CO-ORDINATED SCIENCES

Paper 0654/04
Coursework

General Comments

This was the last examination series in which Coursework was available, and there were few entries.

Coursework assessment involves identifying activities that involve learners in developing and demonstrating their abilities in each of the components of AO3, Experimental skills and observations. Learners are assessed against the criteria in the syllabus, and given focused, individual feedback on their performance. This helps them to identify what they can do to improve their skills within each area. This approach, assessment for learning, will continue to be of great value for learners who enter for Paper 5 (Practical Test) and Paper 6 (Alternative to Practical).

There is also considerable benefit in the use of relatively unstructured tasks, where learners are required to make decisions for themselves rather than following a series of numbered steps. This approach encourages a deeper understanding of various aspects of practical work, such as planning experiments involving variables, deciding what to measure and how to record and display results, drawing conclusions and evaluating the reliability of results. Learners who have had this type of experience will be well prepared for Paper 5 and Paper 6, as well as developing a secure foundation in experimental skills on which they can build beyond IGCSE.

CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General comments: Biology

Only one question proved to be a demanding test for candidates, and even that fell well within the capabilities of the more able. There was, perhaps, some evidence of rushing into an answer without sufficient thought.

Comments on individual questions: Biology

Question 1

It may be that some of the candidates took a (false) clue from the wording of the question that referred to the plant *growing* in Central and South America, since they then suggested that its behaviour demonstrates 'growth and sensitivity' (option B). However, a few of those candidates were otherwise especially competent on the rest of the paper.

Question 4

Perhaps predictably, the most common error was to confuse the venae cavae with the arteries. Less predictably, a few of the more able candidates thought that the aorta and the pulmonary vein are both arteries, and this may be to do with their knowledge that both carry oxygenated blood.

Question 7

Able candidates with the appropriate knowledge had no problem with this question, but many others guessed.

Question 8

There was clearly some difficulty in deciding whether the diagram showed a motor or a sensory neurone, and quite a few candidates were unable to make the correct identification.

Question 10

The clue was in the question with a reference to the offspring being genetically identical. The fact therefore that reproduction could only have been asexual was missed by a number of candidates.

Comments on individual questions: Chemistry

Question 14

Some of the more able candidates thought that helium exists as molecules, rather than as isolated atoms.

Question 15

It appears that some of the more able candidates had misunderstood what is meant by *volatility*, and in particular what the relationship is between volatility and boiling point.

Question 17

Option C was chosen more often than the key, D. While candidates did know the name for the negative electrode, it seems that they either did not know name of the gas, chlorine, produced at the positive electrode or they did not recall that the effect of this acidic gas on damp litmus paper is to bleach it.

Question 20

A few of the more able candidates apparently thought, for no understandable reason, that both metallic oxides and non-metallic oxides are basic.

Question 24

The majority of candidates answered this question correctly. It is clear that candidates know the properties of aluminium.

Question 25

The majority of candidates answered this question correctly. It is clear that candidates understand the conditions required for rusting.

Question 26

Option D was chosen more often than the key, B. Whilst candidates, particularly those with more ability, recognised that lime is formed from limestone by thermal decomposition, is seems that they considered this high temperature process to be exothermic, rather than endothermic.

General comments: Physics

In the physics section only **Question 35** proved to be a challenging question. No questions were found to be particularly easy.

Comments on individual questions: Physics

Question 30

Although a majority of candidates answered this question on distance/time and speed/time graphs correctly, a significant number chose option C, either confusing the information given in each graph or misreading the axis labels.

Question 32

The topic here was the effect of additional thermal energy on the volume and temperature of a gas. Candidates were generally very clear that the temperature would increase, but many did not think that the volume would also increase (since the pressure remained constant). It is always possible in questions such as this that some candidates believed that the choices in the two columns must be different, and it would be worth advising them that this is not always the case.

Question 33

The most able candidates scored well in this thermal energy transfer question, but others appeared to resort to guessing.

Question 35

The majority of candidates had difficulty with this question on critical angle, with both options A and C being more popular than the correct option B.

Question 36

Despite the bold font used to emphasise the word 'difference' here, option B was frequently chosen.

Question 38

Many candidates confused the parallel connection shown with a series connection, simply adding the two values and therefore choosing option D.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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

General comments: Biology

All but one of the questions in the biology section of the paper were correctly answered by the majority of candidates, and the correct answer to one that was not (**Question 5**) was still answered correctly by quite a few candidates – many of whom also performed ably on the rest of the paper. In general, candidates showed a high level of competence based on a sound knowledge of the subject matter.

Comments on individual questions: Biology

Question 5

There was a good deal of information to process in this question before arriving at the correct answer. A significant number failed, being unable to appreciate that, in the dark, stomata will close, and being enclosed will increase humidity – both of which will decrease transpiration. It suggests that those candidates had not realised that the loss of mass referred to would be the result of water loss.

Question 8

There was clearly some difficulty in deciding whether the diagram showed a motor or a sensory neurone, and quite a few candidates were unable to make the correct identification.

Question 11

This question tested simple knowledge of flower structure, and this is a topic with which candidates traditionally struggle. It was therefore not surprising that a number of candidates felt that it is the petals rather than the sepals that protect the flower when it is in bud.

Question 13

Candidates correctly know that methane is a gas that pollutes the atmosphere. To suggest that it is the result of deforestation (the most popular of the incorrect answers) represented a train of thought that indicated a serious misunderstanding of the causes of pollution.

Comments on individual questions: Chemistry

Question 14

It is clear that candidates understand chromatography well, the properties of Group I metals, how to deduce a reactivity order from experimental evidence and the conditions required for rusting.

Question 19

The majority of the more able candidates recognised that the speed of the reaction could be determined by collecting and measuring the volume of gas produced over time. However, they failed to consider that gases have measurable weight (mass), and that the change in weight (mass) can be used to determine the speed of the reaction.

Question 20

Some of the more able candidates thought that cooling the solution would reduce its volume, which it does but only by a very small amount. However, in the context of crystallisation, it is expected that candidates should understand that the solution is heated to reduce its volume significantly in order for crystallisation then to occur.

Question 22

It is clear that candidates understand the properties of Group I metals well.

Question 24

Candidates understand how to deduce a reactivity order from experimental evidence.

Question 25

Candidates correctly knew the conditions required for rusting.

General comments: Physics

In the physics section no questions proved to be too difficult. **Question 30** was found to be particularly easy.

Comments on individual questions: Physics

Question 30

Very few candidates were unclear about which energy source was renewable.

Question 31

This question was about evaporation. Although the great majority of candidates knew that it is the more energetic molecules that escape, quite a few thought that this had no effect on the temperature of the remaining liquid.

Question 33

The most able candidates scored very well in this thermal energy transfer question, but others appeared to resort to guessing.

Question 38

A number of responses were correct in this question about fuses. Candidates were generally aware of the purpose of a fuse, but a significant number believed that the fuse rating had to be higher than the maximum current that could safely be carried by the cables.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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

General comments: Biology

All questions in the biology section fell within the scope of the majority of the candidates. The two most difficult ones contributed well to distinguish between candidates of differing abilities.

Comments on individual questions: Biology

Question 1

For most candidates, this question became very largely a straight choice between whether the nucleus of a plant cell is found in the cytoplasm or in the vacuole. Almost as many opted for the vacuole as selected the cytoplasm, but it was significantly the better candidates who made the correct choice. It may therefore be the case that the less able were under the impression that the central part of a plant cell contains cytoplasm.

Question 2

Although this proved to be by far the easiest question in the biology section of the paper, it still required an understanding of the terminology used, and the ability to interpret the graph and candidates are to be congratulated on so many being able so to do.

Question 4

Perhaps predictably, the most common error was to confuse the venae cavae with the arteries. Les predictably, a few of the more able candidates thought that the aorta and the pulmonary vein are both arteries, and this may be to do with their knowledge that both carry oxygenated blood.

Question 7

There is a common confusion over the processes of photosynthesis and respiration in a plant (and exactly which of these is occurring and when). Apart from the relatively implausible suggestion that alcohol may be produced, the remaining options all received strong support with the greatest support being for the production of oxygen in the light, i.e. for an answer that referred to photosynthesis rather than to respiration as asked.

Question 9

Virtually all candidates knew that adrenaline increases pulse rate, but its effect on blood glucose was less well known.

Question 13

Perhaps the word ‘natural’ in the question led candidates to suggest, incorrectly, that natural gas is a renewable commodity.

<u>Comments on individual questions: Chemistry</u>

Question 14

It is clear that candidates understand chromatography well.

Question 19

The more able candidates knew the products of the electrolysis of dilute sulfuric acid. Other candidates knew the identity of one product, hydrogen, but not the other (oxygen).

Question 22

It is clear that candidates understand the properties of the Group I metals.

Question 23

It is clear that candidates understand the use of inert gases. A few of the more able candidates recognised that option D represented a gas, but failed to recognise that this gas is a Group VII gas, not a Noble gas.

Question 24

Candidates understand how experimental evidence can be used to determine an order of reactivity for metals. A few of the more able candidates chose option A, identifying the correct order of reactivity of three metals but confusing the order of reactivity of copper and of iron.

Question 26

Candidates clearly knew that lime is formed from limestone by thermal decomposition. However, the chemical name for lime, calcium oxide, was not so well known, particularly amongst the more able candidates.

General comments: Physics

In the physics section **Question 34** was a challenging question; no questions were found particularly easy.

Comments on individual questions: Physics

Question 28

Although the great majority of responses to this question on a speed/time graph were correct, several candidates chose option B, apparently discounting the steeper gradient of section RS, possibly because it was negative.

Question 32

The most common error here was to choose option A. These candidates possibly misread the question and chose the two methods of thermal energy transfer that are *prevented* by a vacuum.

Question 34

Candidates were asked to choose a suitable position to place an object so that a converging lens would produce an enlarged image on a screen. Only a minority of candidates knew that this should be between one and two focal lengths from the optical centre of the lens.

Question 35

More candidates thought that grills used microwaves and that infra-red was used for sending telephone messages than chose the correct option B. The first of these is an everyday application of infra-red and the second is a specific example from the syllabus; these are often tested.

Question 36

This straight recall question about the range of human hearing led to many choosing the correct answer.

Question 38

The most common error here was to divide the current by three, as for a parallel arrangement, and so choose option B.

CO-ORDINATED SCIENCES

Paper 0654/21
Core Theory

Key message

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

Some candidates were not able to gain full credit due to misinterpretation of the question. Candidates should take notice of command words such as *name*, *state, define, describe* and *explain* in deciding what response a question requires. This is particularly the case for questions asking candidates to *describe* or *explain* phenomena.

