CO-ORDINATED SCIENCES

Paper 0654/01
Multiple Choice

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

General comments on whole paper

The mean of this paper was 60%, a statistic which, whilst reasonable, has been higher in the past. The questions are no more testing than before, and are all questions which are likely to appear on equivalent single-subject papers.

Comments on individual questions (Biology)

Question 1

This was, perhaps, a slightly difficult start to the paper, since many candidates may not have readily associated scales (on their legs) with birds. Certainly many candidates who did quite well on other questions in the paper, preferred to believe that birds lay soft-shelled eggs rather than that they possess scales – even though 'scales' were linked with feathers in Option **A**.

Question 9

This question proved to be largely an option between **B** and **D**. It is difficult to follow the reasoni 39% who thought that excess protein in the diet would cause more amylase to be secreted – a case, it appear, of faulty knowledge. It was reassuring that, generally, the better candidates linked protein greater urea production.

Question 10

Interpretation of graphs often leads to confusion. In this case, however, 90% of candidates reasoned their way to the correct answer. That only **D** showed a population continuously rising may not have placed too great a demand on those particular skills, making this the easiest question of the biology section.

Comments on individual questions (Chemistry)

Question 15

Only a quarter of the lower-scoring candidates answered correctly, key **A**, with responses **B** and **C** being about equally popular at nearly 40%. Did the candidates choosing **B** not realise that He is the first of the noble gases with only 2 electrons, and did the candidates choosing **C** not realise that the Question refers to 'an atom'?

Question 16

There seems to be no ready explanation as to why some 40% of the lower-scoring candidates thought that polythene contains silicon (IV) oxide combined with metal oxides.

Question 21

Nearly a third of the lower-scoring candidates chose each of responses **A**, **B** and **C** with only a small minority answering correctly. This may, despite the use of bold type for the word **original**, be an example of insufficiently careful reading of the Question.

Question 23

Only a fifth of the lower-scoring candidates chose the key (**D**), response **B** being the most popular choice of such candidates. This implies some lack of understanding of the nature of colloids.

Question 27

This appears to be a very clear example of lack of care in reading the Question in that half of all candidates chose response **C** rather than the key (**D**) - the fact that the words unlit and lit had been deliberately printed in bold type escaped the candidates' attention. Perhaps some pictorial representation as well as verbal expression of the states of the bulbs might have helped. However, careful reading is always to be recommended.

Comments on individual questions (Physics)

Questions which candidates in general found relatively easy were **Questions 28**, **32**, **34** and **38**. Questions which had a low facility (i.e. a low proportion of candidates answering correctly) were **Questions 29** and **33**. The following comments about individual questions might prove to be instructive.

Question 28

All that was required was to multiply the area by the depth of water. One-fifth clearly thought that the question was asking about the total volume of the tubes.

Question 29

The majority of candidates appeared not to read the question carefully and assumed that it wa... and weight, instead of force and weight. Consequently, all but 36% chose options which inclu... and kg.

Question 30

Nearly a quarter answered **D**, which was the density of water, not meths.

Question 31

Questions of this type have been asked many times on Physics papers, so should be familiar to candidates. In this instance, less than half answered correctly, with a third mistakenly thinking that the person had energy of motion when she was standing at the top of the stairs.

Question 33

Over a half of candidates thought that the still water level would be that of the bottom of the waves. If this were the case, where would the water, above this level in the waves, go to?

Question 35

It should not be difficult to work out which pair of values of *I* and *R* multiply to give 3.0 V, but less than half could manage this.

Question 37

The absorption of radiation by paper is usually well known. On this occasion, however, it is clear that a lot of candidates were unsure.

CO-ORDINATED SCIENCES

Paper 0654/02

Core Theory

General comments

Most candidates were able to attempt most questions. There was a good range of marks on all questions. The candidates generally scored 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 answer to the question, their answers were very vague. Language difficulties played some part here, although the general level of English was reasonable. Performance depended not only on scientific knowledge but on the ability to understand the question.

Questions 4 and **11** seemed to be the most difficult for the candidates to answer successfully.

It is becoming apparent that when a numerical answer is required, weaker candidates will merely take any numbers that are given in the question and either multiply them or divide them. Quite often they make up a formula / equation to confirm this. Another problem with calculations is that candidates will often draw a triangle with three letters in it and expect that this will be accepted as a formula/equation. Any formula quoted should be in the 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 fairly well answered.

