CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice 11

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

Comments on individual questions (Biology)

In the Biology section, all questions fell comfortably within the range of the candidates' abilities.

Question 1 the somewhat hypothetical flower shown in the diagram confused a few candidates who otherwise performed well on the paper. Two separate ovaries are shown, each with one ovule, but some, assumed that the flower had only the one ovary and thus there were two ovules present. In this respect, the question failed to test the candidates' abilities to follow a dichotomous key as was the intention.

Question 2 this proved to be the most difficult question in the section, and hinted at the common misconception that 'plants respire by the process of photosynthesis'. Thus, almost as many candidates believed that the major site of respiration in a plant cell is in a chloroplast as believed that it is in the cytoplasm.

Question 3 this was one of the easiest questions on the section, and candidates are to be congratulated on successfully navigating their ways through the not inconsiderable amount of information given in the question.

Question 11 the word 'must' appeared five times in the question, but even so, over a quarter of the candidates selected an answer that referred to a situation that *might* be correct, but not *must* be correct (namely that one parent of a girl with red hair *might* carry a dominant allele).

Question 12 this was, again, an easy question, but it exposed just a few candidates who were confused about the meaning of arrows in a food chain, and, in particular, of arrow 1 in this food chain.

Comments on individual questions (Chemistry)

Questions 15, **16** and **22** proved particularly straightforward with the majority of candidates selecting the correct answer.

Questions 17, **21**, **23**, **26** and **27** proved to be the most difficult with less than half of the candidates selecting the correct answer.

Question 17 more candidates chose option **C** than the correct response. They presumably chose the first response to mention silicon without reading to the end.

Question 24 candidates clearly did not know that nitrogen oxides are acidic (non-metal oxides).

Question 27 candidates correctly understood that a negative ion would be formed but confused the effect of a change in the number of electrons with the effect of a change in the number of protons.

Comments on individual questions (Physics)

Question 28 dealt with density and was found quite difficult, leading to widespread guessing.

Question 29 on the average speed was answered well.

Question 30 a significant number of candidates chose option **C**, these candidates failing to notice or understand that there would be a turning effect produced by the two forces.

Question 31 on pressure was well understood.

Question 32 on specific heat capacity was less secure with distractors **A** and **D** being popular.

Question 33 required knowledge of the Ohm's law equation, the most common error involved dividing current by voltage to find resistance.

Question 34 on electrical safety was well answered.

Question 35 on resistance, using length and diameter of a wire, showed evidence of guessing.

Question 36 involved a simple understanding of the meaning of frequency, and most candidates understood this concept.

Question 37 on lenses however, more candidates chose option **C** rather than the key, not appreciating that the rays in this option were *ending* at O, rather than starting at it.

Question 38 option **D** was the popular distractor, confusion being apparent between magnetic poles and electrical charges.

Question 39 more than one in five candidates believed gamma-rays to be positively charged.

Question 40 had mixed responses, suggesting that the concept of half-life is not well understood.

CO-ORDINATED SCIENCES

Paper 0654/12

Multiple Choice 12

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

Comments on individual questions (Biology)

In the Biology section, all questions fell comfortably within the range of the candidates' abilities.

Question 1 a few candidates appeared to believe that the arrival of pollen grains on the stigma signals the completion of fruit formation, rather than of the process that *leads* to fruit formation.

Question 3 this proved to be the most difficult question in the section, and hinted at the common misconception that 'plants respire by the process of photosynthesis'. Thus, almost as many candidates believed that the major site of respiration in a plant cell is in a chloroplast as believed that it is in the cytoplasm.

Question 10 this was one of the easiest questions on the section, and candidates are to be congratulated on successfully navigating their ways through the not inconsiderable amount of information given in the question.

Question 11 almost a third of the candidates thought that protein provides more energy than fat, thus exposing a rather serious misunderstanding.

Question 13 this was, again, an easy question, but it exposed just a few candidates who were confused about the meaning of arrows in a food chain, and, in particular, of arrow 1 in this food chain.

Comments on individual questions (Chemistry)

Questions 19, **23**, **24**, **25** and **26** proved particularly straightforward with the majority of candidates selecting the correct answer.

Questions 15 and **17** proved to be the most difficult with less than half of the candidates selecting the correct answer.

Question 17 candidates clearly did not know that nitrogen oxides are acidic (non-metal oxides).

Question 20 candidates got the litmus colour change correct but did not fully understand the test.

Question 27 more candidates chose option **C** than the correct response. They presumably chose the first response to mention silicon without reading to the end.

Comments on individual questions (Physics)

Question 28 on pressure was well understood.

Question 29 required knowledge of the Ohm's law equation, the most common error being to believe that resistance is found by dividing current by voltage.

Question 30 on average speed was well answered.

Question 31 had mixed responses, suggesting that the concept of half-life is not well understood.

Question 32 option **D** was a popular distractor, confusion being apparent between magnetic poles and electric charges.

Question 33 on lenses more candidates chose option **C** rather than the key, not appreciating that the rays in this option were *ending* at O, rather than starting at it.

Question 34 on density, although reasonably well answered, showed evidence of guessing.

Question 35 a significant number of candidates chose option **C**, failing to notice or understand that there would be a turning effect produced by the two forces.

Question 36 on specific heat capacity was less secure with distractors **A** and **D** being popular.

Question 37 on resistance, using length and diameter of a wire, showed evidence of guessing.

Question 38 on electrical safety was well answered.

Question 39 involved a simple understanding of the meaning of frequency, and most candidates understood this concept.

Question 40 the most common mistake was to believe that gamma-rays are positively charged.

CO-ORDINATED SCIENCES

Paper 0654/21

Core Theory 21

General comments

Most candidates were able to attempt most questions. Parts of some questions seemed quite inaccessible to many candidates. There was a good range of marks on most questions. Candidates generally gained marks on all questions. Very few gained no marks on any question and very few gained full marks on any question. Although it appeared that candidates often knew the answers to the questions, their answers were often very vague. Language difficulties may have played some part here, although the general level of English was good. Performance depended not only on scientific knowledge but on the ability to understand the question.

It was apparent that when a numerical answer was required, weaker candidates merely took any numbers that were given in the question and either multiply them or divide them. In some cases it was necessary to refer back to previous parts of a question to find the correct data. Quite often the candidates made up a formula / equation to confirm this. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided.

There was no evidence of candidates running short of time to complete the examination. **Questions 8, 9** and **10** at the end of the paper, where fatigue and concentration factors, may have contributed to lower marks being gained. This may have affected the overall outcome in that they presented more difficulty to candidates.

Comments on specific questions

Question 1

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

(a) A number of candidates were unable to label the brain correctly**.**

(b) Most candidates answered this exercise well, gaining at least three marks.

(c) Again most candidates answered this exercise well, gaining at least two marks.

Question 2

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

(a) (i) Metamorphic was not well known for rocks **B** but many candidates identified igneous for rock **C**.

(ii) Many candidates were able to refer to heating.

(b) (i) This was poorly answered. Very few candidates were able to link the carbon dioxide gas produced to the presence of a carbonate in the soil.

(ii) Ammonia was not well known.

(iii) Ammonium ions were not well known.

Question 3

Most candidates gained some marks on the calculations.

(a) There were many correct formulae given followed by incorrect substitution.

(b) Candidates frequently knew the correct formula but then forgot that the total distance travelled was 600 m.

(c) Many candidates used outdated symbols or a pictorial form of the component. The candidates needed to use accepted symbols.

(d) Many candidates gained full marks on this part.

(e) Many candidates knew that the rays of light needed to come to a focus on the twigs, however some candidates failed to produce the focus there.

Question 4

(a) (i) Protein was not well known. The most common wrong answer was cellulose.

(ii) Monomers were not well known.

(iii) Glucose was reasonably well known.

(b) (i) Many candidates were able to name two uses for wood.

(ii) 'Loss of habitat' was a frequent correct answer.

(c) There were few awards of three marks – apart from those candidates muddling thermoplastic and thermosetting there was little recognition of the thermoplastic cycle and many candidates assumed both material were thermoplastic.

Question 5

(a) There were many confused answers in both part **(i)** and part **(ii)**.

(b) There were a large number of creditworthy responses indicating that valves prevent backflow but no responses indicating that pressure change was involved in the closure.

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

(ii) Iron was not well known.