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. There was a good range of marks on most questions. Candidates generally scored on all questions. Few gained no marks on any question but very few gained full marks on any question. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depended not only on scientific knowledge but also on the ability of the candidates to understand the question and express themselves clearly.

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

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

When drawing or labelling diagrams, candidates should be reminded to take care to use the correct labels and draw clear labelling lines.

A number of candidates wrote down a correct answer and then crossed it out and replaced it with a wrong answer. This was a common problem throughout the paper.

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.

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

Comments on specific questions

Question 1

(a) (i) Many candidates were able to correctly identify nitrogen and oxygen as the two gases.

(ii) Few candidates gained full credit. Either they were able to make a general comment about the variation, or they were able to quote some quantitative information. Responses from candidates were sometimes inaccurate. For example candidates referred to changes happening in the year 2000 rather than changes happening between 1800 and 2000.

(b) (i) Respiration was well known as the process releasing carbon dioxide into the atmosphere.

(ii) Photosynthesis was less well known as the process removing carbon dioxide from the atmosphere.

(c) (i) Few candidates knew the effect of large scale deforestation on the carbon dioxide concentration in the Earth's atmosphere.

(ii) More candidates knew the effect of burning fossil fuels on the carbon dioxide concentration in the Earth's atmosphere.

(d) Many candidates gave two undesirable effects of global warming.

Question 2

(a) (i) Few candidates identified both test-tube **C** and hydrogen gas.

(ii) Very few candidates identified both test-tube **B** and carbon dioxide gas.

(iii) No candidate was able to identify silver chloride as the white solid produced in test-tube **D**.

(b) (i) Most candidates only gained partial credit for describing a catalyst as a substance that speeded up or altered the rate of a chemical reaction. Few candidates were able to explain that the catalyst was used up or permanently changed in the reaction.

(ii) The numbers of neutrons and electrons were correctly determined by many candidates.

(iii) The transition metals were not well known as the collection of metals in the Periodic Table to which vanadium belongs.

(c) (i) Some candidates correctly determined the formula as SO_3. A number suggested S_3O_9.

(ii) This was not well answered. A number of candidates appeared to be trying to explain that box **Y** contained molecules that had already been oxidised rather than molecules that were oxidised in the reaction vessel.

Question 3

(a) (i) The idea that the water in kettle **B** had expanded was not well known. A number of candidates incorrectly referred to the water particles expanding.

(ii) More candidates were able to explain that the difference in the water volumes between kettles **B** and **C** was due to some of the water boiling away or evaporating.

(iii) The definition of boiling point was not well known.

(iv) Many candidates knew that diagram **B** represented water and diagram **C** represented water vapour but few candidates could explain this.

(b) Convection was not well known as the method of energy transfer through the water in the kettle.

(c) The calculation was completed correctly by many candidates, who showed good data handling skills. The unit of resistance was also well known.

(d) Many candidates gained partial credit here, although very few gained full credit. Many knew what happened to the fuse but not why it happened.

Question 4

(a) (i) A number of candidates stated that asexual reproduction involved only one parent, but fewer mentioned that the offspring were identical.

(ii) **Aa** was quite well known as the genotype.

(b) (i) Few candidates gained full credit here. Xylem as the second answer was the commonest correct term.

(ii) The idea that the plastic bag retained the water in the air around the leaves was not well known.

(iii) Many candidates were able to state one way in which the cutting used the water that it absorbed. Photosynthesis and transport were the commonest correct answers.

(c) (i) Protein synthesis was quite well known.

(ii) Very few candidates were able to suggest the importance of magnesium ions to the developing cutting.

Question 5

(a) (i) Hydrogen was not well known as the flammable gas **G**. Very few candidates identified the white solid **S** as magnesium oxide. There were no popular wrong answers.

(ii) Many candidates were able to explain that there would be no reaction. Very few were able to explain why, in terms of the reactivity of copper.

(b) (i) Many candidates were able to link an increase in temperature with an exothermic reaction.

(ii) Many candidates incorrectly suggested that the time would be ten minutes.

(iii) Many candidates were able to give one correct change that the student could make to increase the rate of reaction. All the answers in the mark scheme were regularly seen.

Question 6

(a) (i) Many candidates gained credit for drawing the acceleration line with the correct gradient. Fewer candidates were able to draw correctly the constant speed line.

(ii) Many candidates gained full credit for the calculation to find the distance travelled.

(b) Most candidates calculated an answer of 64 000 g because they were unable to rearrange the density formula correctly.

(c) Some candidates gained full credit here. Many gained only partial credit.

(d) (i) This part was not well answered. Many candidates failed to gain any credit. A few gained one marking point, usually for showing an energy transfer. Very few candidates gained more than this.

(ii) A wide variety of correct responses was seen on this part. Fossil fuels as a non-renewable source was a response seen occasionally, which was not accepted.

Question 7

(a) Most candidates gained one or two correct responses but few gained full credit. Arterioles as the third answer was rarely seen.

(b) (i) This was almost invariably correct. Most candidates were able to use the data to give the correct response.

(ii) Some candidates did not read the question carefully. The question stated that the external environment stayed the same. So candidates who gave explanations involving a change in the external environment gained no credit.

(iii) The role of fatty tissue in the control of body temperature was not well known. Few candidates mentioned that fat was a good insulator.

Question 8

(a) (i) Although the word equation was completed successfully by a number of candidates, other candidates failed to include plus signs and arrows.

(ii) This question was well answered. Candidates who failed to gain credit did so because they placed the sodium ions and the chloride ions in the wrong places and therefore did not match the ions to their charges.

(iii) A number of candidates were able to describe chloride ion formation in terms of electron gain.

(b) (i) Many candidates where able to describe copper chloride being made into an aqueous solution, but no candidate mentioned immersing the electrodes in the solution.

(ii) Few candidates were able to describe the change to the cathode and fewer were able to explain it.

(c) (i) The word alloy was not well known.

(ii) Many candidates were able to describe the meaning of the term malleable.

(iii) It was encouraging to note that a number of candidates were able to use the idea of malleability to explain that a bell would be less likely to be dented if it was made of a metal that was not malleable.

Question 9

(a) (i) Few candidates knew that a nucleus splits during nuclear fission.

(ii) Few candidates were able to place the radiations in the correct order. Many candidates wrote down the reverse order.

(iii) Very few candidates could explain that alpha radiation had low penetration. Many candidates tried to describe the damage done by ionising radiation.

(b) (i) Some candidates knew that the resistance would decrease if the diameter of the cable was increased.

(ii) Some candidates correctly suggested the length, material or temperature of the cable. A number suggested changing the thickness or width of the cable, which in effect is the same as changing the diameter and therefore gained no credit.

Question 10

(a) (i) Identifying the cervix for **Y** was the least well known response from the three.

(ii) The function of the ovaries (**X**) was well known.

(b) (i) The oviduct as the place where the egg is fertilised was not well known.

(ii) Candidates struggled to express their ideas clearly. Many gave vague responses referring to fertilisation. Few candidates suggested that the fertilised egg divided and formed a ball of cells. Nor did they suggest that implantation occurred in the lining of the uterus.

Question 11

(a) (i) Very few candidates gained full credit here and some failed to gain any credit. The cobalt chloride test for water was not well known. The limewater test for carbon dioxide was better known.

(ii) Many candidates recognised that the balance reading would decrease.

(b) (i) Most candidates gained some credit for one of the definitions but few gained full credit.

(ii) This was very poorly answered. Few candidates could identify ethane as molecule **K** and even fewer could identify ethanol as molecule **I**.

(iii) Water was also not known as the molecule that reacted with molecule **K** to form molecule **I**.

Question 12

(a) The position of gamma rays in the electromagnetic spectrum was not well known. Many candidates placed it at the opposite end. A number of candidates attempted to complete the whole of the electromagnetic spectrum.

(b) Most candidates did really well on this question with many gaining full credit.

(c) (i) Many candidates showed the angle of incidence correctly.

(ii) Many candidates knew that the angle of reflection was 36° because the angle of incidence equals the angle of reflection.

(d) Many candidates drew the image considerably larger than the object.

(e)(i)(ii) Neither the principal focus nor the focal length were commonly identified.

(iii) Refraction was well known.

(f) (i) A number of candidates correctly answered this. Common errors were to explain that light travels faster than sound or that the sound waves have a frequency above the human audible frequency range.

(ii) A number of sensible answers were seen.

CO-ORDINATED SCIENCES

Paper 0654/22
Core Theory

Key message

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(ii) A wide variety of correct responses was seen on this part. Most candidates gained credit. Fossil fuels as a non-renewable source was a response seen occasionally, which was not accepted.

Question 7

(a) Most candidates gained partial credit using the list of terms but few gained full credit. Arterioles as the third answer was rarely seen.

(b) (i) This was almost invariably correct. Most candidates were able to use the data to give the correct response.

(ii) Some candidates did not read the question carefully. The question stated that the external environment stayed the same. So candidates who gave explanations involving a change in the external environment gained no credit.

(iii) The role of fatty tissue in the control of body temperature was not well known. Few candidates mentioned that fat was a good insulator.

Question 8

(a) (i) Although the word equation was completed successfully by a number of candidates, other candidates failed to include plus signs and arrows.

(ii) This question was well answered. Candidates who failed to gain credit did so because they placed the sodium ions and the chloride ions in the wrong places and therefore did not match the ions to their charges.

(iii) A number of candidates were able to describe chloride ion formation in terms of electron gain.

(b) (i) Many candidates were able to describe copper chloride being made into an aqueous solution, but no candidate mentioned immersing the electrodes in the solution.

(ii) Few candidates were able to describe the change to the cathode and fewer were able to explain it.

(c) (i) The word alloy was not well known.

(ii) Many candidates were able to describe the meaning of the term malleable.

(iii) It was encouraging to note that a number of candidates were able to use the idea of malleability to explain that a bell would be less likely to be dented if it was made of a metal that was not malleable.

Question 9

(a) (i) Few candidates knew that a nucleus splits during nuclear fission.

(ii) Few candidates were able to place the radiations in the correct order. Many candidates wrote down the reverse order.

(iii) Some candidates were able explain that alpha radiation has low penetration. Many candidates tried to describe the damage done by ionising radiation.

(b) (i) Some candidates knew that the resistance would decrease if the diameter of the cable was increased.

(ii) Some candidates correctly suggesting the length, material or temperature of the cable. A number suggested changing the thickness or width of the cable, which in effect is the same as changing the diameter and therefore gained no marks.