(a) Most candidates gained some marks but few gained full marks. The main difficulty was knowing that electrical charge was measured in coulombs

(b) (i) Many candidates knew the correct formula and used it to obtain the correct answer.

(ii) Only the better candidates were able to quote the correct formula and carry out the calculation. Some candidates failed to convert the time from minutes to seconds before carrying out the calculation.

Question 2

This question was poorly answered.

(a) (i) Fractional distillation was not well known.

(ii) A use for hydrocarbons, apart from fuels, was not well known. Many candidates gave an answer which indicated that the hydrocarbon was being used as a fuel.

(iii) This too was not well known. Many candidates suggested that the butane should be heated.

(b) Many candidates gained at least one mark here. Many incorrect answers gave elements rather than compounds.

Question 3

All parts were accessible to many candidates, with some candidates gaining good marks.

(a) Almost all candidates gained one mark here and many gained two. Marks were lost wh candidates gave features which were not visible on the diagram.

(b) (i) and **(ii)** These parts were well answered.

(c) (i) Not very many candidates understood the meaning of a phenotype, with most giving the answer Aa.

(ii) Most candidates gained at least two marks here. Many candidates lost a mark on the genetic diagram for failing to describe each box with 'has horns' / 'has no horns'.

Question 4

This question was poorly answered.

(a) (i) Few candidates knew the meaning of half-life.

(ii) Whilst there were many correct answers, many candidates simply restated the information given in the question.

(b) This part was better answered. However, a number of candidates thought that the harmful effect of the radioactive source was to their ears and consequently gave methods of ear protection in part **(ii)**.

Question 5

Weaker candidates gained few marks on this question.

(a) The idea of a period was not well known. Many confused groups with periods.

(b) (i) and **(ii)** Only the most able candidates gained full marks here. In each case there were two marking points and few candidates gained more than one mark on either part.

(iii) Atom 3 was the most popular answer, but many candidates suggested that it was because it had the same electron configuration as boron rather than because it had 3 electrons in its outer shell.

(c) (i) Most candidates thought that this was a molecular structure.

(ii) Very few candidates realised that electrolysis was the correct method.

Question 6

Most candidates gained good marks on this question.

(a) This part was surprisingly poorly answered. Many candidates just labelled the parts rather than giving a function.

(b) A number of candidates were very unclear about the differences between sexual and asexual reproduction.

(c) The majority of candidates gave the answer fruit rather than seed.

(d) The response depended upon the Centre. There were many Centres whose candidates who all answered this part successfully, whereas there were other Centres from which the majority of candidates were unable to do so.

(e) (i) The correct conditions for germination were well known.

(ii) This part related to ideas about fair testing and was less well known.

Question 7

(a) This was well answered by many candidates. Part **(i)** was the poorest answer, as many ca failed to realise that there were two possible answers here.

(b) (i) This was well answered.

(ii) Many candidates did not know the formula for kinetic energy.

(c) (i) Many candidates found this difficult, although the more able candidates did this easily.

(ii) There were few correct answers to this question. Many candidates used their answer to part **(i)** and simply substituted their number into the formula.

Question 8

This question was poorly answered.

(a) (i) There were many correct answers here. Incorrect answers showed lack of understanding about pH levels and acidity.

(ii) and **(iii)** Although many candidates gained marks here, it was evident that there was a lot of lucky guesswork. Quite often there was an incorrect substance identified but the descriptions gained some marks.

(b) Very few candidates related the problem of acid rain to sulphur or sulphur dioxide.

(c) The test for sulphate ions was not well known.

Question 9

There were some good answers to this question.

(a) Palisade cells were not well known.

(b) This was answered well by many candidates. Many gained full marks and most gained at least one.

(c) (i) Most candidates correctly identified the process as osmosis.

(ii) Few candidates correctly identified cell **C** as having the highest concentration of solutes in its cell sap and even fewer could correctly explain why.

(d) Many candidates gained full marks here. Respiration was a common wrong answer for the third missing word.

(e) Few candidates managed to gain any marks. Many candidates simply answered with the words branches, stems and roots.

(f) