candidates gained full credit here, but some did not continue the ray of light as far as the retina.

(iii) Most candidates correctly labelled the lens as a part of the eye that focuses the light.

(iv) The idea that the information travelled as an impulse or electrical signal was not well known. However, most candidates knew that the signals passed along nerves.

(b)

(i) Red blood cells were well recognized as cells that do not contain a nucleus.

(ii) Most candidates correctly gave the answer 46, although there were a number of other values chosen.

(iii) This was not well answered. A number of candidates were able to explain that DNA stores information, but few were able to explain what the information was

Question 2

(a)

(i) Many candidates were able to explain why atom **Y** was carbon by referring to the number of protons carbon atoms contain.

(ii) Most candidates correctly determined that the nucleon number of atom **X** was 11.

(b)

(i) This was well answered. Most candidates were able to state that the formula meant that aluminium oxide contained aluminium and oxygen, but fewer explained the aluminium and oxygen were atoms or ions and that they were present in a ratio of 2:3.

(ii) This was well answered. Many candidates explained that ions were electrically charged and that atoms were not.

(c)

(i) Electrolysis was well known as the name of the process, but few candidates correctly stated that the anode was the positive electrode.

(ii) Few candidates were able to explain that the ions needed to be mobile to create an electrolyte.

(iii) The equation for the electrolysis of aluminium oxide was well known.

Question 3

(a)

(i) This part was well not well answered. Many candidates were far too vague with their descriptions many did not refer to the constant speed of the athlete.

(ii) Many candidates managed to describe the motion as deceleration or slowing down.

(b) Most candidates correctly managed to use the change in speed and time to calculate the acceleration of the athlete.

(c) Almost all candidates carried out this calculation correctly.

(d) Almost all candidates carried out this calculation correctly.

(e) Many candidates gave good descriptions of the process of sweating but did not relate it to evaporation. Many candidates did not refer to particles in their description.

Question 4

(a) Most gained at least partial credit here.

(b) The missing enzymes and substrates were quite well known.

(c)

(i) Urine was a common incorrect answer.

(ii) Kidneys were the commonest answer but many different organs were suggested by different candidates.

(iii) Few candidates realised that osmosis would cause water to be taken in by the cells.

(iv) Many candidates gained at least partial credit for referring to respiration and the release of energy during respiration.

Question 5

(a)

(i) Candidates need to understand the significance of labels such as 60 W and 230 V in context.

(ii) These energy transformations were well known.

(iii) Few candidates were able to relate the unreactive gas to a lack of reaction with the hot filament in the bulb.

(b)

(i) Many candidates gained full credit, but a common error was to misread the value of the constant current as 0.25 A. A number of candidates also quoted times in seconds rather than milliseconds.

(ii) Again, many candidates misread the current value as 0.25 A.

(c)

(i) The formula was well known although a number of candidates chose to quote it in an unacceptable format.

(ii) The thickness or diameter of the wire was a well-known factor. The temperature of the wire was less well known.

Question 6

(a)

(i) Many candidates correctly gave element **B** as the answer, but fewer candidates identified the correct property – low electrical conductivity**.** Many candidates quoted all three properties of element **B** and high melting point is not a typical property of a non-metal.

(ii) Element **C** was often correctly given, but few candidates were able to suggest the two typical properties – high melting point and high electrical conductivity.

(b)

(i) Many candidates suggested mixing the metals together rather than melting the metals together.

(ii) Most candidates explained that a non-metallic adhesive (glue) would not conduct electricity.

(c) Many candidates correctly drew a second electrode and immersed both electrodes in a beaker containing a liquid. Quite often the second electrode was a different metal to the original electrode. Few candidates named the electrolyte or showed that a potential difference was produced by drawing a value on the voltmeter.

(d)

(i) Carbon dioxide and water were well known as the products of combustion. Carbon monoxide and hydrogen were common wrong answers.

(ii) Carbon monoxide was a frequently seen correct answer.

Question 7

(a)

(i) 0.5 Hz was frequently given as the correct answer.

(ii) This was well answered by candidates who found suitable, relevant words to insert into the sentences.

(iii) Sound waves were well recognised as longitudinal waves. Frequently given incorrect answers were either 'electromagnetic waves', or an example of an electromagnetic wave.

(b)

(i) Many candidates correctly stated the weight as being 500 N but then did not use this value in **(ii)**.

(ii) The correct answer, 5000 J, was commonly seen.

(iii) Although many candidates were able to quote the correct formula, many had difficulty making the correct substitution for mass and velocity and then in squaring the velocity.

(c) Radiation was well known. There were few responses of conduction or convection.

Question 8

(a)

(i) Few candidates knew the term binomial.

(ii) Few candidates were able to suggest an advantage of giving each species a Latin binomial name.

(b)

(i) Most candidates completed the food web correctly. Candidates were able to use the information given to determine both the producers and predators in the web. A few candidates drew the arrows the wrong way.

(ii) Most candidates identified a producer, usually the tree.

(c)

(i) Most candidates were able to describe the pattern in distribution of golden lion tamarin faeces in broad terms. The best answers, gaining full credit, included detail in their description of the pattern.

(ii) Most candidates were able suggest one way in which the seed dispersal could benefit young plants grown from the seeds but few could suggest two. Competition for light was a common answer.

Question 9

(a)

(i) Most candidates were able to give a good description of either an element or compound, but few were able to explain a difference between them satisfactorily.

(ii) Use of litmus to detect ammonia was well known. A few candidates described the chemical test for ammonium compounds.

(b)

(i) The unreactive nature of nitrogen was not well known as a reason for why it could not be used directly by plants.

(ii) Nitric acid was not well known.

(iii) Most candidates managed to name two out of the three correct elements although few candidates were able to supply all three.

(iv) The idea that amino acid molecules join together to make a long chain molecule was quite well known.

(c)

(i) The idea that a catalyst was a substance which increases the rate of a reaction was well known.

(ii) This was not well known. The idea that sodium was very reactive and therefore likely to react with some of the other reactants was the only idea any of the candidates could suggest.

CO-ORDINATED SCIENCES

Paper 0654/22
Core Theory

Key Message

Candidates need to read questions carefully, taking note of the stimulus words (a glossary is provided at the back of the syllabus) and ensure that their answers address the questions asked.

General Comments

Most candidates were able to attempt most questions. Although it appeared that candidates often knew the answers to the questions, their answers were often vague. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question.

It is clear that, when performing calculations, weaker candidates struggled to use the numbers in the correct way to achieve the correct answer. Quite often the candidates would make up a formula to confirm their answer. In some cases it was necessary to refer back to previous parts of a question to find the correct data. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols and units should also be avoided.

Candidates need to be aware that their answers should be written in the designated area. Answers written elsewhere could well be missed.

Comments on Specific Questions

Question 1

(a) Most candidates were familiar with identification keys and gained at least partial credit here. Some candidates wrongly assumed that, as the example given had two ticks, all the other rows of insect data would also require two ticks.

(b) Few candidates were able to suggest an advantage of giving each species a Latin binomial name.

(c)

(i) Protease was commonly known.

(ii) The soluble product produced by the enzyme was less well known.

(d)

(i) White blood cells were well known.

(ii) Most candidates gained credit here for referring to the idea that pesticides were not selective and could kill other organisms.

(e)

(i) Candidates need to be able to transfer their knowledge between domains. Many candidates seemed unable to apply their knowledge and understanding of a physics concept to what they perceived to be a biology question. The idea that the sound produced was caused by a vibration was rarely mentioned and almost no candidates were able to describe the connection between sound waves and the air particles.

(ii) The link between higher pitch and higher frequency was rarely mentioned.

Question 2

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(a)

(i) Far too many candidates did not realise that they had to draw an arrow showing the direction of the friction force. Many candidates drew labelling lines or arrows to show where they thought that friction forces were.

(ii) This was quite well known although many candidates were unable to express the fact that forces needed to be both equal and opposite.

(iii) Despite the fact that the question described the aircraft moving along the runway, many candidates suggested that the effect of balanced forces on the movement of the aircraft would be that the aircraft was not moving.

(b)

(i) Many candidates gained full credit here.

(ii) This was not well answered. Natural sources of background radiation were not well known.

(c) The most popular answer was X-rays but many candidates were unable to supply the name of another part of the electromagnetic spectrum.

(d)

(i) Many candidates explained that the nitrogen would stop the snacks spoiling but few stated that this was because nitrogen was very unreactive.

(ii) Although most candidates realised that the situation was caused by air pressure, few were able to explain clearly that the pressure in the bag would be greater than the air pressure in the aircraft.

Question 3

(a)

(i) A common incorrect answer to this question was 6 electrons.

(ii) Many candidates were able to suggest silicon but fewer were able to explain why in terms of groups in the Periodic Table.

(iii) Neon was not well known. Many answers included elements from a different period in the Periodic Table.

(b)

(i) Many candidates gained at least partial credit here.

(ii) The correct answer, sentence **B,** was the commonest answer. Many candidates were able to explain why it was the correct answer, usually by referring to exothermic reactions as reactions in which heat is given out.

(c)

(i) Detergent and soap were well known. References to local brands of detergents or the term washing powder could not be accepted.

(ii) Few candidates were able to answer in terms of the effects on the environment - for example water pollution. Most referred to a deterioration of the quality of clothes.

Question 4

(a) Many candidates gained partial credit. Either they knew that the long hair trapped a layer of air or they knew that the air was an insulator.

(b)

(i) Candidates found this question difficult. They needed to work out that the combined mass was 1080 kg and then multiply by ten to calculate the weight. Many candidates divided by ten.

(ii) The formula work = force x distance was well known. Some candidates found it difficult to substitute the correct values into the formula.

(iii) Although many candidates were able to quote the correct formula, many had difficulty making the correct substitution for mass and velocity and then in squaring the velocity.

(iv) This was well answered. Most candidates knew the formula and completed the calculation correctly.

(c) Few candidates described yak dung as a renewable energy resource. Many incorrectly assumed that yak dung produced no carbon dioxide when it was burned and that therefore burning yak dung did not contribute to global warming.

Question 5

(a) Sexual and asexual were the correct and commonly given answers. Some candidates attempted to answer in terms of the types of pollination involved.

(b)

(i) Some candidates did not follow the instructions in the question and refer to *visible* features.

(ii) Many candidates did not refer to sex cells, gametes or zygotes. Many candidates were also not clear enough about what happeed to the gametes. The answer required the idea that the gametes joined together, fused together or combined together. Statements that simply referred to games meeting, with no further detail, were not credited.

Ovary and seeds were well known in **(iii)** and **(iv)**.

(c)

(i) Many candidates gained partial credit here for referring to an increase in the growth of plants. A number of candidates suggested that fertilisers contained protein. Some candidates described the effects of pesticides rather than fertilisers.

(ii) Many candidates mentioned the nitrogen-fixing bacteria in the root nodules, but few candidates went on to explain that the nitrogen-fixing bacteria supplied the plants with nitrogen containing compounds. Some candidates were confused about the bacteria and assumed that they were causing damage to the plants.

Question 6

(a)

(i) Many candidates correctly calculated the missing value as 89 %.

(ii) Many candidates suggested that the metals needed heating and mixing but did not refer to melting the metals together in their answer.

(iii) Many candidates gained full credit for a correct property and the importance of this property in making coins. A few candidates wrongly described a general property of metals such as being a good electrical conductor.

(b)

(i) Although there were many correct equations written, a number of candidates only wrote carbon monoxide on the right hand side of the equation.

(ii) Carbon combining with oxygen was well known.

(c)

(i) Few candidates correctly stated that the cathode was the negative electrode and fewer were able to describe the electrolyte. Commonly seen incorrect ideas were that electrolytes were produced during electrolysis or that electrolytes allowed electrons to flow.

(ii) The idea that aluminium atoms loose electrons when they become ions was not well known.

(iii) Very few candidates could carry out this ratio calculation.

(d)

(i) Sol and colloid were not well known. Melting was a commonly seen incorrect answer.

(ii) Many candidates gained credit for suggesting why sunscreen could protect human skin from ultraviolet light.

Question 7

(a) This was well answered with many candidates gaining full credit. Candidates knew about the roles of the red blood cells and haemoglobin.

(b)

(i) This was not well answered because many candidates ignored the instructions in the question and stated uses of energy in the body which related to muscle contraction.

(ii) Homeostasis was well known.

(iii) Many candidates explained the need to replace water lost in sweat, but many other candidates described the use of energy drinks.

(c) This was not well answered, although many candidates did gain partial credit for referring to blocked blood vessels caused by cholesterol, for example. The coronary artery and its role were rarely mentioned, nor was the effect of lack of oxygen on the heart muscle.

Question 8

(a)

(i) Many candidates correctly drew arrows going downwards. However, many other candidates drew arrows in the form of convection currents and left it very unclear whether the cooled air was going up or down.

(ii) Convection was quite well known.

(iii) Few candidates understood that cool air is denser than warm air and therefore sinks.

(b)

(i) The formula for calculating density was well known. Most candidates correctly calculated the volume of the ice cube. A large number of candidates either forgot to state the units for density in their answer or stated incorrect units.

(ii) This was poorly answered. Few candidates managed to draw particles of similar size to the particles originally drawn. There were few candidates who successfully drew a diagram for the liquid containing particles which were randomly arranged but had particles which were usually touching other particles.

(c)

(i) Most candidates correctly calculated the resistance of the lamp.

(ii) Most candidates correctly calculated the combined resistance of the two lamps.

Question 9

(a) The correct answers, **A** and **C,** were the most commonly given answers.

(b)

(i) Many candidates were able to supply the correct answers; photosynthesis and respiration. Unfortunately, a number of candidates gave the answers in the wrong order.

(ii) Few candidates were able to correctly name the compound produced during photosynthesis.

(iii) Most candidates were able to explain that each organism produced either oxygen or carbon dioxide which the other organism then used.

(c)

(i) Many candidates realised that the activities involved were either the increased burning of fossil fuels or deforestation. Candidates need to express their ideas clearly in order to be sure of gaining credit.

(ii) This was poorly answered. Few candidates could explain what was happening. The best answers mentioned carbon dioxide as being acidic and dissolving in water.

(iii) Many candidates found this part challenging.

CO-ORDINATED SCIENCES

Paper 0654/23
Core Theory

Key Message

Candidates need to read questions carefully, taking note of the stimulus words (a glossary is provided at the back of the syllabus) and ensure that their answers address the questions asked.

General Comments

Most candidates were able to attempt most questions. Although it appeared that candidates often knew the answers to the questions, their answers were often very vague. Performance depended not only on scientific knowledge but on the ability to understand the question.

It is clear that when a numerical answer was required, weaker candidates often did not have the confidence to use the numbers in the correct way to achieve the correct answer. Quite often the candidates made up a formula to confirm their answer. In some cases it was necessary to refer back to previous parts of a question to find the correct data. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols and units should also be avoided.

Candidates need to be aware that their answers should be written in the designated area. Answers written elsewhere could well be missed.

Comments on Specific Questions

Question 1

(a)

(i) Some candidates were unable to identify cell **A** as a cell found in the leaf. Many candidates placed the root cell incorrectly.

(ii) Consequently few candidates were able to explain why cell **A** contained chloroplasts but cell **B** did not.

(iii) Again, once the candidates had incorrectly placed the cell, it was difficult to state the correct connection between shape and function.

(b)

(i) There were many correct answers. The common error was to write down pink as the phenotype for **Rr**.

(ii) Many candidates correctly circled **Rr**, but many other candidates gave no response, indicating that they struggled to understand what the question required. Candidates need to be familiar with the appropriate scientific vocabulary.

(iii) The correct answer of 3:1 was commonly seen. Some candidates gave the incorrect 2:1 as an answer.

(c) Candidates need to be more familiar with the ideas of tissue culture.

Question 2

(a)

(i) This was quite well known although some candidates seemed confused by the two other forces on the diagram.

(ii) This was well answered by most candidates.

(iii) Although many candidates were able to quote the correct formula, many had difficulties making the correct substitution for mass and velocity and then in squaring the velocity.

(iv) Most candidates were able to identify the correct formula and produce a suitable answer. A number of candidates did not convert the time from minutes to seconds.

(b)

(i) This was well answered by most candidates. However, a number of candidates wrote an **X** somewhere near the correct point, and assumed that this gave enough detail. If candidates placed the **X** anywhere apart from the correct point, then a labelling line was required.

(ii) This calculation was well done.

Question 3

(a)

(i) This part was well answered. Most candidates were able to suggest element **R** with the reason being either that it was a non-metal or a halogen or in group 7.

(ii) Many candidates were able to suggest element **S** but fewer were able to explain why in terms of the trend in reactivity going down the group.

(iii) Many answers demonstrated a misunderstanding of the atomic structure behind this question. Candidates answers were often very vague.

(iv) Many candidates were able to suggest two correct elements, but fewer could produce a correct explanation in terms of ionic bonding.

(b)

(i) Sodium chloride solution was the commonest answer, but both of the alternative answers were popular. Fewer candidates were able to gain further credit by explaining the role of an electrolyte.

(ii) Most candidates struggled to explain what would happen to the voltmeter reading if two identical electrodes were used.

Question 4

(a)

(i) Many candidates knew the relationship between work, force and distance and most were able to substitute correct values to determine the work done.

(ii) The connection between work done and the gain in potential energy was not well known.

(b) Few candidates gained credit here. They found it difficult to relate loudness to amplitude and pitch to frequency

(c)

(i) Many candidates chose yellow as the third primary colour rather than green.

(ii) Few candidates were able to name one of the secondary colours. Yellow was the commonest correct answer. References to either cyan or magenta were uncommon.

(d)

(i) Most candidates correctly calculated the volume of the air in the theatre.

(ii) Some candidates found it challenging to rearrange the formula for density, and consequently calculated the wrong answer.

Question 5

(a) Many candidates gained at least partial credit. A common error was to confuse 'monomer' with 'polymer', describe the formation of a long monomer molecule from many polymer molecules joining together.

(b)

(i) Most candidates knew this but some needed more clarity in their explanations.

(ii) This was well answered.

(iii) Amino acid was not well known. Ammonia and nitrogen were commonly given wrong answers.

(c) Many candidates knew this but a few gave vague answers that showed a lack of understanding.

(d)

(i) Most candidates correctly identified the calcium compound but many were unable to explain why it caused hard water.

(ii) Many candidates were able to suggest one advantage of a water supply which did not contain compounds which caused hardness.

Question 6

(a) Many candidates gained full credit in **(i)**, **(ii)** and **(iii)**.

(iv) Some candidates referred to respiration in cells producing carbon dioxide and therefore gained partial credit, but few were able to describe what happened to the carbon dioxide.

(v) This part was very poorly answered. The functions of the components of the heart were not well known.

(b)

(i) This was also not well known. Few candidates referred to goblet cells or the connection between mucus and cilia.

(ii) Few candidates were able to work out the significance of the fact that there was a greater distance for the gases to diffuse.

Question 7

(a)

(i) Many candidates referred to the particular effects of caffeine on the body rather than describe what a drug does to the body.

(ii) Pain relief was well known as a reason why people take analgesics.

(b)

(i) Some candidates answered this part effectively but many candidates produced some very vague answers from which it was not possible to identify the correct idea. Only the most able candidates answered this well.

(ii) Most candidates correctly suggested that the reaction was exothermic or gave off heat.

(iii) This was well answered. Most candidates were able to work out that the equation was not balanced and were also able to explain why. This was usually done by referring to the number of hydrogen atoms on each side of the equation

(c)

(i) Most candidates knew the correct result for the limewater test for carbon dioxide.

(ii) This was poorly answered. Few candidates were able to identify an acid as a correct solution and even fewer were able to state a suitable product – either a correct salt or water.

Question 8

(a) Few candidates were able to provide a correct answer for what happened to the rest of the energy supplied.

(b) Both parts were well answered.

(c) This was poorly answered. Few candidates managed to draw particles of similar size to the particles originally drawn. Fewer candidates drew a suitable diagram for the gas. There were almost no candidates who successfully drew a diagram for the liquid containing particles which were randomly arranged but had particles which were usually touching other particles.

(d)

(i) This was well known.

(ii) Most candidates knew how to do this, but many forgot to convert the time involved to seconds.

(iii) Most candidates knew the correct formula relating resistance, current and voltage and calculated the correct answer.

(e) The idea that cold water sinks and that hot water rises was well known. The explanation in terms of the density of the water was less well known. Many candidates seemed to be confusing convection with conduction.

(f) Most candidates gained at least partial credit here. Credit could not be awarded for vague statements relating to people being killed or injured.

Question 9

(a)

(i) Fins and scales were well known features, characteristic of fish. Some candidates did not follow the instructions in the question and gave features clearly not visible on the diagram.

(ii) Scales was a well-known feature shared by fish and reptiles.

(b) Many candidates did not refer to sex cells, gametes or zygotes. Many candidates were also not clear enough about what happened to the gametes. The answer required the idea that the gametes joined together, fused together or combined together and not simply that the gametes met.

(c)

(i) This was found difficult by most candidates, who were unable to analyse the data on the graph and explain the differing testosterone concentrations.

(ii) This was poorly answered. Few candidates could explain that, although the results showed correlation, they did not necessarily show cause.

(d) This was well known.

CO-ORDINATED SCIENCES

Paper 0654/31
Extended Theory

Key Message

Candidates should be reminded to take care to show working clearly, and to give formulae using correct abbreviations as listed in the syllabus. They are expected to give correct units with their answers.

General Comments

The majority of candidates showed a range of knowledge and understanding across the syllabus, including material from the supplement. Almost all of them attempted to answer all questions, and the majority communicated their responses clearly.

There were numerous instances of candidates appearing to write answers to a previous question, rather than the one being asked. Some did not do as asked, for example attempting to 'explain' when asked to 'describe', or giving a formula of a compound when asked for a name.

Comments on Specific Questions

Question 1

(a)

(i) A small majority of the candidates drew an arrow going from right to left.

(ii) This was generally well answered, with most candidates correctly naming the central nervous system, brain or spinal cord.

(iii) Candidates who understood that the neurone transmits nerve impulses were awarded at least partial credit, and there were numerous excellent answers that received full credit. This was not always the case, however. Some candidates thought that the cell moves through the body to carry 'messages'.

(b)

(i) The description of the function of DNA in the syllabus – that is, to store coded instructions for making proteins – was rarely known. Most answers described what DNA is, rather than its function, for example that it contains genes or is found in chromosomes.

(ii) Relatively few candidates recognised that a gamete is a haploid cell and a neurone is a diploid cell, and therefore a neurone would contain twice as much DNA as a gamete. Many answers suggested that it would contain half as much, while others simply said the neurone would contain 'more' DNA, which was not sufficiently precise to be credited. Some stated the number of chromosomes, without relating this to the quantity of DNA.

Question 2

(a)

(i) Many candidates found this difficult; not understanding the term 'frequency', or how to work this out from the information provided. Some correctly arrived at an answer of 0.5, but did not give a unit such as Hz, or waves per second.

(ii) Some candidates understood the fundamental differences between longitudinal and transverse waves and gave good descriptions in terms of the relationship between the direction of the movement of the medium and the direction of movement of the wave. These were often accompanied by well annotated diagrams. Such answers were relatively rare, however. A few candidates confused longitudinal waves with transverse waves, but most were simply unable to explain any difference between them.

(b) This was well answered. Most answers gave a correct formula, calculated the value correctly and gave the correct unit, joules, with their final answer. Some used the right formula but did not remember to square the velocity in their calculation.

(c)

(i) A minority of candidates gave a correct answer. Credit was not available for simply stating 'yes' or 'no'; either of these responses were accepted, and it was the explanation that was given credit. Most of those giving a correct response decided that the weight would not change, because neither the boy's mass nor gravity would change.

(ii) Many candidates correctly explained that the kinetic energy would increase and gave a reason; for example in relation to the greater potential energy converted to kinetic energy, or the greater velocity achieved at the bottom of the 20 m slide.

(d) This was very well answered. Most candidates knew the equation relating energy, specific heating capacity and temperature change, and were able to substitute correctly and arrive at the correct answer with a suitable unit. Some did not include temperature *change* in their equation.

Question 3

(a)

(i) This was very well answered.

(ii) Only a very small minority of candidates recognised that the reaction is reversible, and therefore that some product changes back to reactants. Some did gain partial credit for stating that not all the nitrogen and hydrogen would react and would pass through unchanged.

(iii) Most candidates were able to balance the equation.

(iv) A minority of candidates correctly named sulfur dioxide. Frequently occurring incorrect names included 'sulfur oxide' and 'sulfuric oxide'. Numerous answers gave the formula, which was not accepted, as the question specifically asked for the name.

(b) This was well answered. The most commonly seen errors were extra electrons on the nitrogen and, more rarely, on the hydrogen atoms. Some showed single electrons being shared or occasionally, groups of three electrons shared. The N and H symbols were sometimes missing. Some candidates showed sulfur trioxide instead of ammonia.

(c)

(i) Most answers included a correct calculation of the relative molecular mass of ammonium nitrate, but this was by no means always the case. Several candidates then multiplied this by 0.2 instead of 0.1. The majority of answers were clearly presented, so that it was easy to follow the working. This made it possible to award credit even if there was an arithmetical error somewhere along the way.

(ii) This was less well answered than **(i)**. Some answers did not even get the NO_3 part of the formula correct, and relatively few described the need for charge balance between the ammonium ion and the nitrate ion in ammonium nitrate. Many did not make use of the formula given in the equation at the top of the page.

Question 4

(a) There were some excellent and well expressed answers to this question, using the terms conduction, convection and radiation and explaining how these processes would transfer heat between different parts of the bulb. However, these were in the minority. Numerous answers did not use these terms at all. Incorrect or imprecise descriptions such as 'heat rising' or 'heat waves' were common.

(b) Most candidates did this calculation correctly. The most common error was to give an answer of 90 %.

(c)

(i) This was well answered. However, some candidates tried to *explain* what happens, rather than describing as asked.

(ii) A small majority of candidates gave the correct answer though a common error was to read the value as 0.25 A rather than 0.20 A. Some did not include a unit with their answer.

(iii) Most candidates knew the formula power = voltage x current. Candidates should be reminded that formula triangles are not accepted (although candidates can, of course, use them as an aid to remembering the formula), nor formulae containing only units (for example, watts = volts x amps). Some otherwise correct responses left off the unit, or gave an incorrect unit such as joules.

(d) A wide variety of responses were seen here. Most used the formula $1/R = 1/R_1 + 1/R_2$, but many were then unable to add the two fractions, or forgot to turn their answer 'upside down' to obtain the final value for resistance. Some used an incorrect formula $R = 1/R_1 + 1/R_2$. As both resistances were the same, this opened up the possibility of using other valid methods of calculation, and these were all accepted as long as they were clearly stated.

Question 5

(a)

(i) This was quite well answered. Most correctly identified the substance as carbon and many could also explain why it is an element. Fewer explained why it is not a compound.

(ii) Candidates who recognised that both diamond and aluminium oxide have giant structures generally went on to gain credit, usually for stating that the bonds are strong and therefore need much energy to break them. It was relatively rare to see any mention of the large number of bonds that need to be broken.

(iii) This was not well answered. Few candidates recognised that diamond must be harder than sapphires or rubies to enable them to be polished in this way.

(b)

(i) Most candidates had the correct idea about attraction between the negative oxide ions and the positive anode. However, there were numerous answers stating that oxygen 'atoms' have a negative charge, which is incorrect. Use of the word 'they' was taken to refer to the oxygen atoms in the question. Candidates need to take care with the correct use of scientific terms.

(ii) There were some excellent answers to this question, demonstrating clear understanding of what happens during electrolysis. Many candidates, however, gave their answer in terms of the formation of ions, rather than the formation of uncharged atoms from ions. There were numerous instances of aluminium ions losing electrons and oxide ions gaining them.

Question 6

(a) Almost all candidates gave at least some correct responses here. The commonest errors were to give glucose as the product of amylase (amylase hydrolyses starch to maltose, not glucose) and the small intestine as a site of production of protease enzymes. A few candidates did not know the meaning of the word 'substrate'.

(b) This was very well answered. Most candidates knew about villi, and also that these increase surface area for absorption. Other correct responses included the length of the small intestine, its thin wall and the good blood supply within the wall.

(c)

(i) Few candidates knew the name of the hepatic portal vein.

(ii) Most candidates gave the correct answer, urea. The commonest incorrect response was urine.

(iii) A minority of answers mentioned kidneys. Many thought that urea is excreted through some part of the alimentary canal, the reproductive system or even the lungs.

(d)

(i) This proved to be a very difficult question. A small proportion of candidates recognised that, if there is a solution of glucose in a cell, then water will move in by osmosis which may harm the cell or make it burst. However, most showed a fundamental misunderstanding of osmosis, often suggesting that glucose would move into or out of a cell or the liver by this process.

(ii) The use of glucose to provide energy was widely known, but many candidates wrongly stated that energy is 'produced' from glucose, and some thought that energy is needed to allow respiration to take place. Relatively few candidates knew any of the uses of energy stated in the syllabus, such as movement, growth or warming the body.

Question 7

(a) This was well answered. The majority of candidates attempted to calculate the area under the graph, and most did this correctly. Not all, however, gave a correct unit with their answer.

(b) Where the appropriate formula was remembered, answers were usually correct, although a wrong unit was common.

(c) This proved to be the hardest of these three calculations. The formula relating power, work and time was not always given, and many candidates had trouble rearranging this so that they could find the value for work. Incorrect units were frequently seen.

(d) Many answers appeared to be answering a different question, about how sweating cools the body. It was clear that most candidates do not understand the difference between evaporation and boiling. Relatively few even made clear that evaporation involves the change of liquid to gas. Answers often suggested that the particles themselves change, rather than their arrangement or movement.

Question 8

(a) Around half of all answers were correct. Some identified the correct metal but did not give a full explanation, while others incorrectly identified element **A**.

(b)

(i) A similar proportion of responses were again correct. Frequently seen incorrect answers included 'air' and 'nothing'.

(ii) Many answers included good diagrams, clearly showing that bronze contains atoms of different sizes, and some also showed that this disrupts the regular arrangement of layers of atoms. Fewer went on to explain that this means a greater force is needed to make the layers slide over one another.

(c) There was no credit available for identifying the correct cell; both marking points were for the explanation. Relatively few candidates explained that the voltage depends on the relative reactivity of the two metals used as electrodes.

(d)

(i) Although many candidates were able to translate the word equation into a correct balanced equation, many did not recognise that nitrogen gas has the formula N_2. The formula for nitrogen monoxide also caused numerous problems. Even where the formulae were all correct, many candidates were unable to balance their equation.

(ii) This was usually answered correctly.

(iii) Many answers correctly stated that carbon dioxide is not removed, or is produced, by the catalytic convertor. However, not all of these explained the effects of pollution by carbon dioxide. There was much confusion with acid rain and the ozone layer.

Question 9

(a)

(i) The food webs were generally correctly drawn. A common error was to place all three predators in a single box. Predators eating each other were allowed, but all needed to be shown eating monkeys in order for credit to be given. Some candidates did not include arrowheads, or drew arrows pointing in the wrong direction.

(ii) This was much less well answered than **(i)**. Many candidates did not mention the loss of energy along a food chain, and some did not mention energy at all.

(b)

(i) This was usually answered well, but some candidates tried to explain reasons for the distribution instead of describing it, which generally meant they were not awarded credit. Some wrote about the distribution of seeds or monkeys rather than faeces, which was not credited.

(ii) Most answers gave at least one correct point, generally relating to the reduction of competition with the parent tree, although not all suggested a resource that might be competed for, such as light, water or nutrients. Some also recognised that the faeces might provide extra nutrients (mineral ions) for the young plants.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

Key Message

When answering numerical questions, candidates should adhere to the rule of using one more figure than the least precise item of data used in the calculation.

General Comments

Candidate's responses did not always follow any directive to 'describe' or to 'explain'. Not all candidates appreciated the guidance that could be provided by the number of marks given for each part question in planning the number of assessable items they provided in their response.

The use of English was good, with ideas clearly expressed. Extended answers were generally well structured. Handwriting was usually good with very few scripts that were difficult to interpret. When changing answers, candidates should cross out the answer and write it again, rather than write over the original.

Sometimes calculations were carried out without using standard symbols in formulae as defined in the syllabus, which could lead to ambiguity. Answers were sometimes presented with too few significant figures. Some candidates used derived units, which were not usually acceptable.

Comments on Specific Questions

Question 1

(a) Most candidates could recall at least one of the main features of insects.

(b)

(i) Lipase or a protease enzyme was often correctly quoted as an enzyme that would digest a substance in meat, with amylase sometimes give as an incorrect answer.

(ii) If the name of the enzyme was recalled, candidates usually knew that the products of protein digestion were amino acids.

(c) There were some very good descriptions of phagocytosis and the production of antibodies as a means of destruction of microorganisms.

(d)

(i) Successful candidates described how a fly's wings set air molecules into vibration.

(ii) Good answers used the numerical data to explain the difference in sounds in terms of frequency, while others involved the speed of sound or physical features of the fly. They recognised the relationship between frequency and pitch rather than discussing loudness.

Question 2

(a) A suitable property of the alloy and the reason for its importance were usually provided. Since there is no iron in the alloy, rusting was not acceptable. 'Not corrosive' was sometimes used when candidates meant that it should not corrode.

(b)

(i) Many candidates wrote the balanced equation. Using a subscript for balancing, as in C_2, was the most common error.

(ii) Most candidates were able to give at least one reason why carbon can be used to extract aluminium but not tin from the oxide in terms of relative reactivities. Others were less successful when attempting an explanation in terms of the stability of the oxides.

(iii) The details of the electrolytic extraction of aluminium were not well known, although there were some good descriptions of the migration and discharge of ions.

(c) Many well-presented calculations of the number of moles of copper were provided. Some candidates had difficulty in calculating the mass of copper from the percentage. Others used the mass of the alloy instead of copper. Credit available for working sometimes could not be awarded when ambiguous results were not accompanied by an explanation.

Question 3

(a) Many candidates stated that a yak keeps warm by its hair trapping a layer of air which is a good insulator. Others discussed vasodilation or used vague statements like 'trapping heat' or repeated information in the question.

(b)

(i) Candidates were usually given credit either for using the formula *work = force x distance* or for calculating the potential energy gained. Candidates often did not include the mass of the load on the yak.

(ii) The maths involved in evaluating $\frac{1}{2}mv^2$ was usually handled well. Again most errors involved use of the wrong mass.

(c) The formula $P = F/A$ was not well-known. Candidates should note that a relationship between units is not acceptable when asked for a formula. The use of mass rather than weight was common. It was not always realised that the force is spread over four feet. Many good calculations were spoiled by an unnecessary and unsuccessful conversion of units to pascals. Sometimes N/m^2 was equated to Pa.

Question 4

(a)

(i) An example of a fossil fuel with which methane is associated was often given, but refined products of crude oil other than natural gas were not acceptable. It should be noted that, although methane is sometimes associated with coal seams, it is not contained in the coal itself.

(ii) The arrangement of electrons in the outer shell of the carbon atom in methane was usually correctly described by means of an accurate diagram rather than by prose.

(b)

(i) Rather more than half the candidates appeared to know the meaning of the term 'homologous series'.

(ii) Most candidates could describe the relationship between chain length or saturation and boiling point of hydrocarbons. Some used the number of bonds or of hydrogen atoms as the relevant variable, which was not precise enough to gain full credit.

(iii) The bromine test for alkenes was well known although not all candidates explained the use of the test to detect unsaturated hydrocarbons. A sizeable minority of candidates missed the requirement for a *chemical* test and described the measurement of boiling points.

Question 5

(a) There was evidence that some candidates misread the question and consequently described the process of pollination or germination. Those who attempted a description of the process occurring after pollination usually knew that, following fertilisation, the ovule becomes the seed and the ovary the fruit. Candidates gaining full credit mentioned the growth of the pollen tube, and the passage of the male nucleus along it, before fusion with the female nucleus to form a zygote.

(b)

(i) It was well-known that fertilisers increase the growth of crops, but for further credit, a statement was required that growth is caused by the production of protein needed to make new cells.

(ii) Most candidates recognised that the field growing plant **Q** requires less nitrogen fertiliser because the plant has nitrogen-fixing bacteria in its root nodules, rather than in the soil. A few answers explained that these bacteria provide plants with nitrogen compounds, but others incorrectly cited the formation of nitrates rather than ammonium compounds.

(iii) The process of nitrate fertiliser being washed into rivers was often described well. Given reasons as to why this could harm the environment often involved vague terms such as 'pollution' or 'eutrophication'. Better answers correctly identified the production of algal blooms. Candidates often went on to describe direct removal of oxygen by the algae, rather than by the bacteria feeding on the decomposing plant material.

Question 6

(a)

(i) Downward arrows had to be drawn on the diagram to denote the flow of cold air in the refrigerator. Where a circular convection current was drawn, the cold air flow needed to be labelled to gain credit.

(ii) Candidates successfully explained why cold air sinks by describing the air, rather than the particles, as being denser; this should have been supported by the idea that the particles in denser air are closer together for full credit. Less successful explanations referred to the energy of particles causing them to spread, or to particles that move from an area of high to low concentration.

(b) There were a few examples of carefully drawn diagrams of solids and liquids, based on an understanding of their particle structure. In the best answers, solids were shown as a regular pattern of equal size circles in contact, rather than roughly drawn circles with smaller circles unnecessarily squeezed into gaps at the edges of the box. The best

answers also showed liquids as equal size circles in random arrangement, with most but not all touching.

(c) The formula for heat transfer in terms of specific heat capacity was well known though candidates sometimes did not denote *change* in temperature in the formula. Some candidates had difficulty in calculating the temperature difference between -20 ºC and +5 °C.

(d)

(i) The Ohm's Law calculation was answered correctly by most candidates.

(ii) The formula for calculating the combined resistance of lamps in parallel was usually used in the form of $1/R = 1/R_1 + 1/R_2$ or $R = (R_1 + R_2)/ R_1R_2$, but some candidates substituted into $R = 1/R_1 + 1/R_2$. A minority of candidates could not rearrange the substituted formula. Candidates were also given credit for a statement of the rule for combining equal resistances in parallel.

Question 7

(a)

(i) Some candidates supplied a description of the freeze-thaw process as an example of *physical* weathering, but irrelevant descriptions of *chemical* weathering were more common. The best answers included the role of rivers in transporting rock fragments to the sea.

(ii) Correct examples of carbon dioxide production were respiration, the decomposition of organic matter or an example, or the burning of fossil fuels or an example, but the exhaust from motor vehicles was not sufficient.

(iii) Most candidates gained partial credit for explaining the damage to ships hitting a coral reef. Some stated that the compound calcium carbonate, rather than the coral, is hard due to the strong chemical bonds in its giant ionic structure. Credit could not be awarded when there was a contradiction implied by use of the term 'intermolecular force'.

(b)

(i) It was well known that algae produce oxygen by photosynthesis.

(ii) Most identified glucose and its formula as the other product of photosynthesis.

(iii) Most candidates recognised the interdependence between algae and coral polyps but candidates needed to describe the roles of the processes of photosynthesis and respiration.

(c)

(i) Candidates could usually state that lower pH indicates increased acidity in seawater. Fewer could explain this in terms of the reaction between carbon dioxide, an acidic non-metal oxide, with water.

(ii) Ideas about how decreased pH causes damage to the coral reef were sometimes based on coral not surviving in more acidic seawater, but it was not usually clear whether reference was being made to the *living* polyps and algae or the coral reef structure. Explanations using solution in acid were attempted but the reaction with calcium carbonate was seldom included.

Question 8

(a) Most candidates received credit for knowing that oxygen is transported to cells in the blood. Many gained further credit for writing that the oxygen is carried on haemoglobin, or in red blood cells, or that oxygen moves in or out of the blood by diffusion. The use of the abbreviation RBC was not accepted, unless the full term was also used somewhere in the answer.

(b)

(i) Most answers included the fact that water in sweat evaporates and the best explained that evaporation takes latent heat from the skin. Others incorrectly implied that the heat capacity of sweat lost from the body was sufficient to cool it. Discussion of vasodilation did not answer the question.

(ii) A simple comparison between the maximum temperatures at the two running speeds was common. For further credit to be awarded the data could have been used as evidence for this statement.

(iii) An explanation of the difference in body temperature was sometimes attempted, rather than simply repeating the comparison. The best answers explained that a shortage of water reduced sweating in order to maintain the water content, or used the reverse argument that water was replenished.

(iv) Successful candidates stated that the drink replaces the lost ions. Others implied that the ions, as well as glucose, provide energy, or that the ions enable the athletes to sweat. The suggestion that energy is 'created' was not acceptable.

Question 9

(a) The formula *force = mass x acceleration* was well known and the calculation was usually set out logically with the correct units. A common error was to use the force of one engine rather than all four.

(b) Most candidates could suggest at least one reason why exposure to ionisation can be harmful.

(c)

(i) Many candidates explained the use of nitrogen in the packet as being because it is unreactive or that it prevents spoiling. The comparison with oxygen in the air which would oxidise the potato or support respiration of micro-organisms was less common.

(ii) Few candidates found the explanation for the expansion of the packet in flight easy. Comparison of the pressure *outside* the packet with atmospheric pressure rather than that *inside* the packet did not allow the argument to progress. Some candidates did mention collision of particles with the packet but then gave statements referring to 'more' or 'faster' collisions rather than their frequency. Some candidates attempted to apply Boyle's Law but a mathematical approach would only allow credit for volume increase. Less successful responses assumed diffusion into the packet or a tendency for particles to move from a region of high to one of lower concentration.

CO-ORDINATED SCIENCES

Paper 0654/33
Extended Theory

Key Message

Candidates should be reminded to take care to show working clearly, and to give formulae using correct abbreviations as listed in the syllabus. They are expected to give correct units with their answers.

General Comments

The majority of candidates showed a range of knowledge and understanding across the syllabus, including material from the supplement. Almost all of them attempted to answer all questions, and the majority communicated their responses clearly. Some candidates had difficulty in rearranging formulae.

Important information given in the question was often missed. See, for example, the comments below on **Questions 1(c)(ii)**, **2(c)** and **5(a)**. Candidates should be reminded that time spent reading the question very carefully is well spent, as it gives them a much better chance of writing a fully relevant and correct answer.

Comments on Specific Questions

Question 1

(a)

(i) Most candidates correctly drew a line from the mesophyll cell to a leaf, and from the root hair cell to part of the root.

(ii) Where candidates recognised that cell **A** contains chloroplasts and cell **B** does not, they generally went on to obtain further credit, relating this to photosynthesis or the presence of light.

(b) There were numerous excellent answers, frequently referring to the lack of genetic variation if tissue culture is used. Some candidates tried to explain in terms of the likelihood of further mutations happening, which was not credited.

(c)

(i) This was quite well answered, many candidates explaining that the farmer would not have to spend money on pesticides, or that he would get a higher yield from the crop.

(ii) Some good answers to this question were seen. Most candidates appeared not to notice that the toxin 'only kills insects that eat parts of the plant' and there were many references to killing insects in general, or other animals. Few mentioned the possibilities of harm to useful insects that do eat parts of the plant, such as pollinators. Some did recognise that there could be harmful effects in the ecosystem because of the loss of insects from the food chain, and a few correctly stated that it might be difficult for the farmer to market the crop if people did not like the idea of eating food made from genetically modified crops.

Question 2

(a) A majority of candidates correctly stated that a polymer is a long chain of monomers. Many stated that it was made of many smaller molecules joined together, but did not give the idea of a chain. Some simply gave examples of polymers, such as 'plastic'.

(b)

(i) This was very well answered. Most candidates correctly showed pairs of shared electrons, and also the unshared electrons on all four fluorine atoms. A few showed only single electrons being shared, or occasionally sets of three. Some did not show the unpaired electrons on the fluorine atoms.

(ii) This was almost always answered correctly.

(iii) A wide variety of responses was seen, of which only a small minority were completely correct. Most did show eight fluorine atoms, and many of these also showed eight hydrogen atoms, but there were frequently double bonds involved. Relatively few candidates gave some indication that what they had drawn was part of a longer molecule, for example by showing 'spare' bonds at either end.

(c) The wording of the question gave considerable guidance on how to word the answer, but nevertheless many candidates did not refer to forces between molecules. Some did recognise that the intermolecular bonds are stronger in melamine than in PTFE, but only rarely did answers go on to explain why this means that PTFE readily melts when heated.

(d)

(i) A minority of candidates were able to complete the equation correctly. Many wrote formulae for substances that do not exist, generally attempting to make the equation balance with only two products.

(ii) This question, like **(i)**, appeared to be testing material that was unfamiliar to the majority of candidates. Some gave very good answers, describing how hard water is poured through the resin, and that sodium ions from the resin go into the water while calcium or magnesium ions from the water become attached to the resin. There was confusion about which ions cause hardness, with chloride ions and carbonate ions frequently mentioned. Many described the removal of temporary hardness by boiling, while others did not appear to know the meaning of the term 'hard water'.

Question 3

(a)

(i) Most candidates gave correct answers here.

(ii) Some candidates recognised that, as the direction of the car has changed, then so has its velocity or momentum. Very few also mentioned that velocity or momentum are vector quantities; most inappropriately tried to explain in terms of the forces acting on the car.

(b)

(i) This was almost always answered correctly.

(ii) This was well done. Most candidates knew how to calculate deceleration, but some gave an incorrect unit, generally m/s or sometimes m/s^{-2}.

(iii) This also well answered. Many candidates, however, used the formula distance = speed x time, ending up with an answer twice as large as it should be.

(c)

(i) Most candidates knew the formula $R = V/I$ and used it correctly. Some got it upside down. Candidates should be reminded that formula triangles are not accepted (although candidates can, of course, use them as an aid to remembering the formula), nor formulae containing only units (for example, ohms = volts ÷ amps).

(ii) A wide variety of responses was seen here. Most used the formula $1/R = 1/R_1 + 1/R_2$, but many were then unable to add the two fractions, or forgot to turn their answer 'upside down' to obtain the final value for resistance. Some used an incorrect formula $R = 1/R_1 + 1/R_2$, or $R = R_1 + R_2$. As both resistances were the same, this opened up the possibility of using other valid methods of calculation, and these were all accepted as long as they were clearly stated

Question 4

(a)

(i) To gain credit, answers needed to state a general characteristic of drugs that is shown by caffeine, such as that it changes the way the body works, or that it affects metabolism or physiology. References to addiction were not credited and neither were specific effects of caffeine such as 'keeping you awake'.

(ii) Some very novel uses of analgesics were suggested. A small majority of candidates knew that they are used as painkillers.

(b)

(i) Most candidates recognised that the can contains calcium oxide, not calcium carbonate (limestone). Some became confused with the product, calcium hydroxide.

(ii) This was well answered. Most answers included the statement that calcium is in Group II and therefore tends to lose two electrons when it forms an ion. However, relatively few then went on to explain that this results in a charge of +2 by referring to the imbalance in numbers of positively charged protons and negatively charged electrons.

(iii) Numerous candidates attempted to do this by working out what happens to electrons when oxygen and hydrogen combine together, rather than using the information about the charge on a calcium ion and the formula of calcium hydroxide, both of which they had been given.

(c)

(i) This was another well-answered question. Most candidates correctly calculated the relative formula mass of calcium oxide and then divided this into 224. Arithmetical mistakes sometimes occurred, however.

(ii) This question proved slightly more difficult than **(i)**, but was still answered entirely correctly by many candidates. Wrong answers from **(i)** could be brought forward to here without incurring further penalty.

Question 5

(a) Many candidates did not notice the words 'visible on Fig. 5.1', and included gills as one of the features. These are not visible, although the gill cover (operculum) is, and was accepted as a feature. Both features had to be correct and visible, to obtain credit.

(b)

(i) The majority of answers correctly explained the 'external' part of this term, but most did not attempt to explain what is meant by 'fertilisation'. Candidates should remember that, if a two-word term is to be explained, then both parts of it should be dealt with. The allocation of two marks to this question was a further clue as to what was required.

(ii) A minority of candidates appreciated that the gametes would rapidly dry out on land, or that the sperm would be unable to swim to the egg.

(c) Candidates who had an understanding of how natural selection works often gave excellent answers to this question, describing how young fish whose mothers showed this behaviour would be more likely to survive, reproduce and pass on the gene for this behaviour to their offspring. Many, however, simply wrote about the fish 'needing to adapt', without any explanation of how this would occur. Others described the fish 'learning' to behave in this way.

(d)

(i) This question tested understanding of the causes of variation, in an unfamiliar context. The best answers were very simple, stating that the fish had all been kept in the same environment and so it could not be the environment that was causing the differences, leaving only genetic variation as a possible cause. Most made much more complicated attempts to suggest numerous scenarios that might or might not have occurred.

(ii) This was usually well answered, with most candidates able to make a general statement about the differences in testosterone concentration between the two groups, and often a more specific one as well, such as giving a value for this difference in one or other of the two sets of data.

(iii) This question proved to be challenging. Very few candidates recognised that a correlation between two variables, such as is shown here, does not mean that one has caused the other. Even fewer appreciated that the very small numbers of fish in the studies make it very unsafe to draw any firm conclusions from the results.

Question 6

(a)

(i) Reference to both vibrations and air particles was rare. Some answers referred to compressions and rarefactions, and this was accepted as an alternative valid description.

(ii) Many answers showed confusion about the relationship between frequency and pitch, and between amplitude and volume.

(b)

(i) This was very well answered. Most answers were entirely correct and clearly presented.

(ii) Many candidates knew the equation relating energy, specific heating capacity and temperature change, and were able to substitute correctly and arrive at the correct

answer with a suitable unit. Some did not include temperature *change* in their equation.

(c)

(i) Most candidates gave a suitable definition of 'wavelength'.

(ii) Most candidates knew the formula $v = f\lambda$, but not all were able to rearrange it to find frequency. Some had trouble with the large numbers, and some did not know the correct unit to give with their answer.

Question 7

(a)

(i) A minority of candidates recognised that these elements are all found in Groups I or II, or on the left of the Periodic Table.

(ii) This was generally answered correctly. Some candidates made the error of stating that there were 7 neutrons.

(b)

(i) Most candidates had difficulty with this question. Some correctly stated that sulfuric acid would react with the electrodes. A few recognised that hexane would not conduct, or that it does not contain ions, but such answers were very rare.

(ii) Most answers correctly placed magnesium at the top of the list, but **X** was often wrongly placed next, rather than at the bottom.

Question 8

(a)

(i) This was well answered. Wrong spellings of alveolus were not penalised, as long as it could not be confused with any other scientific term (such as ovule).

(ii) Fewer candidates answered this correctly than **(i)**. Quite a few left this blank, while others suggested veins and arteries.

(iii) Most candidates recognised that the arrow represents diffusion, but there was often confusion about which gas was moving. Some did clearly state that it was carbon dioxide, but others wrote about both oxygen and carbon dioxide, without making clear which gas was represented by arrow **Y**. Good answers also went on to explain why the diffusion takes place, in terms of a diffusion gradient.

(b) The pathway and process of movement of blood from heart to lungs was very poorly known. A few candidates correctly named the right ventricle and pulmonary artery. Very few described the role of the heart in any way other than saying that it 'pumps', without saying what does this or how.

(c) A very similar level of response was seen to this question as to **(b)**. A minority of candidates knew that both sets of muscles contract. Some were able to describe the resulting increase in volume of the lungs or the thorax, and a few went on to explain how air therefore moves into the lungs down a pressure gradient. Some wrongly wrote about concentration gradients.

Question 9

(a) Most gave a correct answer, but a significant minority thought that the time would double.

(b)

(i) This was well answered. The most common error was either a wrong unit or a lack of unit with the final answer.

(ii) The relationship between current and charge was not well known, and relatively few candidates gave a correct formula and correct answer. Many did not know the unit of charge.

(c) There were some good answers to this question, correctly describing convection currents in terms of less dense hot water rising and denser cold water falling. Some wrote about air movements, rather than water. 'Heat rises' was often seen, and not credited.

CO-ORDINATED SCIENCES

Paper 0654/04
Coursework

General Comments

(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 generally understood and applied the assessment criteria well for all of their activities. Centres are reminded to check their summary forms, as not all skills can be assessed in the same task. For example skills C1, following instructions, and C4, planning, are mutually exclusive.

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

An indication, on the script, where a mark is awarded is useful when assessing a candidates performance, as are the explanatory comments on scripts. When marking a candidate against set criteria, tick lists were informative.

(d) Good practice.

There was evidence of good practice in all the scripts assessed.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

Key Messages

- Candidates should be able to read the display of a timing device and convert the display into seconds.

General Comments

Only a very small number of candidates did not complete the paper. The level of English in the responses was generally very good and there were few instances of a candidate misunderstanding a question.

Comments on Specific Questions

Question 1

This question worked well and candidates obtained useful results. The discrepancy between the test in the Centre Instructions and the Question Paper, regarding the volume of hydrogen peroxide solution, did not affect the results.

Many candidates simply copied the display of their stopwatch or stop clock without converting to seconds as instructed. This is an essential skill which was required in all questions on this paper. Averaging of the times in **(a)(iii)** was done well, as was the completion of the table. Most candidates were able to compare the difference between the results for the fresh yeast and boiled yeast in **(b)(ii)**; fewer could explain this in terms of the enzyme being denatured by boiling. Reliability of the results in **(c)(i)** was generally well understood; some candidates erroneously tried to explain reliability in terms of fair testing. The most common errors quoted in **(c)(ii)** were associated with timing and the amount of detergent not being controlled. Other acceptable responses about errors were rarely seen and errors in measuring volumes of liquids were only accepted if accompanied by a discussion of the accuracy of the scale of the measuring device. Part **(d)** required the candidates to design a similar investigation varying the temperature. Answers were vague and were not specific enough in most cases. It is important to state amounts of chemicals used and what must be kept constant to ensure a fair test, as well as giving detail of the variable and a method for measuring the rate.

Question 2

The order of decomposition of the three carbonates varied from Centre to Centre but the mark scheme allowed for this and candidates were in no way penalised. Recording of the time for decomposition was an issue in some cases as in **Question 1** and a small number of candidates recorded the changes in the limewater rather than any colour change to the carbonate as instructed. Parts **(a)(iv)** to **(b)(ii)** proved straightforward for most and better candidates were able to comment on the relationship or lack of relationship between the two lists in **(a)(iv)** and **(b)(ii)**. Due to unreacted acid in **(c)(i)**, it was necessary to add plenty of dilute sodium hydroxide to obtain a blue precipitate. Many candidates obtained a blue precipitate and then recorded it in an inappropriate way, such as “blue mass” although they often mentioned a blue precipitate as

evidence in **(c)(iii)**. The displacement reaction in **(c)(ii)** worked well, allowing many to use the brown colour on the zinc as a piece of evidence for the identification of copper in **(c)(iii)**.

Question 3

The majority of candidates produced all fifteen results in the results table. Recording of the time for 10 oscillations was an issue in some cases as in **Question 1**, resulting in marking point 5 in **(a)** not being awarded. In addition many candidates gave the time to hundredths of a second when the instruction in **(a)(i)** told the candidates to record the time to 0.1 second. Averaging of the time for 10 oscillations was generally well done. The calculation of the period, **T**, only required the average to be divided by ten; many candidates produced odd answers here and there were a number of rounding errors too. The relationship between the period and the angle of swing was commented on sensibly. Candidates were less confident in explaining that the relationship was not proportional although it was very encouraging that some suggested that the angle of swing divided by the period was not a constant value. The calculation in **(c)** was not carried out as well as expected: the main errors were the use of 30 cm instead of 0.30 m for the length, using a length not equal to 0.30 m, not squaring the period, **T**, or not rounding the value of $\mathbf{T^2}$ appropriately. Very few candidates were able to give the units for **g**. In **(d)(i)**, most candidates understood the reason for timing 10 oscillations rather than 1 oscillation and often went on to describe a timing related error for **(d)(ii)**. Giving the length of the pendulum as an error in **(d)(ii)** needed a qualification in terms of the pendulum bob and this was rarely seen. Measuring the angle of swing was accepted as an error; the method for the reduction of this error needed to be a check with a plumb line rather than simply the use of another pin.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

Key Messages

- Candidates should be prepared to use their results and calculations to describe and explain general conclusions.

General Comments

Only a very small number of candidates did not complete the paper. The level of English in the responses was generally very good and there were few instances of a candidate misunderstanding a question. Measurements were made to a suitable level of accuracy and graph plotting was usually well done.

Comments on Specific Questions

Question 1

Candidates were expected to be able to read the display of a timing device and convert the display into seconds. Calculations of volumes and ratios generally presented no difficulties; a few candidates did not calculate the ratios as instructed. Many understood that the acid had neutralised the alkali but fewer included diffusion in their answer. In **(a)(v)** candidates were expected to use the results and calculations in **Table 1.1** to describe and explain the relationship between volume and time. There was some confusion between time and speed with frequent use of the phrase *faster time*. *Faster speed* was allowed as an alternative to *lower time*. In **(b)** candidates found it difficult to apply their findings in **(a)** to the theoretical question about absorption of food. In **(c)** it was common for answers to state what would happen rather than to describe an appropriate experiment which should have included the variable, constant factors and what would be measured.

Question 2

Test **(a)** worked well to give ammonia gas in the majority of cases. Two marks available for the conclusion should have alerted candidates to identify the gas and the ion from which it came. Tests **(b)(i)** and **(b)(ii)** required careful addition of the reagent to produce a precipitate before it dissolved in excess reagent. Descriptions of the precipitate as *milky* or *cloudy* were not accepted, especially as the correct terminology is given in the Chemistry Practical Notes on the last page of the Question Paper. However such descriptions did not prevent candidates from being awarded credit for identifying zinc as the ion. The same marking system was applied to **(b)(iv)** and **(b)(v)**, which were well done. Surprisingly many candidates were unable to convert their conclusions into the names of the two salts. Often two zinc salts or two ammonium salts were given. Sometimes the name of a cation and an anion were given and, if correct, this was awarded credit; two cations or two anions were not credited.

Question 3

This exercise required perhaps greater precision than many practicals. Consequently it was relatively rare to see outstanding sets of results. There were many examples of sound results and this allowed most candidates to plot good graphs. The reading with an angle of incidence of 80^o was the most challenging one and in some cases this resulted in too low a displacement which had an effect on the value of d_{90}. There were very few graphs with non-linear axes although several candidates did not allow for the extrapolation to 90^o when constructing the vertical scale for displacement. The instructions made it clear that candidates should draw the best curve through their points and many did this; some drew straight lines which were not credited and others drew a series of curves which were credited if the points had sufficient spread to justify this. It was felt that this was fair as candidates would not know the relationship between the angle of incidence and the displacement. Extrapolation was usually carried out competently and only in some cases was the extrapolation "forced" to give a particular value of d_{90}. The width of the block was sometimes given in cm rather than mm and sometimes the thickness of the block was recorded. In **(b)(v)** this calculation was marked according to the candidate's value of d_{90} and w only. There was no penalty at this stage for percentages well below or well above 100 %. The most common sources of error quoted were the 80^o reading being hard to carry out and lining up of the pins being difficult. Vague answers describing bent or leaning pins were only credited if they also stated that this would make lining up of the pins inaccurate. Candidates rarely produced a method by which to reduce their stated error.

CO-ORDINATED SCIENCES

Paper 0654/53

Practical Test

Key Messages

- When drawing an object, it is important to use a sharp pencil, pay attention to the view required and label parts of the diagram as instructed.

General Comments

The majority of candidates completed this paper and tended to score most highly in the Physics exercise.

Comments on Specific Questions

Question 1

Most candidates observed bubbles in **(a)(i)** but often did not state where they were coming from or what had caused them. Part **(a)(ii)** was done quite well; a number of candidates labelled all partial squares with a **P,** contrary to instruction, and some did not label the squares at all but this did not prevent them from obtaining credit. Most multiplied the surface area from **(a)(ii)** by 10 instead of 100 to convert to mm^2; however this did not prevent them from obtaining credit for multiplying by 100 (stomata per mm^2). The explanation for the lower number of stomata on the upper surface of the leaf was not well known and understood.

The quality of the drawings for **(b)(i)** varied enormously and many were not of the cross-section. Those who drew cross-sections generally showed the xylem bundles but rarely labelled them as such. Description of experiments should include what is done (in this case placing the celery in red dye) with amounts if appropriate, what is measured, how it is measured and how the results are processed. This was rarely seen and most candidates tried to explain what would happen.

Question 2

In **(a)(i)** a wide range of responses were given and blue litmus remaining blue was often explained as carbon dioxide being alkaline. Those who observed blue litmus turning red probably allowed hydrochloric acid spray to come into contact with the litmus paper. Universal Indicator gave a wide range of colours in this question and, guided by the Supervisors' results, due allowance was made for this. Very few candidates realised that their observations were typical of a weak acid. The reactions with limewater worked well, with many candidates recording the correct observations in **(b)**. Repeating the experiment with Universal Indicator present produced the expected range of colours; candidates found it difficult to link these colours to conclusions about neutralisation and acidity, as well as to the formulae in **(c)(ii)**. That the lighted splint was extinguished by carbon dioxide was observed by most candidates.

Question 3

This question, which required a large amount of manipulation of circuits and wires, as well as reading of meters, was carried out relatively well. It was rare to see incomplete tables and the number of decimal places used was usually appropriate. In **(a)** some candidates used 0 volts and 0 amps for the fifth reading. This was allowed; however the candidate could not then use the calculated resistance of 0 ohms in the calculation to find the average resistance. In the resistance calculations, there were some poor rounding of answers. Part **(b)** generally produced data good enough for graph plotting. Most candidates used the vertical axis of the graph for resistance, and scales had been chosen to make use of over 50 % of the grid. Common errors were to omit the units for resistance and to plot points incorrectly. Suitable extrapolation was exhibited in most cases; the value of resistance for 5 parallel wires was not always read correctly which links to the problems that some candidates experience reading scales. Many understood **(d)** and referred to the closeness of the resistances in **Table 3.1** to decide whether repeats should have been carried out for all of the experiments.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key Message

This paper is firmly associated with experience at the laboratory bench so candidates need to be able to demonstrate practical skills.

General Comments

Many candidates demonstrated their practical knowledge. Others showed poor appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. Candidates need to be reminded to read each question carefully; otherwise they may use incorrect units or give irrelevant information in their answers.

The number of significant figures is an area where candidates need to consider their answer, in general it should be the same as in the question or table, so, if 1.75 was already in the table all other answers should be similar e.g. 2.40 or 2.00. Zeros are important as they are a sign of accuracy. Rounding must also be correct; the calculator readout of 1.666666666 may be written as 1. 667, 1.67, 1.7 or even 2, depending on the precedent, but never as 1.66 or 1.6.

Comments on Specific Questions

Question 1

(a)

(i) Most candidates correctly converted the time to seconds.

(ii) Many identified the gas as oxygen.

(iii) Given the closeness of the times an answer of 57.67 or 57.7 was expected.

(iv) Many candidates realised that the enzyme had been denatured, expressions such as the enzyme was 'killed' or 'was not working properly' were not credited.

(b)

(i) Answers suggesting that the liver had not been heated thoroughly or that not all the enzyme had been denatured were credited.

(ii) Surface area of the liver, volume of detergent used or concentration of hydrogen peroxide solution were credited.

Question 2

(a) The reading of the stopclock dials and the subsequent listing of carbonates in their speed of decomposition were both done well.

(b)

(i) The minimum required for the diagram was a funnel with a filter paper lining and a receptacle of some kind to catch the filtrate. Some candidates diagrams had a piece of filter paper hanging in mid-air with no funnel to support it. A significant minority drew distillation apparatus.

(ii)(iii) Candidates familiar with chemical analysis had no difficulty in identifying copper and its compounds. Some candidates appeared to have little laboratory experience and gave incorrect answers.

(c) A number of candidates drew the bubbles above the level of the liquid rather than from the metal; however credit was given if the correct comparisons were stated.

(d) The question asked if the reactivity of the metals could be used to predict the speed of thermal decomposition of the carbonates, many candidates said 'no' instead of noting the inverse relationship; the more reactive the metal the slower the decomposition of the carbonate.

Question 3

(a) Candidates were required to read protractors for three angles and transfer them with the corresponding times to a table. Most candidates did this correctly however some ignored the labelling of the angle to be measured and read the protractor incorrectly. The times recorded were for ten swings, the final row of the table required these numbers to be divided by 10 to find the time for one swing. Most candidates did this correctly, but a significant number had answers that Examiners were unable to work out how they were calculated. Candidates are reminded that they should show their working. Most candidates then went on to calculate the average for their figures.

(b) The times in the table showed no pattern and were all within expected experimental error. Some candidates tried to see patterns that were not there.

(c) Most candidates realised the need to repeat the experiment to make the result more reliable, but taking the average was also required.

(d) Candidates had to convert the length of the pendulum, in centimetres, to metres. Although most candidates did this correctly, some candidates gave an answer of 30 000 m.

(e) The acceleration due to gravity was calculated using a formula supplied. Most candidates did this, although some did not square the denominator value shown by the formula.

Question 4

(a) Brown and blue / black were well known, although some candidates wrote these in the incorrect order.

(b) After reading the stopclocks candidates had to plot a graph on a grid with the scales already chosen and axes labelled. Most graphs were plotted correctly and smooth curves drawn as instructed. Some candidates drew a straight line or a series of straight lines and these were not credited. The enzyme was most active when the time was the lowest, a pH range of 6 to 7.

(c) Two improvements to the experiment in order to find a more accurate pH value were asked for. Answers that suggested taking readings more frequently, for example every 10 seconds, and using pH values between 6 and 7, for example 6.5 were credited with the explanation that either improvement would allow narrowing down the endpoint.

Question 5

(a) Some candidates could not picture what would happen if a gas-jar of soluble gas was opened in water as shown in the diagram. The expected answer, that some of the water would rise up the gas-jar, was not often seen. The explanation of resulting pressure difference being responsible was rarely seen.

(b) Use of an indicator to identify acidic and alkaline gases was reasonably well known, but as there are a number of indicators, any colours given for an unnamed indicator cannot receive credit. Similarly red litmus paper turning blue is acceptable as a test for an alkaline gas; red litmus staying red will not test for acidic gases as neutral substances would not change the colour either.

(c)(d) The tests for oxygen and hydrogen are reasonably well known, but it must be a glowing splint for oxygen and a lighted splint for hydrogen.

(e) By careful study of the original key, more able candidates could name ammonia and sulfur dioxide.

Question 6

(a) Candidates had to measure the lengths of two pieces of resistance wire. Most candidates gave correct answers within the required +/-0.1 mm tolerance.

(b)

(i) Almost all candidates knew that the ammeter should be in series and the voltmeter in parallel.

(ii) Most candidates were able to correctly read two analogue dials showing voltage and current, however a significant number gave 0.45 V instead of 4.5 V.

(iii) Candidates had to remember that resistance is found by dividing the voltage by the current, or they may have worked it out by looking at the example given, either way, this question presented few problems.

(c) Candidates answers indicated that they were sometimes confused by the comparative resistances of thick and thin wires, and long and short wires. Candidates should be aware that the thinner and longer the wire a greater resistance.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key Message

This paper is firmly associated with experience at the laboratory bench so candidates need to be able to demonstrate practical skills.

General Comments

Many candidates demonstrated their practical knowledge. Others showed poor appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. Candidates need to be reminded to read each question carefully; otherwise they may use incorrect units or give irrelevant information in their answers.

The number of significant figures is an area where candidates need to consider their answer, in general it should be the same as in the question or table, so, if 1.75 was already in the table all other answers should be similar e.g. 2.40 or 2.00. Zeros are important as they are a sign of accuracy. Rounding must also be correct; the calculator readout of 1.666666666 may be written as 1. 667, 1.67, 1.7 or even 2, depending on the precedent, but never as 1.66 or 1.6.

Comments on Specific Questions

Question 1

(a)

(i) A significant number of candidates did not convert the readings to seconds even though the instruction, in seconds, was emboldened.

(ii) Most candidates understood that neutralisation had taken place, but very few mentioned that the acid had to travel into the block.

(iii) Using the volumes and surface areas already in the table candidates were given a formula to calculate the surface area to volume ratio. Candidates were expected to use this formula, and give the answer as a decimal number.

(iv) Most candidates noted that the time similarly decreased, but few explained that the distance the acid had to travel was less.

(b) Candidates had to use the practical results obtained to explain the role of diffusion in the real world of the human ileum, a diagram was provided to remind them of the structure of the villi in the ilium. A number of points were credit-worthy; a large blood supply, thin cell walls, a large surface area, the large number of villi present and the diffusion distance being small.

Question 2

(a)(b) The tests described in **Question 2** are standard chemical analysis tests, and it is expected that candidates have experience of carrying them out in the laboratory. A significant number of candidates described unlikely colours and gave unlikely outcomes. Candidates should be aware that ammonia is an alkaline gas that turns red litmus blue and that zinc ions will form a white precipitate with aqueous sodium hydroxide that dissolves in excess. The standard tests for sulfate ions with acidified barium chloride solution and chloride ions with acidified aqueous silver nitrate should also be known.

(c) Candidates had already been informed that zinc ions and ammonia, hence ammonium ions were present, but most were unable to name these.

(d) Very few candidates were able to give the correct equation using standard chemical symbols.

Question 3

(a) Candidates were required to measure distances and angles on the diagram; almost all candidates measured accurately. There were a small minority who did not appear to have the equipment to do this.

(b) Examiners note that graph plotting is a skill that has been mastered by most candidates. Errors of plotting are few and far between, but some candidates are not correctly labelling axes or supplying units. When asked to show on the graph how a value was obtained, candidates are reminded to draw proper construction lines.

(c) Many candidates completed the sentence with the required word, width. Some candidates gave actual values, and this often meant the sentence then made no sense when read.

Question 4

(a) Candidates were required to measure the field of view of a microscope. A ruler was shown and had to be used. Some candidates incorrectly used their own ruler.

(b) Candidates drawing more than one cell did not receive credit. Some candidates added features not visible in the original figure, and this was also not creditworthy. Some incorrectly copied the cell diagram from part **(c)**. Subsequent calculations were well done by many candidates.

(c) Given a diagram of a cell, candidates were asked to label a structure not in an onion cell. Most were able to identify a chloroplast and gave the correct reason, onion cells do not photosynthesise, for their absence. Similarly many identified the vacuole as being the structure present in onion cells but not visible in the earlier figure.

Question 5

(a) Some candidates did not name an indicator that could be used to investigate the neutralisation of sodium hydroxide by fruit juices. Incorrect answers of sodium hydroxide, iodine and Benedicts were the most common seen. Universal Indicator was not allowed as it has no distinct end point. Litmus, methyl orange and phenolphthalein were the most common accepted answers. Many did not name sodium citrate as the name of the salt produced.

(b) Candidates were shown three burettes with the level of acid remaining shown, and had to read off how much acid had been used. Following some simple calculations candidates were asked to put the fruit juices in order of the amount of acid they contained and this was carried out well.

(c) Two values were required, the volume of juice used and the concentration of the sodium hydroxide solution. The words volume and concentration were required in the candidates answers to gain credit as the word ‘amount’ is too vague and imprecise.

Question 6

(a) Four metals were heated and the expansion measured. Candidates had to read scales and complete a table; most did this correctly.

(b) Candidates had to explain why the expansion of the bar is actually one tenth of the value on the scale. Candidates had to realise that when the zero adjuster moves 1 mm, the scale will move 10 mm, or that the pointer arm is 10 times as long as the zero adjuster arm, and that movement of the pointer is 10 times larger.
Candidates who did not score here could still gain credit in part **(ii)**. As the scale read in cm was ten times the actual increase then the same numerical value, but now in mm, gives the expansion.

(c) The order was well understood by stronger candidates, however some weaker candidates did not realise that 0.07 is smaller than 0.1.

(d) Most candidates realised that particles vibrate in a solid, but few could explain that heating gives energy to the atoms thus they collide with each other more, thus pushing the particles further apart.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key Message

This paper is firmly associated with experience at the laboratory bench so candidates need to be able to demonstrate practical skills.

General Comments

Many candidates demonstrated their practical knowledge. Others showed poor appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. Candidates need to be reminded to read each question carefully; otherwise they may use incorrect units or give irrelevant information in their answers.

The number of significant figures is an area where candidates need to consider their answer, in general it should be the same as in the question or table, so, if 1.75 was already in the table all other answers should be similar e.g. 2.40 or 2.00. Zeros are important as they are a sign of accuracy. Rounding must also be correct; the calculator readout of 1.666666666 may be written as 1. 667, 1.67, 1.7 or even 2, depending on the precedent, but never as 1.66 or 1.6.

Comments on Specific Questions

Question 1

(a)

(i) Many candidates correctly identified the bubbles to be made of oxygen or carbon dioxide and that they were passing through the pores or stomata, fewer however mentioned that the heat from the water was making the gas expand thus being forced out.

(ii) It was evident from the answers written that some candidates had not followed the instructions and therefore had difficulty in telling which squares had been counted and which not.

(iii) Many candidates were unable to correctly convert cm^2 to mm^2.

(iv) Candidates who wrote answers relevant to stomata and water loss gained credit, for example the upper surface is hotter, in direct sun, with more wind movement, it is less humid, there is more water loss, therefore more wilting. References to photosynthesis were not credited.

(b) The xylem was shown as a series of circles, but many candidates shaded other areas leaving the circles blank. Candidates are reminded that while perfection is not expected, care is required when drawing or annotating diagrams.

Question 2

(a) Many candidates were able to give the colour change from green to yellow / orange, however some did not read 'weak' and gave red as the end colour. Few were able to name the acid as carbonic.

(b)

(i)(ii) When carbon dioxide is bubbled into limewater a white precipitate forms; as more gas is bubbled through, the precipitate disappears and the liquid becomes colourless. It appears that few candidates have witnessed this reaction as even though the equations were given later on in the question, only a small number gained credit for this part.

(iii) The state symbols are well known to many. No credit was given when 'liquid' was given for the symbol **(aq)**. Others incorrectly gave answers such as 'gram' and 'sulfur' for **(g)** and **(s)** respectively.

(iv) Given the information in the question, very few candidates completed the sentence using the word 'precipitate'.

(c) The two correct statements, **B** and **C**, were identified by most.

Question 3

(a) Candidates were required to read ammeter and voltmeter dials and to calculate the resistance produced when 1, 2, 3 and 4 wires were connected in parallel. This was done well by most candidates.

(b)

(i) Some candidates did not label the graph axes. Point plotting was almost always accurate, but when asked for a smooth curve, some candidates drew straight lines and were not awarded credit.

(ii) To find the resistance of five wires candidates had to extend their graph and read off the value; although one or two candidates produced unlikely extrapolations, most did this correctly.

(c) Most candidates realised the need to repeat the experiment to make the result more reliable, but taking the average was also required.

Question 4

(a) As explained in the general comments above the value for 1 / time for 55 °C should be recorded as 0.50 and not 0.5.

(b) A grid already labelled was supplied for candidates to plot a graph. The plotting of points was done accurately. This graph was unusual as some of the points were far from each other, Examiners therefore accepted curves that were far from ideal, but extra thick lines or graphs drawn with more than one line were rejected. There was a very obvious high point; the optimum temperature of 50 °C. When asked to explain why they could not be sure that this was the optimum temperature, the expected answer of not knowing the rate either side of 50 °C, was not always seen.

(c) Many candidates could not explain why the results between 35 and 45 °C were increasing and why they were decreasing between 55 and 60 °C. An answer relating to particle theory; particles gaining (kinetic) energy, moving faster or there being more collisions and enzymes being denatured at higher temperatures was expected.

(d) It was suggested that two further test-tubes should be set up. From the answers given candidates had not checked what was in the original test-tubes or did not appreciate what the experiment was trying to show. Test-tube **1** was to check if acid was required for the reaction to occur and test-tube **2** was to see if the pepsin was necessary.

Question 5

(a)

(i) Any suitable solvent received credit; water, ethanol, propanone etc., but not any acid.

(ii) The volume of liquid added should not cover the spots of ink on the start line; many lines were seen well above this at the very top of the paper.

(iii) Many candidates incorrectly wrote about 'things' entering the container, rather than the problem of the solvent evaporating.

(iv) Times suggested by candidates were often far too short, answers above 30 minutes were accepted.

(b) There were many acceptable conclusions that candidates could use when comparing the pairs of inks, and most candidates gained some credit.

(c) Many candidates did not answer this question in the way expected, but they were able to gain full credit for their answers. The expected answer was to cut the spot out of the paper and add hydrochloric acid to it, look for a colour change then add sodium hydroxide and look for a different colour change. Most candidates expected the spot to turn red in acid and blue in alkali even though many other indicators have different colour changes.

Question 6

(a) to (d)

Candidates had to construct lines on the diagram, measure them and calculate the refractive index of fresh water and salty water. Candidates that followed instructions and measured accurately received credit in these parts. Some candidates misread the instructions, and then drew incorrect lines. These candidates were able to gain some credit if their calculations were correct. Some candidates had difficulty in measuring both their lines and the pre-drawn one.

(e) Due to refraction, light is bent away from the normal as it leaves the surface of the water so the fish is deeper than the bird sees it and so it has to aim below where it appears. In salty water as the refractive index is greater than in fresh water and the bird has to aim even deeper. A large number of candidates incorrectly stated that the light was entering the water from the bird to the fish.