Question 10

(a) (i) Identifying the cervix for **Y** was the least well known response from the three**.**

(ii) The function of the ovaries (**X**) was well known.

(b) (i) The oviduct as the place where the egg is fertilised was not well known.

(ii) Candidates struggled to express their ideas clearly. Many gave vague responses referring to fertilisation. Few candidates suggested that the fertilised egg divided and formed a ball of cells. Nor did they suggest that implantation occurred in the lining of the uterus.

Question 11

(a) (i) Very few candidates gained full credit here and some failed to gain any credit. The cobalt chloride test for water was not well known. The limewater test for carbon dioxide was better known.

(ii) Many candidates recognised that the balance reading would decrease.

(b) (i) Most candidates gained some credit for one of the definitions but few gained full credit.

(ii) In this question few candidates could identify ethane as molecule **K** and even fewer could identify ethanol as molecule **I**.

(iii) Water was not widely known as the molecule that reacted with molecule **K** to form molecule **I**.

Question 12

(a) The position of gamma rays in the electromagnetic spectrum was not well known. Many candidates placed it at the opposite end. A number of candidates attempted to complete the whole of the electromagnetic spectrum.

(b) Most candidates did really well on this question with many gaining full credit.

(c) (i) Some candidates showed the angle of incidence correctly.

(ii) Many candidates knew that the angle of reflection was 36° because the angle of incidence equals the angle of reflection.

(d) Many candidates drew the image considerably larger than the object.

(e)(i)(ii) Neither the principal focus nor the focal length were commonly identified.

(iii) Refraction was well known.

(f) (i) A number of candidates correctly answered this. Common errors were to explain that light travels faster than sound or that the sound waves have a frequency above the human audible frequency range.

(ii) A number of sensible answers were seen.

CO-ORDINATED SCIENCES

Paper 0654/23
Core Theory

Key message

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

Some candidates were not able to gain full credit due to misinterpretation of the question. Candidates should take notice of command words such as *name*, *state, describe* and *explain* in deciding what response a question requires. This is particularly the case for questions asking candidates to *describe* or *explain* phenomena.

Calculations were frequently completed well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. There was a good range of marks on most questions. Candidates generally scored on all questions. Few gained no marks on any question but very few gained full marks on any question. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depended not only on scientific knowledge but also on the ability of the candidates to understand the question and express themselves clearly.

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

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

When drawing or labelling diagrams, candidates should be reminded to take care to use the correct labels and draw clear labelling lines.

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.

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

Comments on specific questions

Question 1

(a) (i) Protein synthesis was not well known as the reason why nitrates are important for the growth of grass.

(ii) Magnesium was the expected answer and this was given by a few candidates. A number of other ions were suggested which were accepted.

(b) Carbon dioxide was sometimes correctly suggested. A few candidates suggested water, methane or ammonia. These were also accepted as correct answers.

(c) Some candidates correctly explained that no light could reach the grass and that this prevented photosynthesis. Some candidates referred to the Sun rather than sunlight. This was not accepted.

(d) (i) Many candidates drew a correct food chain. A number of candidates incorrectly drew the arrows in the reverse direction.

(ii) Owl and mouse were usually suggested for the two consumers in the food chain.

Question 2

(a) (i) Most candidates were able to name nitrogen as gas **A**. Fewer knew the percentage of the gas in clean air.

(ii) Most candidates who knew this suggested argon, neon or carbon dioxide.

(iii) To gain full credit here, candidates needed to refer to the combustion or incomplete combustion of fuels and suggest where this would happen.

(b) Most candidates knew that chlorination killed harmful microorganisms in the water. Fewer mentioned that this would make the water safe to drink.

(c) (i) A number of candidates gained full credit here. Both the correct symbols and the correct numbers of each atom were required.

(ii) Candidates who realised that compound **D** had a boiling point of 11 °C, were able to explain that compound **D** was a gas because at room temperature the compound had already boiled.

Question 3

(a) (i) Most candidates placed **A** and **B** in the correct positions.

(ii) Most candidates were able to use the graph to determine the maximum speed of the train.

(iii) The calculation was completed correctly by many candidates, who showed good data handling skills.

(iv) The idea of kinetic energy changing into thermal energy was quite well known.

(b) Many candidates knew that the frequency range was 20 Hz to 20 000 Hz. Common wrong answers included 200 Hz and 2000 Hz.

(c) The problem of thermal expansion was not well known. There were many answers suggesting that the gaps helped to make the train ride smoother.

(d) (i) Despite the large number used for the volume, many candidates correctly calculated the mass. A common problem was not being able to rearrange the density formula.

(ii) This calculation was very often worked out correctly.

(iii) The unit for weight was not well known. Many candidates wrote down grams or kilograms.

Question 4

(a) (i) Insect pollination was well known. Many candidates correctly suggested bees.

(ii) Pollen was the usual answer given.

(iii) The idea of the brightly coloured petals attracting insects was well known.

(b) (i) The correct answers were water or oxygen. Humidity and rain were not accepted.

(ii) The correct answer was 95%. A number of candidates calculated 9.5%.

(iii) Few candidates were able to make a general conclusion but many were able to state the optimum temperature for germination.

(iv) Very few candidates were able to link temperature, rate of germination and enzyme action.

Question 5

(a) Some candidates suggested correctly that sodium would explode if added to dilute sulfuric acid. Some candidates suggested correctly that sulfur does not react with dilute sulfuric acid.

(b) (i) This part was not well answered. Many candidates described a physical test for water. No candidate knew the cobalt chloride paper test for water. A few attempted to describe the anhydrous copper sulfate test but could not remember the name of the reagent.

(ii) Many candidates knew that oxidation meant the addition of oxygen.

(iii) Many candidates were able to refer to water vapour condensing. A number of candidates thought that the metal plate was melting.

Question 6

(a) Many candidates failed to gain any credit in this question. A few candidates gained one marking point usually for showing an energy transfer. Very few candidates gained more than this. One common misconception was to suggest that heat was driving the turbine.

(b) (i) Very few candidates were able to suggest a method for monitoring the workers' exposure to radiation. Many candidates described the effects of exposure to radiation.

(ii) Most candidates correctly described one hazard of ionising radiation to living things.

(c) Few candidates were able to place the radiations in the correct order. Many candidates wrote down the reverse order.

(d) (i) The position of gamma rays in the electromagnetic spectrum was not well known. Many candidates placed it at the opposite end. A number of candidates attempted to complete the whole of the electromagnetic spectrum.

(ii) Few candidates gained credit here. Common incorrect responses were that the waves all had the same wavelength or frequency.

Question 7

(a) (i) This part was quite well answered with most candidates gaining a fair degree of credit. Some candidates failed to state the phenotypes of the offspring.

(ii) Candidates need to take care in the way they express probabilities. For example the correct answer here was one quarter or 0.25 or 25% or 1:3. A number of candidates wrote down 1:4.

(b) (i), (ii) and (iii)
Most candidates gave correct answers for at least two of these three parts. All three terms were equally well known.

Question 8

(a) (i) Transition metals were quite well known.

(ii) Many candidates gained some credit for identifying either property **A** or property **B**.

(b) (i) Filtration for step 2 and either evaporation or crystallisation for step 3 were well known.

(ii) Many candidates found it difficult to determine the acid used in reaction and simply stated dilute acid in the word equation. Water was the popular and correct missing product in the word equation.

(c) (i) Few candidates labelled the electrolyte correctly. Many candidates did not attempt this part. Many others labelled the electrode as the electrolyte.

(ii) Graphite was a common correct answer.

(iii) The explanation for zinc-plating steel was not known. Few candidates referred to a barrier being formed and even fewer explained that this barrier prevented oxygen and water from reacting with the steel.

Question 9

(a) (i) Many candidates gained some credit. Either they were able to explain that the kinetic energy of the particles increased or that there were more frequent collisions between the particles and the tyre. Many candidates only referred to the particles colliding more frequently with each other.

(ii) This was well answered with most candidates suggesting weight or force.

(b) (i) Many candidates correctly stated lamps **L1** and **L2**. A number of candidates incorrectly stated **L3** and **L4**.

(ii) The correct answer of $1.5\,\Omega$ was seen less often than $3\,\Omega$ or $6\,\Omega$. Very few candidates were able to explain why $1.5\,\Omega$ was the correct value.

(iii) The calculation was completed correctly by many candidates, who showed good data handling skills.

(c) Candidates needed to suggest a simple way of deciding whether the bodywork was made from steel or aluminium. Some candidates correctly suggested the use of a magnet. Some candidates attempted to explain why steel was used rather than aluminium but that did not answer the question.

Question 10

(a) The oesophagus was not well known as part **X**, which was frequently called the throat. The function of the oesophagus was better known.

(b) Few candidates knew that amylase is secreted by the salivary glands, nor that amylase's function is to digest starch.

(c) The mouth was sometimes identified as the place where the process of ingestion occurs. Many candidates incorrectly labelled the stomach.

(d) Many candidates gained full credit. They were able to describe some part of the process of mechanical digestion and then explained that this allowed the food to be swallowed easily.

Question 11

(a) (i) In this question only a few candidates were able to suggest that protons are positive and electrons are negative. Very few candidates could state that there were equal numbers of protons and electrons or that the charges balanced.

(ii) The nucleon number of hydrogen was often correct. A common incorrect answer was two.

(b) (i) Some candidates were able to state the correct term hydrocarbon.

(ii) Many candidates were able to show the correct structure for a methane molecule. The structure of ethane was sometimes drawn.

(c) None of the correct statements describing ethane were well known. Few candidates gained full credit and many failed to gain any credit.

(d) (i) Few candidates knew that the type of reaction was (addition) polymerisation or that poly(ethene) was the white solid.

(ii) A few candidates were able to describe the joining together of ethene molecules to make poly(ethene).

Question 12

(a) Radiation was commonly given as an answer although some candidates mentioned conduction and convection.

(b) (i) and **(ii)**
Few candidates were able to correctly indicate one wavelength or the amplitude of the wave. The arrowheads needed to be carefully and accurately drawn to indicate the quantities.

(c) The completed diagram needed to show both refraction through the prism and dispersion. Many candidates attempted to show the refraction but few showed any dispersion.

(d) A number of candidates correctly answered this. Common errors were to explain that sound waves travel too slowly or have a frequency above the human audible frequency range.

(e) (i) The principal focus was not well known.

(ii) Enlarged and inverted were the words commonly used to describe the image formed by the lens.

Question 13

(a) Many candidates knew the four substances involved but some were unable to determine which were reactants and which were products. A few candidates attempted to write a balanced symbolic equation, which was not required. These equations invariably contained errors and consequently gained no credit. Candidates are not expected to be able to write balanced symbolic equations on this paper.

(b) (i) All three parts **P**, **Q** and **R** were fairly well known, although very few candidates gained full credit.

(ii) Carbon dioxide was frequently given as the correct answer although a number of candidates incorrectly suggested oxygen.

(c) Very few candidates were able to explain that the cells were good absorbers of light energy because they were situated near the top of the leaf. A few candidates correctly suggested that these cells contained many chloroplasts.

CO-ORDINATED SCIENCES

Paper 0654/31
Extended Theory

Key message

The most successful candidates in this examination
- could state physical and biological principles and apply them in unfamiliar situations
- set out calculations to show the processes they had carried out
- tailored answers to match the space and marks allowed
- checked their work at the end.

General comments

Some questions on this paper tested the ability of candidates to apply their knowledge in unfamiliar contexts. Being fluent in stating physical and biological principles facilitates their application in these contexts. Candidates should ensure when checking their answers that any practical solutions to problems that are presented are workable.

Most candidates demonstrated mathematical competence to the level required on this paper. Some had difficulty in rearranging formulae and in manipulating large numbers. Sometimes a zero was lost during a calculation and the error not corrected by checking the working. Answer spaces are usually laid out to encourage candidates to write the formula used. This can be in words or symbols, but not both. All stages in the calculation should be shown. Credit for processes carried out can then be given even when the final answer is incorrect.

Several questions posed a challenge to candidates, even though the subject matter has often been tested in past papers. Difficulties were experienced with recall of industrial chemical processes, completion of nuclear equations, representation of the arrangement of particles in solids, liquids and gases, and explanation of energy transfer during change of state. It was noticed that many candidates suffered from the misconception that ozone plays a significant part in global warming. It is worth emphasising the comment for **Question 1(e)** that the effect on the role of ozone depletion in global warming is negligible, so is not included in the Co-ordinated Sciences syllabus, and is not an acceptable answer to this type of question.

The most successful candidates expressed their ideas well using good English and legible handwriting. Their answers were planned to match the number of marks available and the space allocated.

Comments on specific questions

Question 1

(a) (i) Most candidates knew that nitrogen and oxygen make up most of the atmosphere.

(ii) Complete answers summarised the data as fluctuating with little overall change, followed by an increase in carbon dioxide concentration. These answers identified 1800 as the start of the increase, rather than 2000, and included an estimate of that increase.

(b) (i)/(ii) Respiration and photosynthesis were usually given for the processes releasing and removing carbon dioxide from the atmosphere.

(c) Sensible suggestions were usually provided for reasons for the change in carbon dioxide concentration.

(d) Workable methods for checking whether there is a change in concentration when carbon dioxide gets trapped in ice were based on measurements from the current atmosphere and from air recently trapped in ice. The most successful answers included specific sources of the measurements. Some candidates made less practical suggestions of measurements from ancient atmospheres.

(e) The best explanations of how increased carbon dioxide concentration increases global warming included the increased absorption of radiation in the atmosphere, and subsequent radiation back to Earth. Many responses involved damage to the ozone layer. Candidates should be aware that the effect on the ozone layer and the role of ozone depletion in global warming are both negligible, so are not included in the Co-ordinated Sciences syllabus, and are not acceptable answers to this question.

Question 2

(a) (i)/(ii) Some candidates correctly identified the products of reaction between sulfuric acid and magnesium and between sulfuric acid and copper carbonate.

(iii) Those who realised that copper does not react with sulfuric acid usually explained their choice in terms of the low reactivity of copper.

(iv) Fewer candidates knew that barium nitrate forms barium sulfate with sulfuric acid.

(b) (i) Many candidates could use the nuclide notation to obtain the neutron and electron numbers.

(ii) Most candidates knew that vanadium is a transition metal.

(iii)/(iv) A few candidates knew enough about the Contact Process to draw the structure of a sulfur trioxide molecule or to write a balanced equation.

Question 3

(a) (i) Most candidates explained why the volume of water had decreased by recognising that some had evaporated. Those who referred to boiling were usually careful to avoid restating the question and used terms such as *boiled away*.

(ii) Successful explanations of why energy is required to boil water remaining at 100 °C involved energy being required to overcome the forces between molecules. Those that referred to breaking bonds needed to state clearly that these are bonds between molecules.

(iii) Most candidates could describe at least one difference between evaporation and boiling.

(iv) Credit was given for matching the states of matter with the correct diagrams. Correct explanations for the representation of the physical states of water included a description of the random arrangement and the proximity of molecules, rather than a description of the motion of molecules, which was not apparent from the diagram.

(b) The term *convection* was often correctly used in explanations of the position of the heating element in the kettle. The best answers included the fact that hot water rises because it has low density and avoided describing particles as *hot* or *less dense.*

(c) Most candidates could apply the formula for electrical power to verify the size of the current.

Question 4

(a) Some candidates knew that mitosis is the type of cell division by which roots are produced, but an equal number confused mitosis with meiosis.

(b) (i)/(ii) Most suggested correctly that the cutting would have an identical genotype. Fewer candidates knew that the appearance would be similar, but not identical, to the parent tree.

(c) Complete answers providing the reason for placing the plastic bag over the cutting mentioned increasing the humidity, as well as the reduction of transpiration or water loss.

(d) (i)/(ii) The importance of nitrate ions for growth was well known. Some recalled that magnesium ions are required for the production of chlorophyll.

Question 5

(a) (i) The most successful candidates realised that the initial and final colours were required to describe the change in appearance, and explained the change in terms of the displacement of copper.

(ii) Full credit was awarded when the proton numbers were used to identify the three metals and a selection then made on the basis of the correct reactivity relative to zinc and copper.

(b) (i) The abbreviation for aqueous was recognised by most candidates. Those who described the state as liquid without qualification were not given the mark.

(ii) The clearest responses used the information to explain the redox reaction rather than giving a general definition. These responses explained oxidation and reduction separately: the zinc atoms losing electrons and being oxidised, and the silver ions gaining electrons and being reduced.

(c) Many candidates interpreted the graph correctly.

Question 6

(a) (i) Most candidates could use the calibration on the axes to draw an accurate speed/time graph.

(ii) Many correctly suggested calculating the area under the graph to obtain the distance travelled, rather than using the formula: distance = speed · time.

(b) The correct speed was usually read from the graph and the formula for kinetic energy was often applied successfully.

(c) Most candidates could apply the formula relating force to acceleration.

Question 7

(a) The word list was used by some to obtain a correct description of homeostasis.

(b) (i)/(ii) Almost all candidates read the correct time for the highest glucose concentration from the graph, and most correctly suggested eating a meal as an explanation.

(iii) Many candidates knew that respiration causes a decrease in glucose concentration. Glycogen synthesis or insulin secretion was suggested by a few.

(c) There were a few excellent, succinct descriptions of the role of the liver. These stated that the liver stores glucose as glycogen, that insulin causes the conversion of glucose to glycogen and that glucagon causes the conversion of glycogen to glucose. Some candidates confused the words *glycogen, glucagon* and *glycerol*.

Question 8

(a) (i) Candidates needed to give the charge of a sulfide ion as -2, rather than just stating that it is negative. There were some good explanations citing the need to gain two electrons to attain a full outer shell. A few also explained the charge as being due to there being two more electrons than protons in the ion.

(ii) Those who gave the correct charge of the sulfide ion usually predicted the correct charge of a zinc ion. Good explanations were based on the need for charge balance. Candidates who explained this in terms of electron transfer were successful when they used the formula and included the ratio of atoms involved.

(b) Some candidates described the formation of zinc atoms in terms of migration of zinc ions and their discharge at the cathode. Those who referred to movement of zinc atoms were not successful.

(c) (i)/(ii) A few candidates knew that the protection of steel by zinc is called *galvanising* rather than using the more general term *electroplating*. Several realised the importance of the relative reactivity of zinc and iron, but the process was not well understood and the term *sacrificial protection* was not often used. Protection by a zinc oxide layer was a common misconception.

(d) The meaning of the term *malleable* was well known.

Question 9

(a) (i) Some candidates could recall the definitions of nuclear fission and nuclear fusion. Many definitions were imprecise, discussing processes involving atoms rather than nuclei, or separation rather than splitting.

(ii) The highest achieving candidates could apply the principles of conservation of mass and charge to the radioactive decay process.

(b) (i) Most candidates knew that transmitting electrical power at a higher voltage reduces energy loss.

(ii) There were many correct answers to the transformer problem obtained from careful manipulation of the formula.

(c) (i) The minority who knew that resistance decreases when the cross-sectional area of a cable increases, often went on to use inverse proportion to predict the correct cable resistance.

(ii)/(iii) There were many good suggestions for other methods of changing the resistance of a cable. There were fewer explanations of the negative effect of doubling the cross-sectional area involving the increased force on pylons.

Question 10

(a) (i) Many candidates knew the names of some of the features in the diagram of the uterus.

(ii) Most candidates knew the role of the amniotic fluid in the protection of the fetus.

(iii) There were some good comparisons of the composition of the blood flowing to and from the fetus, the best referring to *urea* rather than just *waste*. Some lost marks by suggesting that substances were completely removed from the blood by the fetus.

(b) (i)/(ii) The questions on the benefits of breast-feeding and bottle-feeding were generally well answered.

Question 11

(a) Candidates appeared to be more familiar with the test for carbon dioxide than that for water.

(b) A few candidates could recall the names of the reactants in the production of ethanol.

(c) (i) Most candidates could verify the value for the relative molecular mass of ethanol.

(ii) A few candidates could change the unit of volume and calculate the number of moles from the molar concentration. There was more success in converting the number of moles into mass with the correct unit.

Question 12

(a) (i)/(ii) Many candidates could place γ-rays and visible light in the electromagnetic spectrum and knew that they travel at the same speed.

(iii) Very few realised that γ-rays are more dangerous because they are ionising, often suggesting penetrating power as the reason.

(b) The majority of candidates could match the terms used to describe a wave with their definitions.

(c) (i)/(ii) There were some carefully drawn ray diagrams showing the formation of an image by a mirror. Others did not show how the diverging, reflected rays are used to locate the image behind the mirror.

(d) (i) A minority of candidates appeared to know the meaning of the term *focal length*. Some drew an arrow from the optical centre to the principal focus with sufficient care to gain the mark.

(ii) Most candidates knew that *refraction* is the process whereby the direction of light is changed by a lens.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

Key message

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

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

It would be helpful for candidates to practise labelling and annotating diagrams. Marks were often lost due to inaccuracies in labelling or drawing. Candidates should be reminded to use a sharp pencil and a ruler to draw label lines and to include a written label for their line.

General comments

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

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

Comments on specific questions

Question 1

(a) Care must be taken when referring to water concentration, as a concentrated solution is not the same as a solution having a high concentration of water molecules. It is preferable to use the term water potential.

(b) Many candidates recognised that the root hair cell gives a larger surface area. Fewer could accurately describe its elongated shape, or state that the cell wall is thin or permeable.

(c) (i) Most candidates could state that the root hair cell contents would lose water but only the most able could relate this to differences in water potential between the root hair cell and the soil. There was some confusion apparent with some candidates stating that the cell would fill with salt water.

(ii) This question was well answered. There were some candidates who incorrectly referred to the presence of salt water in the leaves. References to colour changes of leaves were ignored.

(d) (i) Sunlight was a common incorrect answer.

(ii) The answer required the name of the substance, chlorophyll. Some candidates gave the answer sunlight or light energy, which are not considered substances.

Question 2

(a) (i) Argon had a full outer shell of electrons so doesn't need to gain, lose or share electrons. Vague answers referring to argon being unreactive, although true, does not explain why it does not form chemical bonds, so could not receive credit.

(ii) Many candidates referred to chlorine as being a highly reactive element that is positioned between magnesium and argon.

(b) (i) Some candidates, despite having the right idea, struggled to calculate the concentration. Incorrect figures of 0.12 and 6.75 were often seen.

(ii) There were a number of candidates who thought that increasing the concentration would increase the kinetic energy of the particles. Some candidates tried to explain that an increase in collisions causes the increase in rate rather than the increase in **frequency** of collisions.

Question 3

(a) Weight was the correct answer. However, most candidates stated the force as gravity, which was an acceptable alternative.

(b) Some candidates missed that extension was directly proportional to the force applied, simply stating that it was proportional.

(c) (i) The majority of candidates were able to read the correct speed from the graph.

(ii) Marks were available for a correct calculation if an incorrect speed was used.

(iii) Correct answers used the area under the graph to calculate the distance travelled. Some candidates tried to calculate the distance using the speed multiplied by time.

(iv) The most common error was to fail to square the velocity. Partial marks could be gained for a correct formula.

(d) Few candidates realised that the person would bounce back up after five seconds with many incorrectly stating that the person would stop or hang in the air.

Question 4

(a) Candidates should be reminded to use the correct terminology. Trachea is preferable to windpipe.

(b) Candidates had good knowledge of the differences between inspired and expired air. A common error was to describe oxygen as being breathed in and carbon dioxide as breathed out.

(c) (i) Most candidates were able to use the graph to calculate the correct time of 42 minutes.

(ii) Some candidates tried to draw a new line from 0 minutes rather than add a curve to the original line at 50 minutes. Some candidates did not suggest that there would be a cumulative effect. This would have been achieved by making the peak higher than the peak for the first cigarette smoked.

(iii) A common misconception was that carbon monoxide reacted with the oxygen to form carbon dioxide in the blood.

Question 5

(a) The useful product extracted from the electrolysis of molten sodium chloride proved more taxing with the incorrect answer of sodium frequently seen.

(b) A wide variety of answers were seen, oxidation being the most commonly quoted incorrect answer.

(c) (i) Many candidates described the loss of two electrons from calcium to form a positive calcium ion and the gaining of two electrons to form a negative chloride ion. Fewer were able to explain the charges in terms of differences in number of positively charged protons and negatively charged electrons.

(ii) Some candidates were able to describe the balancing of charges. However, many wrote that only one calcium and one oxygen was required for the reaction.

(d) The most common difficulty was calculating the correct number of moles. Some candidates, who were able to calculate the correct number of moles for calcium carbonate, did not realise that the number of moles of calcium oxide would be the same. Some credit was available for correct working from incorrect figures.

Question 6

(a) Candidates frequently lost marks for simply stating all the properties of the material rather than focussing on the thermal conductivity.

(b) This question was answered well with many candidates identifying that particles in the gaseous state were further apart and had weaker forces between them. Answers referring to the motion of particles were more vague, often referring to more motion rather than the increased speed of particle movement.

(c) Many correct calculations were seen with almost all candidates calculating the change in temperature correctly.

Question 7

(a) (i) Candidates should be reminded to use the correct terminology. Homozygous was commonly quoted. However, inaccurate answers of homozygote and homogenous were also seen.

(ii) Heterozygous was commonly quoted. Inaccurate answers were also seen and some candidates did not know the difference between homozygous and heterozygous genotypes.

(iii) Few candidates were able to describe this type of variation as discontinuous. It was clear that this part of the syllabus is not well known, with a wide variety of incorrect answers seen.

(b) (i) This question required a probability rather than a ratio. Some candidates lost the mark available by putting the answer in ratio form.

(ii) This question was answered less well than part **(i)** with many stating a probability of 25%.

(c) Candidates that recognised that the sudden change was caused by a mutation scored well. Many missed this and tried to explain the sudden appearance of polydactyly in terms of recessive alleles or carriers of the polydactyly allele.

Question 8

(a) Some candidates incorrectly tried to draw diagrams including two chlorine and two hydrogen atoms in a single molecule. Some drawings included a correct shared pair but also included extraneous electrons on the hydrogen or chlorine atom.

(b) Many candidates could give details of chloride ions being attracted to the anode and losing an electron. Only the most able candidates described the bonding of two chlorine atoms to form a molecule of chlorine. Credit was given to correct equations.

(c) (i) Some candidates realised that there would be no reaction in test-tube **C** and a reaction would occur in test-tube **D**, however fewer were able to give the correct colour change in test-tube **D**.

(ii) Many candidates were able to explain the reasons for the lack of reaction in test-tube **C** and the reason for the colour change in test-tube **D**. Many candidates correctly referred to the relative reactivity of the elements fluorine, chlorine and iodine. Candidates should take care to use correct terms in responses. References to fluoride, chloride and iodide were rejected.

Question 9

(a) Candidates needed to be quite specific in order to gain the mark. Vague references to liquid turning to gas were ignored as this could refer to evaporation. The best responses made reference to the temperature at which a liquid boils and the change in state from a liquid to a gas.

(b) (i) The vast majority of candidates identified the correct position of ultraviolet on the spectrum.

(ii) Some candidates missed that units were in km/s rather than m/s and gave the incorrect figure of 3×10^8.

(iii) A few incorrect responses of microwaves were seen. Responses of ultraviolet were not credited.

(c) The most common error was to state the wrong formula or to rearrange the formula incorrectly giving a figure of 660.

(d) (i)(ii) Care needs to be taken when labelling diagrams to ensure that they are labelled correctly with the letters **P** for the principal focus and **F** for the focal length. The principal focus was often correctly identified but the focal length less often.

Question 10

(a) Some candidates identified the correct area but gave a vague description of it being acidic. A minority of candidates confused high pH with being more acidic.

(b) Many correct suggestions were seen, most commonly factories or industry in the area. There was some confusion among candidates who thought that greenhouse gases, carbon dioxide and methane caused acid rain.

(c) Some responses were vague referring to damage to lakes or contamination of crops. Candidates should be encouraged to learn the specific effects of acid rain on the environment.

(d) Some excellent answers were seen such as the use of catalytic converters in cars and flue gas desulfurisation. Again, there were some vague answers such as using less fuel or stopping using cars, which were not creditworthy.

Question 11

(a) (i) Most candidates gave the correct answer of petroleum or crude oil. Very few gave incomplete responses such as oil or petrol.

(ii) The correct take-off point was often identified.

(iii) Some excellent detailed responses were seen but many simply repeated the question by stating that the fraction they had chosen had the highest boiling point rather than giving a reason for this. Few candidates referred to the energy required to separate molecules and instead referred to heat. Candidates should be reminded to refer to intermolecular forces rather than bonds as it is not clear whether candidates are talking about forces between the molecules or bonds between the atoms.

(iv) Good candidates could name the products of complete combustion. Incorrect answers of carbon monoxide, methane and hydrogen were seen.

(b) Some responses only gave a partial explanation, referring to the compound being saturated and not relating this to being unable to react with bromine. Some candidates confused the prefixes of but- and prop-.

(c) (i) Many candidates could give the correct formula and balance it. Fewer realised that water was in gaseous state as the state symbol of (l) was often seen. Many candidates omitted to include any state symbols.

(ii) Candidates should be reminded to read the question carefully. If a word equation is asked for then a symbol equation is not appropriate.

Question 12

(a) (i) The vast majority of candidates gave the correct reading of 0.13 A.

(ii) Many correct calculations were seen with very few stating incorrect units. The most common error was to rearrange the formula incorrectly.

(iii) Most candidates stated that as temperature increases, current increases.

(iv) Some candidates incorrectly suggested that resistance increases with increasing temperature. Some candidates chose to describe the temperature and resistance as being inversely proportional, which was accepted.

(b) (i) Y was most commonly linked incorrectly, usually to brush rather than coil.

(ii) Sine curves were often drawn. Some candidates lost marks for inaccurate drawings with variable wavelengths and amplitudes.

(c) (i) The most common error was to multiply the speed and the wavelength.

(ii) Marks were lost due to inaccuracies in drawing. Candidates needed to make sure that only one wavelength was correctly shown. Many showed wavelengths that were slightly too large or too small.

(iii) Able candidates stated that compressions got closer together. There was confusion among some candidates who thought that compressions would get closer together but rarefactions further apart.

Question 13

(a) (i)(ii) Label lines needed to touch the structure being labelled to gain credit. Inaccurate lines that pointed to the choroid or the vitreous humour were not credited.

(b) (i) A few incorrect responses were seen referring to the lens moving forward and backward.

(ii) The more able candidates stated that the muscle would relax. The most common incorrect answer was for the muscle to contract.

(iii) Candidates often used the incorrect terminology of contract, which was not accepted. Muscles are capable of contraction whereas ligaments are stretched by muscles and so tighten rather than contract.

(c) Descriptions should be specific and it is the focus of the person that would be affected rather than the result being complete lack of sight.

CO-ORDINATED SCIENCES

Paper 0654/33
Extended Theory

Key messages

Good preparation for this examination would include

- writing answers to past questions, tailoring them against space and marks allowed
- practicing standard scientific calculations, paying attention to how working is set out
- planning model answers to common questions involving the more abstract scientific ideas.

General comments

Generally candidates expressed their ideas well using good English and legible handwriting. Full marks were achieved when answers were planned to match the number of marks available and the space allocated. Examination preparation could well include answering past papers with the mark scheme to hand. The best prepared candidates could apply their knowledge in unusual contexts.

Mathematical skills were demonstrated by many candidates in answering questions involving calculations. Errors occurred most often when rearranging formulae, especially where fractions were involved. Some candidates were not confident in handling powers of 10. Particular problems were apparent when evaluating a fraction involving a negative power of 10. Answer spaces are usually laid out to encourage candidates to write the formula used. This can be in words or symbols, but not both. All stages in the calculation should be shown. Credit for processes carried out can then be given even when the final answer is incorrect.

Many candidates found some questions on this paper difficult, even though the subject matter has often been tested before. In biology, candidates are expected to be familiar with the structure of certain organs in plants and humans, to explain their function and predict the result of variation. In chemistry, they are expected to suggest appropriate chemical tests, to explain electrolytic processes and to describe polymerisation. In physics, they are expected to apply physical principles to the working of electromagnetic devices and to be able to analyse some nuclear processes.

Comments on specific questions

Question 1

(a)(b) Most candidates knew that a decomposer causes decay, or gave an example such as bacteria or fungi. Many suggested that decay releases nutrients.

(c) Many candidates explained that reduction in light intensity would reduce photosynthesis.

(d)(i) The food chain was usually drawn correctly.

(ii) To explain why there are fewer owls than mice in the food chain candidates needed to make reference to the energy loss at each trophic level providing insufficient energy to sustain the same numbers of owls as mice. Many responses were concerned with the amount of food available rather than considering energy flow through the food chain.

Question 2

(a) (i) Most candidates named a trace gas present in air.

(ii) The presence of carbon monoxide in the air was often explained by the incomplete combustion of a fuel. The fuel had to be described as a hydrocarbon or carbon compound to gain full marks.

(iii) Some responses stated that there are six shared electrons in a nitrogen molecule.

(b) (i) Those who correctly identified the reactant and product from the stem usually constructed a balanced equation for the formation of ozone. Many attempted to include monatomic oxygen, water or oxides of nitrogen.

(ii) Some candidates recognised that ozone kills bacteria. Many used incorrect terminology like purification, or suggested that oxygenation plays a role.

Question 3

(a) (i)(ii) Many correctly obtained the distance travelled by calculating the area under the graph. Some were less successful when they attempted to use the formula: distance = speed $\times$ time.

(iii) Most candidates could measure the gradient of the graph to verify the value for the acceleration of the train.

(b) (i) Most candidates could apply the formula relating force to acceleration, and gave the correct unit for the accelerating force.

(ii) Many candidates read the maximum speed from the graph correctly and could apply the formula for kinetic energy.

(c)(i)(ii) There were a few excellent, succinct explanations of the motion of the coil in the electric motor. These stated that the current through the coil produces a magnetic field. The magnetic fields interact and a force on opposite sides of the coil in opposite directions makes it spin. The split-ring commutator keeps the coil spinning by reversing the current every half-turn. Other responses inaccurately referred to attraction between fields, poles or wires. Some candidates confused the electric motor with the generator.

Question 4

(a) Many candidates could identify at least one of the structures in an intestinal villus.

(b) Many were able to relate the large surface area of the villi to increased absorption.

(c)(i)(ii) Some candidates knew that smaller villi would reduce the absorption of nutrients and that those people affected should eat easily digested or nutrient-dense foods.

Question 5

(a)(i) It was usually recognised that the high reactivity of sodium would make it too dangerous to produce hydrogen from sulfuric acid, and it was often stated that sulfur would not react.

(ii) Many candidates predicted that the pH of the mixture of sulfuric acid and magnesium would increase because the solution becomes less acidic. Sensible suggestions for the range of pH values were credited. Responses which included a description of magnesium as a base were not usually successful.

(b) (i) Correct descriptions of chemical tests for water involved the use of cobalt chloride paper or anhydrous copper sulfate. Those not credited included measurement of pH or physical tests such as measurement of boiling point.

(ii) A very few candidates could predict that the product of the combustion reaction contains more chemical energy than the reactants, and explain that energy is transferred from the reactants to the surroundings as thermal energy in an exothermic reaction.

(c)(i) Most drawings of lithium and hydride ions included charges. There were a few attempts to draw an H^+ ion or to draw a covalent molecule.

(ii) The structured chemical calculation question tested whether candidates could obtain the formula mass from the formula, convert a mass to moles, use the equation to find the ratio of moles of reactant and product, and to use molar volume data. Calculation of the formula mass was sometimes based on the use of 2LiF. The stage involving the stoichiometry of the reaction proved to be the most challenging.

Question 6

(a)(i) Those candidates who knew the specific heat capacity formula could usually substitute values and arrive at the correct answer.

(ii) Successful explanations of why energy is required to turn water at 100°C into steam at 100°C involved the energy required to separate molecules or to overcome the forces between molecules. Those that referred to breaking bonds needed to state clearly that these are bonds between molecules.

(iii) Credit was given for matching the states of matter with the correct diagrams. Correct explanations for the representation of the physical states of water included a description of the random arrangement and the proximity of molecules, rather than a description of the motion of molecules, which was not apparent from the diagram.

(b) Those who realised that four half-lives had elapsed usually obtained the correct answer.

(c) Some candidates knew that α-particles are deflected and γ-rays are not deflected in both electric and magnetic fields. Fewer gave reasons based on only α-particles having charge.

Question 7

(a) Many candidates knew that amylase is the enzyme that breaks down starch.

(b) Flavouring was commonly suggested as a function of malt sugar. Conversion to alcohol and a source of energy for yeast were less common suggestions.

(c)(i) Fermentation was often given as an acceptable alternative to anaerobic respiration.

(ii) The equation for anaerobic respiration in yeast was not well known.

(d) The best responses showed that air in the mixture increases aerobic respiration, releasing more energy for yeast growth, which increases the rate of alcohol production.

Question 8

(a) Many candidates named butene as being an alkene.

(b) (i) The trend was often described as the boiling point increasing as relative molecular mass increases. Expressing the trend relative to size of molecule was accepted, but the number of bonds was not thought to be helpful. Explanations often involved greater energy being required to separate larger molecules. Those that referred to breaking bonds needed to state clearly that these are bonds between molecules.

(ii) Most candidates predicted the relative molecular mass of pentane correctly and provided a good explanation of their method.

(c)(i)(ii) Few recognised that ethene undergoes polymerisation, or correctly named the polymer or drew the structure of poly(ethene) correctly.

Question 9

(a) Many explanations for the increase in tyre pressure with temperature included the greater speed of particles. Some lost credit by referring to more collisions rather than more frequent collisions with the tyre wall.

(b) Those who knew the formula or a rule for combining resistances in parallel usually obtained the correct answer. A common error was to fail to take the reciprocal at the end of the calculation.

(c) Some candidates recalled the safety function of a relay but most confused the device with a circuit breaker.

(d) (i) Many candidates correctly stated that wire E has the lower resistance because of its greater cross-sectional area.

(ii) Some candidates correctly stated that wire D has the greatest resistance, obtaining full credit for giving all three reasons: that nichrome has the greatest resistance for the same length and cross-sectional area, is longest and is thinnest.

Question 10

(a) The best responses described a property of the structure of the dandelion fruit which helps with wind dispersal rather than naming the structure or describing how the wind disperses it.

(b) (i)(ii) Most candidates knew that the structure contains the seed and many suggested that its spines are used for anchorage.

(c)(i) Most candidates reported that the student's idea is not supported as the graph shows no correlation between the distance and length of beak.

(ii) Mass and length were good suggestions for another feature of the fruit which affects distance carried by the wind.

(d) Reducing competition and colonising new areas were often given as good reasons why it is helpful that fruits are carried a long distance from the parent plant.

(e)(i)(ii) Animal dispersion was usually given as another method of fruit dispersal and an assisting adaptation of the plant was often suggested.

Question 11

(a) A few candidates could identify the properties specific to the transition metals.

(b) (i) Many candidates could complete the word equation for the reaction between sulfuric acid and copper oxide. Hydrogen was often suggested as a product instead of water.

(ii) Some candidates explained that zinc is more reactive than copper. They correctly referred to the elements rather than to the ions.

(iii) Some recognised that reduction involves the gain of electrons.

(c)(i) Most candidates could name the electrodes.

(ii) The best responses described copper ions being attracted to the cathode where they gain electrons and form atoms. Some answers involved the migration of atoms, the movement of protons or the accumulation of ions or electrons to explain the increase in mass of the electrode.

Question 12

(a) Many candidates suggested dividing the energy released per second by the energy released by each nucleus. Some could evaluate the fraction and obtained an estimate of the number of nuclei formed every second.

(b) There were a few good definitions highlighting the difference between nuclear fission and fusion. Common errors included reference to atoms rather than nuclei and to separation rather than splitting.

(c)(i)(ii) Many placed γ-radiation and ultraviolet correctly in the electromagnetic spectrum, and indicated that γ-radiation has the highest frequency.

(d) Many candidates explained that sound needs a medium to propagate.

Question 13

(a) Many candidates could recall the balanced equation for photosynthesis.

(b) (i) Many candidates could identify at least some of the parts of the leaf.

(ii) Some correctly drew an arrow right through the lower epidermis to show the route taken by carbon dioxide.

(c)(i) Some identified the palisade cells as absorbing most light energy. They realised the importance of chloroplasts or the chlorophyll they contain, or their position near the top of the leaf. Some thought that chloroplasts are cells.

(ii) There were few descriptions of the conversion of light energy to chemical energy. Many responses recognised its role in photosynthesis without describing what happens to the energy.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

General comments

If a question asks for a colour to be recorded, then this is the required answer, rather than any other descriptions of the mixture.

Comments on specific questions

Question 1

In part **(a)**, a variety of acceptable headings for columns two and three in Table 1.1 were seen. The heading for column one was often omitted. When time was given for column one, it was rare to see incorrect units.

In part **(b)**, most candidates were able to carry out this experiment in full and produce suitable observations. 'Transparent' was accepted as an observation in this context however candidates should use the term 'colourless,' or a stated colour.

Part **(c)** produced a full range of marks because 'diffusion' was rarely stated.

For **(d)** the idea of a control was not fully understood. Better candidates suggested the idea of eliminating water as a cause of the blue-black colour.

In parts **(e)(i)** and **(ii)** a relatively small number of candidates realised that the iodine would change to brown in the bag.

In part **(e)(iii)**, the test for reducing sugars was well known.

Question 2

Some candidates confused cation and anion in part **(a)** despite the tests being stated in the Notes for Qualitative Analysis on the last page of the examination paper. It was pleasing that more candidates were specifically observing precipitates than in previous sessions. A number of candidates recorded a positive test for a chloride. **J** was a sulfate so may have given a slight white precipitate with silver nitrate solution but not the heavy white precipitate produced by a chloride.

In part **(b)(i)**, an acceptable description of the gas observed was usually seen, often as 'bubbling'. Few candidates recorded the appearance of the resulting solution although many candidates identified the gas as hydrogen along with the appropriate test.

In part **(b)(ii)**, care was needed when adding sodium hydroxide solution to the solution of zinc ions. Consequently some candidates did not observe the white precipitate although most realised that the cation was zinc.

The displacement reaction in **(c)** worked well. The appearance of the filtrate varied enormously depending on the relative quantities used. Again, in **(c)(ii)**, the outcome depended on relative quantities. Allowance was made for this in certain circumstances.

In part **(d)**, most candidates recognised this as a displacement reaction.

Question 3

This was a relatively simple practical to carry out. It is important for candidates to read all instructions carefully to establish the level accuracy for the recording of results.

The length in part **(a)(i)** had to be 60.0 ± 0.2, subject to the Supervisor's report.

In **(a)(ii)**, a sensible precaution often involved viewing close-up and at 90°.

Good results were often seen in part **(b)** which incorporated an accuracy mark.

Dividing by twenty in **(c)** was carried out successfully in most cases. The squaring and rounding to one decimal place caused problems for many.

For the graph in **(d)**, candidates were asked to include the origin on the axes. Those who did realised that the origin was effectively a point and consequently drew a better straight line. Many candidates did not indicate on their graph the values chosen to calculate the gradient. The wording of the question for a gradient has been kept the same to help candidates. A significant number of candidates calculated the gradient incorrectly as x/y.

Part **(e)** incorporated an accuracy mark.

In **(f)**, candidates are still reluctant to look at the spread of their results around the best-fit straight line and discuss this in terms of experimental error.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

General comments

When suggesting the values for a variable in a plan, it is important to provide a suitable number of values (usually five) over a realistic and acceptable range.

Comments on specific questions

Question 1

This was a slightly challenging exercise but the majority of candidates carried it out well and generated useful results with evidence that the reaction was slowing at the end.

In parts **(a)** and **(b)**, the table was completed well. Some candidates had not realised that results had to be recorded to 0.1 cm.

The plotting of points for the graph in **(c)** was generally done well; at least half of the grid should be used on both axes. There were many well drawn curves or straight lines. There were some curves which joined all the points and this was unlikely to be correct.

It was pleasing that many candidates for part **(d)** suggested that extra readings should be taken to provide more points to check the curve.

In part **(e)**, the test for oxygen was well known by those who had read and understood the stem of this question.

Part **(f)(i)** was well answered however it was rare to see an adequate number and range of temperatures for part **(f)(ii)**.

Question 2

Generally candidates carried out this thermochemistry exercise well producing meaningful results. The practical skill needed for making up solutions of different concentrations is probably rarely practised. Consequently some odd results were seen.

This reaction is a displacement reaction and copper was produced. Some candidates did not describe the colour of the solid after the reaction and so did not identify copper in **(a)(iii)**.

The plotting of points in part **(b)** was done well. The best-fit straight line should give an even scatter about the line. Some candidates did not draw the line through the origin as requested.

Part **(b)(iii)** required the candidate to consider how close the points (data) were to the line (direct relationship). This was not done well.

In part **(c)**, most candidates correctly recognised this as an exothermic reaction. Some suggested that it was a displacement reaction which is true but did not answer the question.

A range of acceptable responses was seen in **(d)**. A digital thermometer is not necessarily more accurate so needs to be accompanied by more detail, such as ‘a digital thermometer accurate to 0.1 °C’.

Question 3

In part **(a)**, *a* and *b* were measured well although not always recorded to 0.1 cm as requested. Most candidates knew how to ensure that the centre of the modelling clay was directly above the 15.0 cm mark. Not all candidates were able to communicate this effectively even with the help of a diagram.

Mass *M* in part **(b)** was not always recorded to the nearest gram. This did not affect the ability to score subsequent marks.

In part **(c)**, mass *m* was usually calculated correctly. Sometimes too many significant figures were used.

Most candidates scored the marks in parts **(d) (e)** and **(f)**. Occasionally an inappropriate number of decimal places was used for recording the distances.

Many candidates were able to suggest one reason in part **(g)**. Two reasons were seen rarely.

CO-ORDINATED SCIENCES

Paper 0654/53
Practical Test

General comments

Instructions for drawing lines on graphs vary from question to question so it is important to read these with care.

Comments on specific questions

Question 1

The food tests in part **(a)** were well known. A few candidates did confuse the tests. Most knew that heat is needed for the test using Benedict's solution.

In parts **(b)** and **(c)**, the observations were generally accurate and were accompanied by appropriate conclusions.

In part **(d)(i)**, many candidates appreciated the need for controlling the quantities of the test solutions and the Benedict's solution. Perhaps fewer were able to state clearly how concentrations of reducing sugars could be compared using the final colour of the mixture.

In part **(d)(ii)**, many overlooked the simple answer and tried to discuss this in terms of different amounts of reducing sugars.

In part **(e)**, candidates are familiar with the reagents and observation for the test for fats but details of the method are less well known.

Question 2

The concept of concentration affecting the rate of reaction is well known. The practical skill needed for making up solutions of different concentrations was not always seen, resulting in some odd results.

In part **(a)**, candidates were asked to give all times to the nearest second. A relatively small number used a 'minutes: seconds' format, probably by reading directly from their stop clock, perhaps without understanding the figures.

In part **(b)**, averages were generally calculated accurately. Reciprocals were also calculated well. Some candidates did not round correctly or did not give their answers to three decimal places as specified.

Before drawing the axes on a graph, it is important to read through the remainder of the question in case there are any instructions or questions which demand a particular scale. In part **(c)**, the y-axis needed to begin at zero and this was actually shown on the grid provided. The standard of plotting of the points was high. Candidates had to draw the most appropriate line through the origin. In this case a curve could have been the most appropriate. A number of candidates did not draw their line through the origin.

Candidates did not experience problems in identifying and stating the relationship in **(c)(ii)**.

Part **(d)** provoked over simplistic answers such as 'marble chips would be used up'. More detailed answers were required.

Part **(e)** was well answered.

In part **(f)**, candidates needed to identify that an exothermic reaction would increase the temperature of the mixture and then explain the effect of this on the rate of the reaction. Some candidates discussed this in terms of temperature increase and temperature decrease without stating which would occur in an exothermic reaction.

Question 3

In part **(a)**, most candidates knew the symbol for a voltmeter. Sometimes it was positioned across one resistor only. The results produced in this experiment were generally good. Candidates were able to calculate the resistance but the units of resistance were not always stated correctly.

In part **(b)**, the circuit diagram was usually completed well. The readings for voltage and current were not always recorded to an appropriate accuracy.

In part **(c)**, some candidates interpreted the equation incorrectly, for example R_S being half of R_T. Of those who understood the equation many were unable to justify their statements when the R_T value was nearly half of the R_S value. It is important to be able to discuss acceptable and unacceptable deviations from the equation in terms of likely percentages of experimental error.

In part **(d)**, few candidates understood the need for opening the switch between readings. Many suggested that it was to do with maintaining cell voltage, which can be the case in other electrical experiments. In this case the main issue was the resistors heating up and changing their resistance.

Part **(e)** was answered both clearly and well.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper to be able to describe experimental procedures. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, stopwatches, rulers, thermometers etc. and record the values to the requested number of significant figures. Candidates need to be able to plan experiments and discuss the presentation of results.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of a very high standard, although sometimes not to the accuracy requested. Describing experimental detail proved to be very difficult for many candidates. The standard of graph drawing was generally high but chosen scales need to cover at least half of the grid and where a straight line is appropriate, it should be drawn with a ruler and be one single line of constant gradient. Designing an experiment proved to be very difficult for many candidates.

Comments on specific questions

Question 1

(a) Candidates found this quite difficult. The first column unit was often given as m or secs or 2 mins and the second column was frequently given as results which is too vague to be creditworthy.

(b) More able candidates gained some credit, usually for the reaction of starch and iodine. Many candidates thought that starch moved out of the membrane or that the starch was breaking down into sugar which then moved out of the membrane.

(c) (i) Few candidates gave a correct colour; the most common responses were colourless and blue-black.

(ii) The majority of candidates repeated the question that the starch breaks down into sugar without appreciating that all of the starch would be broken down.

(iii) Benedict's reagent and its associated colour changes were quite well known although heating was frequently omitted. Common incorrect responses included iodine, biuret, blue and brown.

Question 2

(a) (i) The test was quite well known. Common incorrect responses included nitric acid, barium nitrate and electrolysis. Of those that gave the correct reagent, the colour was often correct although brown was quite common but precipitate was often omitted.

(ii) The test was not very well known. Common incorrect responses included sodium hydroxide, silver nitrate and electrolysis. Of those that gave barium nitrate, few also added nitric acid and a significant number thought only nitric acid was the reagent.

(b) (i) Most candidates gained credit. A few thought the gas produced was oxygen.

(ii) The test for zinc was not well known. The most common incorrect response was bubbles. Of those that gave the white precipitate, few had it redissolving in excess.

(c) (i) The most common incorrect response was dissolving but others included: reaction with sodium hydroxide, destruction of the cation and zinc being used up.

(ii) Thermal and combustion were quite common incorrect responses.

Question 3

(a) (i) The majority of candidates measured the length correctly. Common errors: recording the length in mm, 7 and 0.65.

(ii) Common incorrect responses included giving the same answer as **(a)(i)** or dividing by 10.

(iii) Candidates found this difficult with many repeating the question, 'measure from the clamp to the centre of the bob', or, 'measure accurately'.

(b) Many candidates rounded the reading correctly but omitted the .0 when recording it.

(c) Many candidates calculated the two values correctly but then didn't record the values commensurate with the significant figures of the values already printed in the table.

(d) A significant number of candidates did not use more than half of the printed grid. Many candidates plotted the last four points correctly but plotted the first point at 60. Some drew a line between the four points clearly in a straight line and then joined this line to the anomalous point.

(e) Able candidates gained credit but many stated only that the line was a straight line which was not creditworthy as the question asked for a straight line to be drawn.

Question 4

(a) (i) Most candidates measured the lengths correctly.

(ii) The vast majority of candidates calculated the averages correctly.

(b) (i) Many candidates labelled the bars on the x-axis but didn't give a unit for the height on the y-axis and also many did not use at least half of the grid. The plotting of the points was usually correct but a few plotted the average results.

(ii) Common non-creditworthy responses included: for accuracy, to compare and reliability.