(iii) There were some very generalised responses relating to blood and no references to cells – respiration was frequently not mentioned. Many responses focused on the blood needing oxygen to move round the body.

(d) White blood cells fighting disease was well known. However few candidates took this further by referring to pathogens, viruses or bacteria.

(e) (i) The secretion of insulin was well known but not what the role of insulin or the liver were.

(ii) The liver was not well known. A common wrong answer was the kidney.

Question 6

(a) (i) Most candidates chose solution **X** and solution **Y** because their pH values added up to 7.7 which was about neutral. Clearly this shows a lack of understanding of the key ideas of neutralisation and pH.

(ii) Many candidates were able to suggest that the pH meter would detect a neutral pH of 7 but very few suggested how the pH meter might be used.

(iii) The idea that litmus indicator only tells you whether something is alkali or acid and that a pH meter tells you the precise pH was quite well understood.

(b) (i) This was not well known. The two correct answers of 'calcium sulfate and magnesium chloride' were no more frequent than any of the other options.

(ii) Boiling the water was well known as a solution.

(c) Many candidates seemed to know what the answer was but lost marks because they were unable to explain their ideas scientifically. For example, candidates were unable to distinguish between atoms and molecules in the explanation. Many candidates frequently referred to 'mixing elements to make compounds'.

Question 7

(a) Few candidates answered this correctly. Few candidates gained two or more marks. Many candidates confused thermal radiation with ionising radiation. Many candidates mentioned heat transfer mechanisms which controlled the distribution of heat energy around the house rather than through the wall.

(b) This was well known by many candidates.

(c) (i) 60 W was well known.

(ii) Knowing that the resistance will double if the length if the resistance doubles was well known.

(iii) Electric (energy) into heat and light was well known.

(iv) A part of the electromagnetic spectrum and its use was well known.

(d) (i) Many candidates were able to explain the basic process relating to the situation.

(ii) The idea that aluminium is not magnetic and therefore would not work in the system was not well known.

(iii) Few candidates appreciated that the iron core would still act as an electromagnet and therefore still attract the iron bolt.

(iv) Most candidates managed to produce a satisfactory answer for this part.

Question 8

This question was quite poorly answered, showing that many candidates lacked a basic knowledge and understanding of the concepts.

(a) Few candidates were able to identify a suitable detector. Some tried to explain which materials would stop the radiation.

(b) (i) A number of candidates referred to removing electrons from atoms. Few referred to the formation of ions.

(ii) This was not understood. Very few candidates gave the answers the Examiners expected. Many candidates lost a mark due to their vagueness.

(c) Frequently candidates offered no response to this part. The idea of nuclear break up was not well known.

(d) Many answers were very vague. Candidates were asked to describe rather just state methods used.

Question 9

This question was very poorly answered.

(a) (i) 'Roots' was a very popular correct answer.

(ii) Few candidates appreciated that nitrogen gas was unreactive.

(iii) Very few candidates appreciated that proteins or amino acids were produced.

(iv) Very few candidates appreciated the link between some component being missing from the soil meant that plants would not grow properly.

(v) The only marking point commonly seen was the idea that something needed to be broken down and took time.

(b) (i) Osmosis was well known.

(ii) Carbon dioxide and water were well known in this equation, but too many candidates reversed the answers.

(iii) Palisade or mesophyll cells was not well known.

(iv) Many candidates were able to explain the process of evaporation.

Question 10

(a) Few candidates correctly identified the positions for either **X** or **Y.**

(b) (i) Most candidates identified one difference between the two metals.

(ii) Few candidates referred to heating with carbon. Some said use a blast furnace, which was too vague. Candidates were unable to explain what happened during reduction.

(c) (i) Carbon dioxide and water were well known as the combustion products for a hydrocarbon.

(ii) Many candidates inaccurately referred to oxygen as a fuel 'oxygen burns better'.

Many candidates seemed to understand but be unable to express the idea that other gases 'dilute' the oxygen.

CO-ORDINATED SCIENCES

Paper 0654/22

Core Theory 22

General comments

Most candidates were able to attempt most questions. Parts of some questions seemed quite inaccessible to many candidates. There was a good range of marks on most questions. Candidates generally gained marks on all questions. Very few gained no marks on any question and very few gained full marks on any question. Although it appeared that candidates often knew the answers to the questions, their answers were often very vague. Language difficulties may have played some part here, although the general level of English was good. Performance depended not only on scientific knowledge but on the ability to understand the question.

Question 1 seemed to cause many candidates difficulty.

It was apparent that when a numerical answer was required, weaker candidates merely took any numbers that were given in the question and either multiplied them or divided them. Quite often the candidates made up a formula / equation to confirm this. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided.

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

Comments on specific questions

Question 1

This question was poorly answered.

(a) Few candidates were able to identify kinetic as the form of energy.

(b) Few candidates were able to state either uranium or plutonium as a nuclear fuel.

(c) (i) Many candidates tried to recycle the question and describe a non-renewable fuel as 'a fuel which could not be renewed'. A correct answer needed to mention that these fuels will run out or are being used up more quickly than they are being formed.

(ii) This was well answered, although a number of candidates answered too vaguely referring only to water rather than hydroelectric power or tides or waves.

(iii) An answer of 'less pollution' was not considered sufficient. The answer needed to state where there would be less pollution.

(d) Considering the question primed the candidates by mentioning energy loss, most candidates failed to state that the reason was to reduce energy losses. The idea that the current was reduced was not well known.

(e) (i) Many answers here were too vague. Many candidates suggested that the nuclei separated. It was not clear whether this meant that a single nucleus separated into smaller parts or whether it was just one nucleus separating from another.

(ii) Surprisingly few candidates were able to answer this correctly.

Question 2

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

(a) This was generally well answered.

(b) Far too many candidates failed to gain both marks here. Many candidates seemed to misunderstand the question.

(c) Most candidates tried to use the data given in the results table. Many candidates did not however know the tests for starch and protein sufficiently well.

(d) This part was rarely answered correctly. Kidney was a common wrong answer.

(e) Many candidates managed to gain at least one mark, but very few scored three.

Question 3

(a) (i) Many candidates correctly identified hydrogen as the gas.

(ii) Very few candidates managed to identify even one of the products. The candidates seemed to know some of the products but were unable to place them in the right position.

(iii) The more able candidates seemed to realise that graphite was a good electrical conductor. Few appreciated that it was unreactive.

(iv) The chemical test for chlorine was well known.

(**b) (i)** Many candidates forgot to include ‘only’ after their description that carbohydrates contained carbon, hydrogen and oxygen.

(ii) There were many correct answers of 42.

(iii) Most candidates found this part hard. They were unable to explain that fewer kilojoules would be consumed or that less can be used.

Question 4

(a) (i) Many candidates misread the question and only showed one block which would move.

(ii) This was well answered.

(iii) Gravity was well known.

(iv) The Earth was well known as the source of gravity.

(b) This was well answered showing good data handling skills.

(c) Whilst many candidates gained all three marks here, a number included misplaced voltmeters and some incorrect cell symbols were used.

Question 5

(a) (i) There were many good answers here, with many candidates gaining at least one mark.

(ii) Many candidates were on the wrong track here. Few mentioned energy and even fewer what the energy was used for.

(b) (i) **Many** candidates gained one mark here but very few gained all three. Identification of **R** as the stoma was the common correct answer.

(ii) Candidates found this very difficult. There were very few correct answers.

(iii) This part was very poorly answered. There were few answers which mentioned water loss. Most answers were about protection from sunlight.

(iv) There were few answers which gained full marks. Most candidates however gained either one or two marks for mentioning diffusion, stomata or air spaces.

(c) Many candidates correctly suggested the environment but less were able to justify their answer.

Question 6

(a) There were few fully correct answers. The neutral pH of 7 was better known than the weakly acidic pH of 5.

(b) (i) This was well answered by the more able candidates.

(iii) Factors reducing the rate of the reaction were not well known or perhaps the candidates were unable to describe them clearly enough.

(iii) Magnesium chloride and hydrogen were commonly given.

(c) (i) Most candidates gained the metallic answer by stating a valid property of metals. The candidates description of an element was less clear.

(ii) Most candidates were able to provide the name or symbol of another Group II element.

(iii) This was quite well answered but many candidates did not read the question carefully and used a value of 24 instead of 26 for the nucleon number.

Question 7

(a) (i) Many candidates got this part right choosing the section from **A** to **B**.

(ii) The car speed between **C** and **D** was well known.

(iii) The formula for momentum was not well known. Consequently many calculations were wrong.

(iv) Many candidates were able to gain the mark for the answer. However less gained the mark available for the working. It was not expected that the candidates would be able to provide a formula for this calculation.

(b) (i) Many candidates correctly derived an answer of 90 Nm. However, less candidates were able to provide the correct formula.

(ii) Most candidates thought that they would need to use a greater force but many also thought that a shorter lever would be better.

(c) Predictably, many candidates chose yellow and red.

Question 8

(a) This question was well answered by the more able candidates. Many candidates seemed to be guessing.

(b) (i) This was quite well done, considering the difficult numbers used.

(ii) The correct answer was no more common here than the other seven possible answers.

(iii) Most candidates had the right idea but failed to give enough information to award the mark.

(c) (i) Anaerobic was well described but few candidates were able to explain what respiration was.

(ii) Lactic acid was well known. ‘Latic acid’ was a common wrong spelling for.

(iii) This was not well answered. Most candidates thought that the lactic acid was sweated out after the race was over.

Question 9

(a) There were surprisingly few correct answers for this part.

(b) Most candidates had some idea here. Most candidates were unable to explain that the hydrogen was unavailable because it was combined in the water.

(c) (i) This part was fairly well answered.

(ii) While many candidates were able to gain one mark here, few gained all three.

(d) (i) This was not well answered. Many answers seemed unfinished.

(ii) Well answered.

(iii) This part was quite well answered.

CO-ORDINATED SCIENCES

Paper 0654/31

Extended Theory 31

General comments

Most candidates made a reasonable attempt at most questions, and few parts of questions were omitted. There was little apparent difficulty in interpreting questions, and expression of ideas and use of English was often good. A significant number found difficulty in applying learned knowledge to unfamiliar contexts used in the examination questions. There was a risk of marks being lost unnecessarily through poor exam technique, specifically not taking advantage of all the information supplied in a question, not structuring extended answers and omitting units. There was no evidence that candidates were short of time.

Comments on specific questions

Question 1

(a) (i) Most candidates identified the vessels containing oxygenated blood correctly.

(ii) Many correctly identified the veins.

(iii) Most knew that the bicuspid valve opens and closes during one heartbeat, but several simply described the flow of blood through the valve. Some did not gain marks by describing the valve as ‘relaxing’ or ‘contracting’. Hardly any described a mechanism for operation of the valve as being pushed open or shut when the atrium or ventricle contracts.

(b) Most candidates could use the information to compare the oxygen content in the right side of the heart in a fetus with that in an adult. Some simply compared the blood in a fetus generally with that of an adult. Hardly any mentioned the mixing of oxygenated and deoxygenated blood in the fetus.

(c) (i) Most knew that haemoglobin is the pigment in blood.

(ii) Relatively few knew that it is a protein.

(iii) Most stated that iron is the inorganic ion required to make haemoglobin.

(iv) It was generally recognised that iron ions are small enough or do not need to be broken down, but less stated the role or described the process of absorption. Several thought that iron ions were not used by the body and excreted.

(v) The need for oxygen for respiration was well known but the description of the provision of energy was often described as production rather than release.

Question 2

(a) (i) Most candidates suggested cancer as an example of damage caused by UV but it was not always explicit that the damage occurred in the skin.

(ii) Many could suggest measures to protect the skin from exposure to UV, although answers with ideas involving reflection from shiny suits rather than absorption were not credited.

(b) The calculation was well done with the formula identified and units given, but many missed the need to double the distance between climber and mountain.

(c) The momentum formula was known by most candidates but a mark was often lost due to incorrect or missing units. Candidates need to know how to derive units from given formulae.

(d) (i) The circuit diagram was well drawn by the majority of candidates.

(ii) The voltage calculation proved to be easy for most, although some forgot to include units.

(e) Many could explain the formation of static charge but missed the friction mark. A minority assumed that the nylon had a charge before it was rubbed. Others referred to moving positive charges or protons.

(f) Many drew the ray diagram well, although some lost a mark by not using a ruler, suggesting that they did not appreciate that light travels in straight lines through space. The most common mistake was to not realise that rays from the Sun arrive parallel. Arrows were often omitted.

Question 3

(a) Most candidates gained some marks, referring to ideas about mutation and cancer. Statements referring to ionised cells suggested that the ionising effect was not well understood. Some candidates were preoccupied with radiation that cannot penetrate being 'trapped in the body'.

(b) (i) Reference was made to atom splitting more often than nuclear fission.

(ii) Some candidates had obviously thought about the advantages and disadvantages of nuclear power and were aware of the problems arising from the need to store nuclear waste. Others made ill-informed statements about the possibility of nuclear explosions and even global warming.

Question 4

(a) (i) A minority of candidates confused 'endothermic' with' exothermic'.

(ii) Some described the shape of the graph rather than interpreting the information in the figure, but most used the temperature changes to explain the end point of the neutralisation.

(b) (i) Whereas most could apply the formula provided, many candidates could not (or did not realise the need to) convert cm^3 to dm^3.

(ii) Even those who found the mole ratio to be 1:2 often failed to use that as an explanation for their result, or applied it incorrectly to get an answer of 2 moles of acid instead of 0.5.

(iii) A pleasing number of higher achievers in the cohort could write the ionic equation.

(c) (i) Many candidates recognised the process to be an example of electrolysis.

(ii) Only the more able candidates were able to apply their knowledge of electrolysis to explain the processes occurring in the cell in terms of the K^+ ion migrating and being discharged at the platinum plate, which formed the negative electrode. The most common misconceptions were that the electric current decomposed the potassium hydroxide into ions, and that platinum reacted with the potassium hydroxide. The charges on metallic and non-metallic ions were not well known.

Question 5

(a) Many candidates lost marks in this question due to failure to note the pointers provided in the question. Three marks were available for use of the ideas of 'conduction, convection and radiation'. Foam was generally not recognised as a poor conductor due to its trapped air. Describing it as an insulator did not add to information provided in the question. Convection was often confused with the possibility of draughts through the brickwork and few candidates were aware of the convection current which occurs in an air filled cavity, or its prevention by trapped air pockets in foam. Reflection of radiation by shiny surfaces was better understood, although some tried to explain this as a failure to absorb.

(b) (i) The explanation involving the relationship between the relative number of turns in transformer coils and its output voltage was described correctly by many.

(ii) The possibility of electrocution or ‘shock’ was usually provided as an example of the danger of using unprotected appliances in a bathroom, but fewer went on to gain the second mark and explain that this was due to water conducting electricity.

(c) (i) The majority of candidates could apply their knowledge of magnetism to this situation. Simple statements of the flow of current through the coil producing an electromagnet which attracted the iron bolt gained full marks. Those with a less clear understanding wrote about a current in the core and implied that the coil or bolt was turning. Misuse of the word ‘induced’ was common. There was some confusion between magnetic and electric fields as the core was sometimes described as charged with positive and negative ends.

(ii) Many knew that aluminium is not magnetic, but a number of candidates suggested that it would not work because it does not conduct electricity or that it would work because it is a metal.

(iii) Not as many candidates realised that the device would work because the coil was still an electromagnet. That ‘the bolt was now repelled’ was a common response. Several mixed information from different question parts being confused that this was now an alternating current, although that would still not have affected the working of the device.

(iv) Most candidates knew that increasing voltage or number of coils would increase the strength of the electromagnet.

Question 6

(a) (i) Few candidates knew that ammonium ions are found in NPK fertiliser. Those that did sometimes failed to include the charge in the formula.

(ii) The most common explanation why the fertiliser gave a higher yield was that more nutrients were supplied. It was expected that candidates show knowledge of limiting factors by stating that fertiliser compensates for a shortage of nutrients, and better candidates wrote of nutrients in the soil being replenished after a previous crop. The functions of the elements N, P and K were often combined together in vague statements about improved growth.

(iii) Poor exam technique often prevented award of full marks here. Candidates cannot usually gain credit by simply copying data from a table. In this case yields needed to be compared and the difference stated with units. In the case of the wheat crop, an appreciation of the insignificance of any difference was required. Some difficulty was experienced in obtaining the unit ‘tonnes per hectare per year’ from the reciprocal heading in the table.

(iv) Some candidates used the information given in the question by stating that the bacteria act as decomposers of the manure. Fewer stated the constituents of the manure, or the composition of those constituents, so could not go on to suggest substances that become available to plants. Some reference to nitrifying bacteria was made, but the prevalent misconception was that nitrogen fixing bacteria are involved.

(b) Higher attaining candidates could state succinctly that leached fertiliser stimulates growth of algae, leading to an accumulation of dead plants that are decomposed by bacteria, which respire and reduce oxygen concentration. Some omitted links in this process. Common misconceptions included reaction between fertiliser and oxygen, and reduction of photosynthesis by plants shaded by the algae.

Question 7

(a) (i) Many candidates knew that glucose is the monomer that forms starch.

(ii) It would appear that the majority chose a substance that burns to produce oxides of nitrogen at random with no logical reason. Unfortunately some of those that correctly chose protein because it contains the elements nitrogen and sulfur failed to state that it is the *only* substance in the list to do so. A few candidates successfully made the converse argument.

(b) (i) There were many good answers that explained the low melting point of nylon in terms of weak intermolecular forces. Few went on to gain the third mark by explaining that molecules are able to move past one another, that the melt can be pumped through small holes, that solid threads are formed when it cools or to describe the change in size of the intermolecular forces in the solid.

(ii) That crosslinks between molecules prevent melamine melting was often known, but candidates would frequently then contradict themselves by saying that it has a high melting point. Marks were not awarded for a description of poor conduction of heat.

Question 8

(a) Most candidates could label the eye correctly, but many betrayed a lack of confidence by pointing their label lines for the retina and optic nerve at the fovea or the depression in front of it. In general precise labelling of structures in biological diagrams is expected. Some attached the **A**, **B** and **C** letters to the labels already on the diagram.

(b) Although some good answers were seen, confusion was apparent in this question. Some mixed up focusing a nearby object with a distant one, so the ciliary muscle would incorrectly relax to make the lens thinner. The suspensory ligaments were often described as relaxing rather than loosening. The physics of the focusing of light on the retina through increased refraction was rarely included. A common misconception was that accommodation is linked to control of light intensity.

(c) Some excellent answers were submitted here. Successful candidates had learned about a well-understood autosomal condition, stated that it was due to a recessive or dominant allele and explained whether one or both parents would have that allele if the disease was inherited. Sometimes the family genotypes were shown. Those that tried to explain the inheritance of an X-linked disease or one that involves an inherited predisposition to the disease did not usually gain full marks. There were many suggestions of diseases which are not inherited.

Question 9

(a) Most candidates correctly placed at least two of the elements in the Periodic Table outline. **X** was most frequently misplaced in the 4^{th} period.

(b) (i) Most knew that metals consist of atoms of the same size, closely packed in a regular lattice. Poor drawing was the most common reason for not gaining the mark, as the intention of the candidate was not always clear to the Examiner. There was no need to completely fill the box (as a solid was being represented), especially with smaller, squashed circles. Compasses or a circle template would help in this common question type.

(ii) There were many good answers describing electrical conduction in terms of mobile electrons, but a surprisingly large number were explanations of the conduction of heat energy by passing on vibrations.

(c) (i) Many candidates correctly suggested that the use of argon prevents oxidation of the metal in MIG welding, but only a minority mentioned the relevance of high temperature.

(ii) Almost all found drawing the 2,8,8 electronic configuration of argon easy.

(iii) The majority of candidates ascribed the lack of reaction of argon with hot metals to its complete outer electron shell but did not always include the lack of tendency to gain or lose electrons.

CO-ORDINATED SCIENCES

Paper 0654/32

Extended Theory 32

General comments

The great majority of candidates had been appropriately entered for this Paper, with relatively few gaining low marks. There were many excellent performances, with numerous candidates gaining most of the available marks. Language only very rarely caused any difficulties.

Candidates should be aware that they will be expected to carry out calculations, and that Examiners will assume that they have access to a simple calculator. Some clearly did not have one, so that answers were left as fractions. This is not ideal.

Comments on specific questions

Question 1

(a) (i) to (iv) Many candidates named all four proteins correctly. The one that was most likely to cause difficulty was **(iv)**, antibodies, for which the most common incorrect response was 'lymphocytes'. Some candidates suggested iron for **(i)**.

(b) (i) Not surprisingly, kidneys often featured here. The correct answer, liver, was given by fewer than half of all the candidates.

(ii) There were some excellent answers to this question, and many candidates gained all three marks. However, there was also a great deal of misunderstanding and confusion. Numerous candidates thought that urine is produced somewhere in the digestive system, and – even when it was made in the kidneys – it often left the body through the anus or vagina. Although many did make clear that urea is removed as urine, in which urea is dissolved in water, they often stated that urine is made in the bladder. Ureter and urethra were often confused.

(c) Once again, there were numerous excellent answers, with many candidates giving very full and entirely correct answers. Frequently, however, there was considerable confusion. Nitrogen fixation was very commonly ascribed to nitrifying bacteria. Plants often took up nitrogen atoms, and passed them on still in the form of uncombined nitrogen atoms to animals. Animals often made proteins from nitrogen that they breathed in. Nevertheless, it was rare for any candidate not to gain at least one mark, as most of them did appreciate that animals obtained their nitrogen from plants that they ate.

Question 2

(a) Most candidates chose to write names instead of formulae. The majority of answers gave chlorine and hydrogen for **X** and **Y**, but they were sometimes the wrong way round. **Z**, sodium hydroxide, was the substance most likely to be misidentified.

(b) (i) Better candidates had no problem with this, answering in terms of there being equal numbers of positively charged protons that balance the charge on the electrons. Some failed to mention that protons are positively charged. However, weaker candidates often went along entirely the wrong track, attempting to describe why this chlorine atom had not ionised.

(ii) This was generally well done, and the extended mark scheme allowed many candidates to gain full marks. The most common error was to describe covalent bonding. Sometimes, candidates drew a covalent bonding diagram and then went on to describe ionic bonding. Examiners cannot choose which answer to mark, so if one contradicts another, credit cannot be given.

(c) (i) Only around two thirds of candidates arrived at the correct answer of 0.005 g. Many made the calculation much more difficult than it need have been, somehow managing to involve the number of kilojoules per 100 g or other data from the table.

(ii) Candidates could bring forward an incorrect answer to **(i)** to their calculation here, without any further penalty. The great majority of candidates knew that they should divide the mass by the relative molecular mass, but not all were able to calculate the latter. Nevertheless, a pleasing number of candidates did achieve full marks here.

(iii) This calculation proved to be even more difficult than that in **(i)**. Once again, many candidates could not see an easy route to the answer, and went through long and involved calculations using a variety of the data that had been provided, or their answer to **(ii)**.

(iv) This was the hardest part of the question, requiring candidates to bring together information they had accumulated through the earlier parts and recognise that Verisweet provides fewer kilojoules for the same sweetness as provided by sucrose. Relatively few managed to make this connection. However, rather more were able to give a reason why Verisweet might be preferred to sucrose, for example to reduce the risk of tooth decay or to help someone with diabetes keep their blood glucose level constant. Weaker candidates often thought that Verisweet *contained* sucrose.

Question 3

(a) This was rather poorly known. Many candidates tried to describe nuclear fission, rather than focusing on the way in which heat energy is used to produce electricity. Some, however, did clearly describe the production of steam from water, and then the use of the steam to turn a turbine to drive a generator.

(b) The most frequent correct responses related to the lack of air pollution from nuclear power stations, contrasted with the release of carbon dioxide or sulfur oxides from coal-burning stations. It was not enough simply to say that there is less 'pollution' from nuclear power stations. Others correctly explained that more electricity could be generated from a given mass of fuel in a nuclear station, although some seemed to think that 'nuclear' was a substance. The suggestion that you could produce 'more electricity' or that it could be produced 'more quickly' was not credited unless suitably qualified. Another correct idea, less commonly seen, was that there are very large reserves of nuclear fuels, while coal, or fossil fuels in general, is likely to run out. The suggestion that nuclear fuel is 'renewable' was not credited.

(c) (i) Most candidates were able to answer this correctly, and almost all showed their working clearly.

(ii) This is quite well known, and was often answered well. However, there was also much misunderstanding, often relating to the need for 'a lot of electricity' to be transmitted.

(d) (i) Candidates needed to state that the *nucleus* of the atom would split. Many simply said that the atom would split, which was not credited.

(ii) This was well answered, the great majority of candidates giving two correct responses.

(iii) It was pleasing to see many candidates able to work out that the element would be yttrium, although most could not. A variety of incorrect responses was seen, of which other isotopes of strontium or rubidium, featured most frequently.

Question 4

(a) (i) There were many brief and entirely correct answers to this, stating that light provides energy to drive the reaction between water and carbon dioxide.

(ii) The majority of candidates correctly identified **section D** as the part of the graph where light intensity was not a limiting factor.

(b) (i) Most candidates were able to gain at least one mark here, and many scored two. They generally realised that this would allow more photosynthesis, and some related this to the increased quantity of chlorophyll or chloroplasts that would be present inside the cells. References to surface area were ignored. Very few candidates made any reference to the reason why this might be an advantage to a leaf growing *in sunlight* rather than in the shade.

(ii) Where candidates had appropriate vocabulary, they were often able to find two clear differences between the leaves. However, many made poor choices, giving vague answers such as one leaf being 'more jumbled' than the other or having a larger surface area. Clear differences were expected. For example, a mark would be given for leaf **B** having a thicker cuticle, but not a bigger cuticle.

(iii) Many candidates mentioned at least two of diffusion, stomata and air spaces, and a few also referred correctly to a concentration gradient. Some said that the carbon dioxide passed through the guard cells, which was not accepted. Some became distracted by describing how guard cells open and close stomata, sometimes equating this with breathing movements. A few described carbon dioxide passing through the cuticle and upper epidermis, or being absorbed from the soil and travelling in the xylem or phloem.

(c) Most candidates appropriately chose 'the environment', but not all could give a valid reason. For the second mark, a clear statement was required that, as the leaves are from the same tree, they must have the same genes. Some just said that 'it cannot be genes, because they are from the same tree', which was not quite enough to earn this mark.

Question 5

(a) This was very well answered, with only very few candidates giving a wrong response.

(b) (i) Most candidates could write correct formulae for Mg and HCl, but if they did not work out that magnesium chloride is $MgCl_2$ they ran into difficulties in completing and balancing the equation.

(ii) A very large number of candidates answered this question without mentioning either particles or collisions. Of those who did attempt to do as asked, many thought that the particles would have more energy, and therefore would be moving more quickly, at the beginning of the reaction rather than at the end, and gave elaborate reasons for this idea. Relatively few made a link between the frequency (or chance) of collisions between particles and the rate of the reaction. The most common correct responses referred either to the decreasing surface area of the magnesium, or the decreasing concentration of the hydrochloric acid, and then related this to a reduction in frequency of collisions and rate of gas production.

(iii) Almost all candidates drew a curve that rose more steeply at the start, but many then showed it levelling off at a higher volume of gas than the original curve. Some did not draw their curve on Fig. 5.2 as asked, but instead drew a new graph in the space at the bottom of the page. This made it difficult – often impossible – for Examiners to judge the shape of the candidate's curve in relation to the first one.

Question 6

(a) (i) This was well answered. Almost all candidates knew the formula for calculating density, and were able to do this correctly and gave a unit as part of their answer.

(ii) A majority of candidates knew the formula to calculate the energy required to heat the block, though some lost a mark by including 'temperature' rather than 'temperature change', and some omitted mass in their formula. However, in most cases these quantities appeared when the calculation was carried out. The most common error was failure to convert 720 g to kg.

(iii) Not all candidates thought of the appropriate formula, F = ma, instead attempting to use various other formulae relating to acceleration. Once again, they often did not convert 720 g to kg, but this was not penalised a second time. Most did include an appropriate unit with their answer.

(b) This was almost always done correctly. The most frequent error was to include a voltmeter in series in the circuit. A few candidates did not include a cell or battery or other power source, and some even omitted the block or any indication of where it might go in the circuit.

Question 7

(a) (i) This was usually answered correctly. However, a few candidates did not take care with their label lines, and left them hanging well short of the relevant part of the diagrams. Some clearly did not know what an axon is.

(ii) This was often answered well, frequently with a single short sentence including all the information required. Many, however, wrote a long story that began with a receptor and used up all the answer lines well before they arrived at a motor neurone.

(b) Most candidates appeared to identify well with this context, and these questions were answered rather better than might have been expected.

(i) This calculation was usually done correctly, although a few got the formula upside down and came up with a very long time, apparently unconcerned that it might take the sound more than two minutes to travel from the gun to the runner's ears.

(ii) This was usually answered correctly, although a small proportion of candidates did not know the meaning of the term 'anomalous'.

(iii) This, too, was generally answered well. Almost all candidates were able to see and describe the relationship. Most were also able to explain that it would take the sound less time to travel to the ears of the runners in lane **1** than in lane **8**. However, care needed to be taken with the use of everyday language. It is not correct to say that the sound would travel 'faster' to the ear of the person in lane **1**.

(c) There was no mark for saying whether or not the reaction times would be significantly different, only for the explanations. Many candidates correctly calculated the difference in the time it would take for the impulse to pass from the brain to the leg muscles, and then put forward a good argument to explain why this would or would not make a difference – either type of argument was equally acceptable.

Question 8

(a) (i) This was usually answered correctly, although a few candidates chose **C** to **D**, and some gave **A** to **E**.

(ii) Most candidates were able to do the calculation, but the units were not always correct.

(b) Once again, the calculation caused relatively few problems, but the units were a little more difficult. Some were unable to multiply 300 by 0.3, arriving at an answer of 100.

(ii) This was generally well known, although a significant minority of candidates thought that you should use a shorter spanner.

(c) Once again, the majority of candidates knew the appropriate formula to use, and were able to substitute into it and do the calculation correctly. Here, units were rarely a problem, as they were the same as those already given in the question. A few tried to use P = force ÷ area. Some changed the values given in K into Celsius, which not only made a lot of extra work but also gave the wrong answer.

Question 9

(a) Many candidates thought only of the start of the arrow and not the end, describing only evaporation and not condensation. (There was another clue that this was required in the use of the plural 'processes' in the question.)

(b) This was generally answered correctly. However, quite a few candidates showed a hydrogen atom in the middle with oxygens on either side. Some showed only the shared pairs, and not the rest of the outer electrons on the oxygen. Some did not give the chemical symbols, as asked.

(c) Hardness of water is not well known. A significant number of candidates appeared not to understand this term at all.

(ii) Very few candidates were able to answer this correctly. A very wide variety of compounds were suggested, of which most did at least contain either calcium or magnesium ions, but it was rare to see either the word 'hydrogencarbonate' or the formula for this.

(ii) Candidates should appreciate that an answer to this question along the lines of 'the ions in the water are exchanged with those in the resin' is not sufficient, as it does not give much more information than is already in the term itself. Better answers referred to calcium ions being trapped in the resin, while sodium ions from the resin replaced them in the water. Even candidates who did not know this often gained a mark by saying that the water would be softened, or become less hard.

(iii) This context proved difficult for many and this, combined with the considerable lack of knowledge of the chemistry of hard water, meant that marks were generally hard to come by. Very few referred to the production of limescale or calcium carbonate when the water is heated. 'Scum' often appeared to be confused with limescale. Some did manage to explain that limescale might build up inside the dishwasher, which could cause problems. A few also correctly stated that more detergent would be required in order to wash the dishes.

CO-ORDINATED SCIENCE

Paper 0654/04

Coursework

(a) Nature of tasks set by Centres.

19 Centres submitted coursework for the June examination.

This year all the tasks set by every Centre were appropriate to the requirements of the syllabus and the competence of the candidates. Most have provided coursework in previous years and have acted on advice given.

All Centres had a good understanding of the skills being assessed. The standard of candidates work was the same as in previous years.

(b) Teacher's application of assessment criteria.

In all 19 Centres the assessment criteria were understood and applied well for all of their activities. There has been a steady improvement in the Centres' application of assessment criteria.

Most Centres had a portfolio of between 6 and 10 assessment tasks, with candidates submitting work from most.

A few Centres use too many tasks, leading to candidates from the same Centre having a different assessment experience from their colleagues.

No Centre tried to assess both skills C1 and C4 in the same investigation.

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

Tick lists remain popular with particularly skill C1.

Some Centres write a comprehensive summary justifying the marks awarded for each candidate but not indicating the point at which the mark was awarded.

(d) Good practice.

Many Centres have developed a booklet of assessment tasks with dedicated assessment criteria.