(c) Many candidates gained partial credit for the stunted growth but only the most able appreciated the quantitative link between the variables. A small number thought that the acid either killed or increased the growth of the seedlings.

(d) A significant number of candidates incorrectly gave the answer as water.

Question 5

(a) The majority of candidates gained credit but a few thought hydrogen or carbon dioxide.

(b) (i) The names of suitable indicators were well known by most candidates but many didn't give any observations or only gave one. There was also some confusion between the colours of litmus and the colours of Universal Indicator. A few candidates only discussed pH numbers with no reference to an indicator or a meter.

(ii) Many thought that either red litmus staying red or blue litmus staying blue was an indication of neutrality and a significant number gave litmus going green. Quite a few candidates gave Universal Indicator with no result or gave cobalt chloride paper going pink.

(c) Candidates found this very difficult. Many poured water from the bowl into the tubes or poured the tubes into the bowl containing water.

(d) Few correct responses with even fewer gaining full credit. The most common responses were hydrogen and oxygen with some nitrogen.

(e) Many candidates gained credit although a few described the test for hydrogen or oxygen.

Question 6

(a) A common error was to reverse the meters.

(b) Many candidates read the current correctly although 0.7 and 0.70 were quite common responses. The voltage proved to be more difficult. Common responses included 1.2, 1.25, 1.3, 1.4, 1.6 and 1.8.

(c) V/A was a common response for the unit and a significant number of candidates rounded the value for wire M incorrectly.

(d) Candidates often failed to gain any credit. Many repeated the experiment in the question but only for one more length of wire. Few chose a control variable and most presented the results in a table.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

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

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. The standard of graph drawing was generally high although candidates need to remember to include units on the axes and to draw smooth curves with a single line. Knowledge of identification tests for ions was limited.

Comments on specific questions

Question 1

(a) Most candidates read the rulers correctly. 3.0 and 3.2 were common incorrect responses for the height at 2 minutes.

(b) For some candidates the units were missing and the curve was often feathery with multiple lines.

(c) (i) Many discussed the results of the experiment rather than the shape of the curve.

(ii) Many discussed the height of the foam and many thought the rate increased during the experiment.

(d) Common incorrect responses included: lighted split either relighting or burning brighter, lighted or glowing splint popping, limewater going cloudy and the celery causing the oxygen bubbles in the foam.

Question 2

(a) (i) The most common incorrect response was Fe(III).

(ii) Most candidates read the thermometer scales correctly but a significant number recorded T_i as 23 rather than 23.0.

(b) (i) Almost all candidates subtracted the values correctly.

(ii) Many candidates chose an appropriate linear scale and plotted the points correctly. Quite a few found drawing the line more difficult. Many joined the points rather than drawing a straight continuous line with a ruler and a significant number did not put the line through the origin.

(iii) Many candidates stated that the line was a straight line which was not creditworthy as the question asked for a straight line to be drawn.

(c) (i) Common incorrect responses included combustion and endothermic.

(ii) Non-creditworthy responses included same initial temperature and stirring.

Question 3

(a) Candidates should be encouraged to gain more experience of answering this type of question. Many repeated the question answering with 'put the centre of the cube on the 15 cm mark'.

(b) (i) Most candidates read the scales correctly. A small number recorded 30.6.

(ii) The majority of candidates subtracted correctly.

(iii) The majority of candidates subtracted correctly.

(c) (i) Common incorrect responses included: 84.43, 84.40 and 84.

(ii) Many candidates calculated correctly but then gave their answer to too many significant figures. A small number inverted the division.

(d) Candidates found this very difficult. Incorrect responses included clay contains air, clay contains water, the density of the clay will change and the distances are inaccurate.

(e) Many candidates had both distances either increasing or decreasing.

Question 4

(a) (i) The majority of candidates read the ruler to the level of the water in the beaker (1.7 cm) rather than the level of the water in the glass tube. The reading was often given in mm.

(ii) The two most common errors were 1.8 cm or 18 mm and 35 mm.

(b) (i) Most candidates subtracted correctly.

(ii) Many candidates calculated the speed correctly. Common errors included dividing by 2 and dividing by 5.

(iii) Many candidates gave generic answers rather than explanations specific to this experiment such as water moves from a high concentration to a lower one, without specifying the direction of travel or which concentrations they were discussing.

(c) The sample to be tested was often omitted. Benedict's reagent was well known but a significant number used iodine or cobalt chloride paper. Heating was often omitted but the expected negative result was quite well known. A significant number of candidates suggested physical methods such as evaporating and there would be no residue or checking the boiling point.

(d) Many candidates had the starch moving or nothing moving.

Question 5

(a) (i) The majority of candidates gained credit. Nitric acid was seen quite often.

(ii) More able candidates gained credit. Some gave either white or precipitate but not both and some just said that it reacted.

(iii) The chloride test was not well known. The majority of candidates used litmus or another indicator or sodium hydroxide or limewater.

(iv) The test was well known but a significant number of candidates thought the precipitate would redissolve. A significant number thought the precipitate was white.

(b) (i) Many candidates chose an appropriate piece of apparatus. Beaker was the most common incorrect response.

(ii) Indicator names were well known but many confused the colours of litmus and Universal Indicator. A significant number gave a named indicator paper rather than a solution.

(iii) Most able candidates gained credit. The majority thought that the volume of solution was already known and so the indicator was not needed or that it was there as a control.

(iv) Filter and crystallise were the two most popular non-creditworthy responses.

Question 6

(a) Most candidates read the scales correctly.

(b) Many candidates chose scales which covered more than half of the grid and gained credit for the points and the curves but many did not include units on the axes. Some of the curves were feathery with more than one line.

(c) (i) Of those candidates who chose **G,** many repeated the question rather than explaining their choice in terms of temperature. Many candidates chose **F**.

(ii) Many candidates gained credit as error carried forward from **(c)(i)**. A significant number chose two metals or two non-metals.

(d) Common incorrect responses included 0°C, 10°C and 60°C.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key messages

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

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of a high standard, although sometimes not given to the accuracy requested. The standard of graph drawing was generally good but chosen scales need to cover at least half of the grid and drawing a curve with a single line proved challenging for some candidates. Designing an experiment proved to be very difficult for many candidates as did completing apparatus diagrams.

Comments on Specific Questions

Question 1

(a) Reagents were well known but Benedict's and biuret were often reversed. Many candidates did not know which test required heat, often giving heat needed for both Benedict's and biuret.

(b) Common incorrect responses included; incorrect colours for the negative tests and the colours for Benedict's and biuret reversed.

(c) Many candidates knew the colour for a positive Benedict's test but the colour of iodine was less well known with purple, brown and yellow being common.

(d) Candidates found this very difficult with the result for the different concentrations of sugar often being the only creditworthy point. A common response detailed timing the solution to go red or timing to the deepest colour.

Question 2

(a) Most candidates recorded the times correctly. 30.22 was the main error for t_1 and 31.8 or 31 for t_2.

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

(ii) Some candidates did not record the values to the required three decimal places.

(c) (i) Many candidates gained credit for the axes but some gave non-linear parts to the *y-axis* close to the origin or didn't use at least half of the grid. Most plotted the points correctly. The curve proved to be a little more difficult with several candidates drawing feathery curves with multiple lines or not passing their curve through the origin.

(ii) A significant number drew a curve but described the relationship as directly proportional.

(d) More able candidates gained credit. Many candidates chose one of the other two values because they did not fit onto their drawn line on the graph.

(e) Incorrect responses included: contaminated chips, all gas already released, all energy released and the most popular not a fair test. A significant number omitted this part.

Question 3

(a) (i) Many candidates gave the correct symbol for the voltmeter but then connected it in series or connected it in parallel between incorrect points on the circuit.

(ii) Almost all candidates read the meter correctly.

(iii) The most common incorrect value was 0.22.

(iv) Most candidates calculated the value correctly but some didn't round their answer correctly. The unit was well known.

(b) The vast majority calculated the value correctly.
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(c) Some candidates did not refer to the data and a significant number argued for the three resistors being 3 · 5 = 15.

(d) Many thought the circuit would overheat, that the student was less likely to be electrocuted, to save energy or that the current would increase.

(e) Commonly, candidates discussed how the resistance would change rather than the reading on the ammeter.

Question 4

(a) Almost all candidates gained credit.

(b) (i) The most common non-creditworthy response was plants take in carbon dioxide with no reference to the process.

(ii) Common errors included either animals giving out or breathing out carbon dioxide with no reference to the process.

(iii) Whilst many candidates appreciated that the carbon dioxide produced by animals was taken in by plants far fewer appreciated that these would be in balance.

(c) The idea of control was well known with ‘to compare’ being the most common non-creditworthy response.

(d) (i) Many found this difficult. Few gave a method and opted for putting them in the same room. Many gave room temperature rather than a value and those that gave a value often did not put units on the number.

(ii) Almost all gained at least partial credit with many gaining full credit. A significant number did not qualify their factor for example ‘tadpoles’ without amount or size.

Question 5

(a) (i) Many candidates included a bulb and an ammeter or a switch with no power supply.

(ii) A wide variety of oxides were given but the most common were iron(III) oxide, magnesium oxide and carbon oxide.

(b) (i) Candidates found this very difficult. Most did not put the thermometer into a stopper but put it into the liquid in the flask and resting on the bottom of the flask and some put it into the beaker. Of those that put the thermometer in a stopper most put the thermometer into the liquid or into the space just above the level of the liquid.

(ii) Almost all candidates read the thermometer correctly. The most common incorrect response was 99°C.

(iii) Many thought this was the start of the boiling process or that it was near enough to round to 100 or that an impurity lowered the boiling point of a substance. Many also used pH paper, cobalt chloride paper or copper sulfate powder.

(c) Common incorrect responses included calcium oxide and carbon oxide.

(d) Electrolysis was a common incorrect response.

Question 6

(a) (i) Most candidates read the measuring cylinders correctly but many didn't record them to the correct accuracy and so didn't gain full credit. Common incorrect readings included 20.9 for **R** and 40.1 for **S**.

(ii) More able candidates gained credit.

(b) Most candidates calculated the values correctly.

(c) (i) Beaker and glass were the most common incorrect responses. Many candidates chose apparatus that would not usually be found in a laboratory.

(ii) The most common non-creditworthy responses included: rounding to 60 would not involve much error and that it was the mass of liquid that was required not the mass of the liquid and measuring cylinder.

(iii) Most candidates gained credit. Some thought that the weighings should be more accurate.

(d) (i) Many candidates chose **S** but often didn't gain credit as low density was given as the reason. A significant number of candidates chose **R** because it had a high density.

(ii) Many candidates put the liquids into three layers or one layer.