CO-ORDINATED SCIENCES

Paper 0654/51

Practical Test 51

General comments

The paper enabled candidates of all abilities to demonstrate their practical ability and knowledge.

It would be most helpful if Supervisors would carry out the experiments and write their results on the paper. Failure to do so could penalise candidates since the correct answer (particularly in the Physics section) would not be known.

There were a few issues of candidates not interpreting the questions correctly in the Biology section (see comments on specific questions).

There is also some evidence that candidates do not use or even look at the Chemistry information on the back page.

Comments on specific questions

Question 1

(a) (i) Most candidates obtained full marks for drawing the leaves although the petiole was often very sketchily executed. Very few confused the two types of leaf.

(ii) Many candidates recorded the true length of the leaf rather than the length on the diagram. Others wrote the actual length in the answer space but fortunately recorded the diagram length alongside the diagram.

(b) Surprisingly, this was not well answered.

(c) (i) A significant fraction of candidates decided that they would just **construct** a table with headings and not fill in any numbers. A number of candidates lost marks because of this. Those who answered correctly scored well although it might have helped if the actual number of palisade cells had been given rather than one / two rows. The size of the air spaces also caused some problems with candidates preferring to give the number of them.

(ii) Many candidates chose a difference which does not affect the rate of photosynthesis and so did not gain the mark.

(iii) A significant number use the word **transpiration** which was pleasing but many offered water-proofing and insect-proofing as it's advantage.

(d) (i) Mostly correct. Those candidates who had incorrectly used cm in part **(a)** were not penalised again.

(ii) Much better done than in the past. Note: ratios 1:315 or 315:1 are not correct.

Question 2

(a) Most candidates correctly measured the dimensions of the boiling tube and those who had been penalised already for the use of cm were given an error carried forward to the calculation. The calculation was well done relatively few candidates omitting the square term.

(b) (iv) The vast majority obtained five readings but it was obvious that many had not followed the instructions correctly because either the values of $\mathbf{d_1}$ increased or $\mathbf{d_2}$ was greater than $\mathbf{d_1}$ or both. Only the best candidates obtained a good set of results.

(c) The vast majority labelled the axes correctly and only a handful of candidates transposed them. Most chose suitable scales and the rest did not make use of all the available space. Whilst plotting was in general well done the drawing of the best straight line through the points was worse than in recent years.

(d) Many candidates did not clearly indicate on their graph (as instructed) the points which been chosen to calculate the gradient. A large number counted squares rather than using the scale differences and a smaller number inverted their gradient. Most values for the density were incorrect since the experiment had been incorrectly done, even if the gradient had been correctly evaluated.

(e) This section was very badly done since candidates did not **describe** how to carry out an actual experiment. Many just quoted the expression for density.

Question 3

(a) Very poorly done by all.

(b) A surprising number of odd results even within Centres. Most got a value for **X** between 20 and 30, but quite often had the value for **Y** larger than that for **X**. Only the most able had the values approximately halving.

(c) After the ‘error carried forward’ had been taken into account, most gave a correct explanation but a sizeable number wrote about requiring the longest time rather than most drops.

(d) This was not particularly well done. Some Centres expressed difficulty about getting this experiment to work.

(e) There still seems to be an aversion to using the word precipitate or its abbreviation even though it is found on the back page. The **name** of the acid is required not its chemical formula.

(f) Most were able to identify the gas ammonia although chlorine was a popular alternative.

(g) Once again there were very few candidates who wrote **describing** an actual experiment. The standard conditions mark was rarely given and many wrote about ‘reacting the most’ without ever identifying which reaction or how to measure it. Candidates again confused the amount of gas given off with the rate of gas being produced.

CO-ORDINATED SCIENCES

Paper 0654/52

Practical Test 52

General comments

Most Supervisors were conscientious in preparing the examination and completing the question paper. However, a minority do not produce a complete set of results. It must be emphasised that Examiners do refer to these submissions and candidates may be penalised if there is no opportunity to do so. The simple provision of say a temperature is important. Candidates figures can be compared to those provided by a competent teacher.

The standard of achievement was very similar to previous years and all three questions were readily accessible to all candidates. The least well answered was question three which required some real practical technique.

Comments on specific questions

Question 1

Parts **(a)** and **(b)** caused no obvious difficulty although a small number did not show their working when calculating the average length of the leaves.

Some candidates did not transfer all 20 measurements to Table 1.2 and lost a mark for failing to do so. Bar charts were generally well done. A mark was lost if several ranges were grouped together.

There was a clear instruction in part **(e)** to 'write the letter **C** in complete squares' and a similar instruction to write **P** in incomplete squares having an area of half a square or more. A number of candidates failed to do this and some marked all squares that were incomplete with the letter **P**. A few candidates failed to draw around the leaf on the grid, just showing letters **C** and **P**.

Part **(f)** generally one mark was awarded for the reason for the variation in length of leaves, but fewer gave a suitable explanation. The common answer was variation in light intensity leading to different rates of photosynthesis.

Question 2

The collection of data caused no difficulty, but too many candidates did not follow the instruction to record the temperatures to the nearest 0.5 ^oC. Good practice means a whole number, say 26 ^oC, should be recorded as 26.0 ^oC. Marks were lost for failing to carry out this instruction.

Candidates were expected to produce a result for the specific heat capacity within 1 $Jg^{-1}\ {}^oC^{-1}$ of the Supervisor's figure. This is an example showing the importance of the Supervisor completing the question paper.

In part **(e)(ii)**, most realised that a factor of 1000 was involved but a good percentage used the 1000 incorrectly.

Part **(f)** was poorly answered, suggesting that such a method had never been seen or discussed. The three points required were: mass of liquid, the power of the heater and the time for the heating.

Question 3

Most were able to carry out the four experiments but with very variable success. Some practical expertise was required to obtain a sensible set of figures. An increase in volume across the table and a decreasing set of figures down each column was expected. With the correct concentration of acid and 6 cm of magnesium a volume 100 cm^3 should not have been exceeded. A simple calculation would confirm this. Nevertheless some did manage to exceed this figure. When the final space indicated the volume was off the scale candidates were not penalised. Most were able to correctly complete column 3 in Table 3.1. Graphs were usually acceptable although a good number were caught out in scaling the horizontal axis. The scale often went from 0.4 to 1.2, missing out 0.8, thereby producing a non linear scale.

Most candidates stated that the rate of reaction increased with increasing concentration of acid but very few attempted to give an explanation. The simplest answer would have compared the volume of gas at a particular time.

Part **(f)** was often answered correctly. The explanation obviously depended upon the answer to the question. Hence, the answer yes because all the magnesium was used up was possible or no because gas was still being evolved. The answer that all the acid was used up was not accepted.

Finally, the answer required in part **(g)** was a **description** of an experiment. Far too many see questions of this type as an opportunity to show what they have learned in theory. This is a practical paper! Whilst many appreciated that the rate would increase by using powdered magnesium few gave a suitable description of how the experiment would have been carried out. The phrase ‘repeat the experiment’ is insufficient and makes no reference to such matters as a similar amount of magnesium etc.

CO-ORDINATED SCIENCES

Paper 0654/61

Alternative to Practical 61

General comments

The Examiners were pleased to see many scripts from good candidates who have thoroughly grasped the practical aspects of the three sciences that make up the syllabus. These candidates are a credit to the Centres who entered them for this examination.

Three of the six questions are based on corresponding items in the Practical examination paper 51.

It was disturbing to see that a few candidates did not possess a ruler and a calculator. Both of these items are necessary to answer the questions. A Supervisor at one Centre even banned the use of a calculator by the candidates. The Examiners draw the attention of Supervisors to the requirements of the Mathematical Requirements in the Syllabus, which states that 'calculators may be used in all parts of the assessment' and 'candidates should be able to use mathematical instruments (ruler, compasses, protractor, set square).'

Comments on specific questions

Question 1

Diagrams are provided of three choice chambers in which woodlice have been placed for 15 minutes. The chambers are divided into four sections; dry and dark, damp and dark, damp and light, dry and light.

(a) (i) All candidates counted the woodlice and accurately recorded the numbers in each section of two of the three choice chambers.

(ii) The average numbers of woodlice in each condition must be calculated. Many poorer candidates simply found the total numbers and did not divide by three each time.

(b) A bar chart had to be drawn, showing the average number in each section. The Examiners looked for correct labelling of the y-axis (average number of woodlice), correct height and equal width of all four bars, and correct labelling of the conditions on the x-axis. There were many excellent answers to this part of the question.

(c) (i) Candidates were asked to list the two external conditions preferred by the woodlice; damp and dark. Instead, many candidates listed the two sections of the choice chambers preferred by the woodlice. This slight error was not penalised.

(ii) One preferred condition had to be chosen and suggestions made about how this would help the woodlice to survive. There were many anthropomorphic comments such as 'woodlice do not have to worry about being seen in the dark' did not gain a mark.

Question 2

This was about the use of a ticker-timer to find a value for **g**, the acceleration due to gravity. A labelled diagram of the apparatus was shown.

(a) (i) The term *alternating current* was incorrectly answered by most candidates. Some candidates described the sine wave shape of the e.m.f./time plot, but were unable to say that the current reverses direction.

(ii) Why does the alternating current make the iron bar of the timer vibrate? A complete answer includes the reversal of the poles of the magnetised iron bar so that it is alternately attracted and repelled by the permanent magnet that surrounds it. There were some good answers to this question, but they were rare. Most candidates wrote about the 'force of the current causing vibration'.

Fig. 2.2 showed part of the strip of paper that was accelerated through the timer as the weight fell.

(b)(i) Candidates had to measure, in centimetres, the distance of the last three points on the paper from the 0 point and record them in a table. Most candidates could do this accurately, but those without a ruler could not do so at all.

(ii) The distances had to be converted to metres and as all the other distances given in the table provided an example the majority of candidates gained this mark.

(iii) Data from the table of times and distances had to be used to prove that the paper had accelerated as the weight fell. Some candidates said that the distance from the 0 point had increased each time; this was not enough to gain the mark, since even a steady speed would give this effect. Candidates were expected to state that the distances in each 0.02 sec interval had increased.

(c) A formula was given to calculate **g**, the acceleration due to gravity, using data from the table. Many candidates were able to substitute data in the formula and then obtain a value for **g** which lay between 9.0 and 10.00 m/s^2. The most frequent error was to omit to square the time of fall.

There were some very good answers, but a majority of candidates lost marks in part **(a)** of this question.

Question 3

The question is based on a simple neutralisation reaction between an acid and an alkali. Then the acid must be identified, and details of an experiment to find the most concentrated of three acid solutions must be given.

(a)(i) The colours of the indicator at pH 5 and pH 9 are red and orange respectively. Candidates had to state the colours in acid and alkali solution. This comparatively easy test was failed by many candidates. Some reversed the colours, but a surprising number gave 'red and blue' as the colours; they thought that all indicators are blue in alkali.

(b)(i) and **(ii)** Candidates had to choose the most concentrated solution, and were given the number of drops of alkali that were used to change the colour of the indicator of each acid solution. Some candidates did not read the description of the experiment carefully enough and chose the least number of drops.

(c) The answer was given by a minority of candidates was 'cleaning the pipette and beaker', suggesting that they had never performed experiments using a pipette.

(d) Not many correct answers were given to this part.

(e) (i) and **(ii)** There is a white precipitate when silver nitrate is added to the acid. Few candidates could name the white precipitate and the acid used.

(f) Candidates had to design an experiment using magnesium ribbon and the three acid solutions, to find out which one is most concentrated. The Examiners were looking for the use of equal volumes of acid and equal lengths or masses of ribbon. The volumes of gas produced in equal time, or the amount of magnesium dissolved, should be measured in some way. It was rare that all three marks could be awarded.

This question demanded a working knowledge of practical chemistry rather than reproduction of facts. As usual in this paper, the general standard was disappointing but there were some good answers, very much depending on the teaching at particular Centres.

Question 4

The experiment on which this question is based could be unfamiliar to most of the candidates. A test-tube, weighted with sand, is floated in water and in salt solution, and the depth of the tube below the surface is measured using a ruler. The experiment is repeated using tubes carrying different masses of sand. The density of the salt solution can then be found.

(a)(i) When the tubes, and the ruler used to measure them, are viewed through the side of the beaker, they appear larger. Poorer candidates merely stated that the ruler was 'magnified'. An answer referring to the refraction of light, or the curved sides of the beaker acting as a lens, was needed. Some candidates wrote that magnification occurred because the water and glass are denser than air; this was an acceptable answer.

(ii) 'Use the scale of the ruler to calculate the depth $\mathbf{d_1}$ of the tube floating in water'. This instruction was often misunderstood, and candidates used their own ruler to measure the depth on the diagram. Occasionally this was because the table in which the answer was to be written was printed on the previous page; candidates filled in the space in the table before they had read the question! Some misread the scale on the ruler and others could not convert centimetres to millimetres.

(iii) Similarly, the depth $\mathbf{d_2}$ of the same tube floating in salt solution must be found.

(b) A graph grid was provided with the axes labelled and units inserted. When $\mathbf{d_1}$ values have been plotted against the corresponding $\mathbf{d_2}$ values, a straight line must be drawn passing through the origin. Most candidates were able to do this.

(c) The gradient of the line had to be found, and the values used to do this must be shown on the graph. The latter instruction was often ignored. The Examiners looked for the y- and x-dimensions indicated as vertical and horizontal lines on the graph and used to calculate the gradient. However, many candidates calculated an acceptable value for the gradient; this corresponded to the density of the salt solution used in the experiment.

(d) Finally, an alternative way of finding the density of the salt solution was asked for, using a pipette or burette, a beaker and a balance. The correct description of measurement of the volume of a weighed sample of the salt solution, followed by the formula density = mass/volume, was necessary to gain both marks. Both marks were awarded to fewer than half of the candidates.

Candidates must read through the question before launching into writing numbers, and must know standard techniques used to find density of both liquids and solids.

Question 5

This question was based on differences between leaves of a dicotyledonous plant grown in sun and shade.

(a)(i) Diagrams of a 'sun leaf' and a 'shade leaf' were shown. The instruction clearly stated that the candidate must 'measure the maximum length of each leaf, excluding the petiole (stalk)'. Far too many candidates did not read this instruction but proceeded to measure and record the total lengths, for which no marks were awarded. A few candidates recorded the lengths in centimetres, for which only one mark out of two could be awarded. A smaller number could not change centimetres to millimetres!

(ii) Most candidates could suggest an advantage to the leaf with the larger area.

(b) Given cross-sectional diagrams of the sun- and shade- leaves, candidates had to construct a table to compare them. Many candidates actually measured and stated the thickness in centimetres, forgetting that the diagrams of the leaves were as viewed through a microscope. Despite this, the mark was awarded. The actual number of palisade cells did not have to be counted, merely stated as 'two rows' or 'one row'. The size of the air spaces could be compared as 'small' or 'large'. Many candidates were awarded all four marks for their answers.

(c) One of the features of the sun leaf in the diagram must be chosen and its adaptation explained as good for photosynthesis. This was usually done quite well, with the many chloroplasts of the palisade cells mentioned as key to photosynthesis in the leaf.

(d) The thicker cuticle of the sun leaf was pointed out to the candidates, who were asked what advantage this has for the leaf. The answer is 'it prevents dehydration'. However, many candidates opted for the reverse reason, that it serves to prevent the ingress of moisture, which was not an acceptable answer for the mark.

Many candidates scored very well on this question, but too many lost marks again because they did not read the instructions carefully enough.

Question 6

The final question on the paper showed the diagram of an experiment in which carbon dioxide is produced by a chemical reaction, changed into carbon monoxide and then used to reduce copper oxide to copper.

(a) A solid and a liquid which will react to give carbon dioxide must be named. This was found to be surprisingly hard for many candidates to do.

(b) The carbon dioxide was passed into a heated steel tube containing charcoal. Candidates had been told in the introduction that the carbon dioxide was converted into carbon monoxide. They had to complete the symbol equation .... + ... → 2CO. A majority could not do this, which the Examiners found very disappointing.

(c) The residue from the reaction of copper oxide with carbon monoxide was a powder. This was placed in a container. Probes from a circuit containing a voltmeter, a lamp and an ammeter were inserted. What observations could be made which show that the residue is a metal? Most candidates seemed unable to interpret the word 'observations', and wrote vaguely about a metal conducting electricity, being shiny and hard or even being attracted by a magnet. The better candidates, however, concentrated on the items in the circuit diagram and correctly wrote that the bulb would light and that there would be a reading on the ammeter. There would be a reading on the voltmeter even if the residue did not conduct, so this observation did not earn a mark.

(d)(i), **(ii)** and **(iii)** The residue was weighed. Candidates had to record the reading on the balance window, then calculate the mass of the copper(II) oxide and of the loss in mass during the reaction. Most candidates were able to do this.

(iv) Removal of oxygen is reduction. This mark was often earned.

(e) To earn this mark, candidates had to write that carbon monoxide is poisonous, toxic or dangerous.

The responses of candidates to this question were often very disappointing. This may sometimes have been because they were running out of time at the end of the one hour examination.

CO-ORDINATED SCIENCES

Paper 0654/62

Alternative to Practical 62

General comments

The Alternative-to-Practical paper is an alternative to the Practical examination and *not* an alternative to the study of practical science which must form part of the course of study leading to this IGCSE qualification. The Examiners were disappointed to see that many candidates could not draw simple apparatus and answer questions on experiments that they should have experienced.

However, there were many excellent answers to the questions and Centres should be congratulated on the results obtained by their hard-working candidates.

Three of the six questions are based on corresponding items in the Practical examination paper 52.

The Examiners draw the attention of Supervisors to the requirements of the Mathematical Requirements in the Syllabus, which states that 'calculators may be used in all parts of the assessment' and 'candidates should be able to use mathematical instruments (ruler, compasses, protractor, set square).'

Comments on specific questions

Question 1

This study of variation in leaves provided candidates with a rather lengthy exercise in simple mathematics, with which most coped well.

(a) Most candidates measured the leaves with acceptable accuracy.

(b) Candidates had to find the total of all the lengths and divide by 20 to arrive at the average length. Those who did not show the working (total length/20) lost a mark here.

(c) (i) The number of leaves in each of six ranges had to be counted and recorded.

(ii) A bar chart was then drawn using the data from **(c)(i)**. The most common error here was incorrect labelling of each range. Beneath each bar, the range must be clearly stated as 30 – 34, 35 – 39 and so on. Many candidates who merely wrote a number at each bar line lost a mark here. The bars also had to be of the same width.

(d) A reason was sought for the variation in the lengths of the leaves. The answer 'genetic differences' did not earn a mark since they were all from the same species. Conditions of growth had to be specified, such as light intensity, nutrient availability and age of the leaf.

Question 2

This question concerned the properties of ammonia gas. References to this gas can be found in the syllabus and in the 'Notes for use in qualitative analysis'. A lamentable ignorance of the facts was displayed by candidates from some Centres. The question began with the reaction between ammonium chloride and calcium hydroxide.

(a) (i) Ammonia gas was variously said to be white, blue, red and some other colours!

(ii) Although given information about the substances reacting, many candidates could not work out that the solid product was calcium chloride.

(b) Three diagrams were provided of the collection of gases; upward delivery, downward delivery or over water.

(i) Most candidates wrote that the best way to collect ammonia gas was over water, forgetting that ammonia dissolves in water.

(ii) A method had to be chosen as the way NOT to collect the gas. More candidates correctly stated that downward delivery cannot be used, but their explanations were often woolly and inaccurate.

(c) (i), **(ii)** and **(iii)**. A table to be completed contained the reactions of ammonia with zinc and copper sulfate and with litmus. Candidates whose lessons had included these practical exercises scored well here.

(d) A diagram was shown of filter paper, soaked in concentrated hydrochloric acid, being lowered into a gas-jar of ammonia, resulting in a cloud of white fumes. Candidates were invited to explain how the white fumes are formed, but most merely repeated the wording of the question. Some correctly stated that ammonium chloride was the solid formed. However, the Examiners were looking for the idea that two gases, hydrogen chloride and ammonia, were reacting. Sublimation occurs, just as it does when ammonium chloride is heated and the resulting gas mixture is cooled. Disappointingly to report, no candidates gave this part of the explanation.

Question 3

This question is based on a simple experiment in which steam contained in a 2 dm^3 bottle is allowed to condense, forming a weighed amount of water.

(a) (i) The masses of the bottle before and after water has condensed into it, are read from the balance scale. This presented few problems with the majority of candidates gaining the marks.

(ii) The increase in the mass is found by subtraction.

(b) (i) and **(ii)** Candidates had to name the processes by which water is turned into steam and back again. ‘Boiling’ was not accepted as a correct answer for process **A**. Most candidates earned at least one mark.

(c) (i) Told that 1 g of water has a volume of 1 cm^3, candidates had to state the volume of water produced 'when the 2 dm^3 of steam had cooled'. This should not have caused any problems; but a significant number of candidates were unable to do this.

(ii) The volume of steam produced from 1 cm^3 of water was correctly calculated using simple proportionality by a minority of candidates.

(d) The final question was to explain why a powerful force is produced by a steam engine. What was needed was the idea that the expansion of the water to a large volume produces this force; candidates could also refer to the large increase in kinetic energy of the molecules. Answers were often not convincing.

The answers to this question were rather disappointing, based as it is on a simple element of physics.

Question 4

Inhaled and exhaled air must form some part of the practical biology studied by candidates for this examination.

(a) Candidates were asked to draw a diagram of the way in which a gas-jar of exhaled air can be collected. The diagrams were almost always disappointing. Many candidates had no idea about the shape of a gas-jar, despite having answered **Question 2**! Those who used a delivery tube to transfer the air from the mouth then placed a stopper in the container, so no air could possibly be blown into it. When the air was collected over water, the method preferred by the Examiners, tubes often entered through the side of the trough.

(b) A candle was burned in the two samples of air, and the time of burning noted.

(i) The stop-watch had to be read and the times recorded. Most candidates were able to do this.

(ii) The average time for three similar experiments had to be calculated. A majority of candidates could do this; however, having recorded all other times to the nearest 1st decimal place, a similar accuracy was expected to be shown. Therefore answers of '7' and '5' gained only one mark instead of two.

(c) (i) and **(ii)** The marks were awarded to the majority of candidates.

(iii) Candidates had to place the times taken for the limewater to change appearance against the descriptions 'before exercise' and 'after exercise'. This was often wrongly answered; after exercise, there is more carbon dioxide in the exhaled air.

(iv) An explanation of why exercise changes the carbon dioxide content of exhaled air was asked for; the answer must refer to an increase in the rate of respiration to gain the mark.

An investigation into the carbon dioxide content of exhaled air is easy to do but many candidates gave the impression that they had never done such experiments.

Question 5

Magnesium reacts with dilute hydrochloric acid; a well-known fact. This question is based on an attempt to relate the speed of the reaction to the concentration of the acid.

(a) The inverted measuring cylinders showing the volumes of gas produced in the first 40 seconds must be read. Most candidates gained all three marks.

(b) Comparison of the figures in the table of results would enable candidates to write the three missing concentrations of the acid. Some candidates failed to do this correctly.

(c) The graph of concentration of acid against volume of hydrogen had to be drawn. Many candidates plotted the points well. However, some failed to draw a straight line, extended to pass through the origin.

(d) (i) In marking the answers for why the same length of magnesium ribbon should be used, the Examiners did not accept the use of the phrase 'the same amount of magnesium'. The same surface area of magnesium and the same mass of magnesium are the two correct answers here.

(ii) The straight line passing through the origin shows that the concentration of the acid and the volume of hydrogen are proportional. No other answer was accepted.

Many candidates drew the graphs well, which was pleasing to the Examiners, but part **(d)** was less well answered.

Question 6

Hot water is poured into a metal food can and the change in temperature is noted. The mass of the can and the mass of water are also found.

(a) The temperatures of the water, the mass of the can and the volume of the water are read from appropriate scales. Most candidates were able to do this successfully.

(b) (i) and **(ii)** The increase in temperature of the can and the decrease in the temperature of the water were found by subtraction. Candidates were not always careful to choose the correct temperatures to use in these calculations.

(iii) Given the formula, the specific heat of the can could be found using the data already recorded or calculated. Again, candidates' choice of data was not always accurate, but many managed to arrive at the correct answer.

(c) The teacher has set up an alternative experiment to find the specific heat of the food can, using an electric heater to deliver a measurable amount of heat energy. Candidates had to state two quantities that must be used to find the energy delivered by the heater, besides the e.m.f. in volts.

These were the current in amperes (amps) and the time in seconds. The word ‘current’ was most often missing, and many candidates wrote 'the ammeter in amps'.

This question contained both easy and more difficult items, like all questions in this paper. Many candidates scored well but a completely correct answer was rare.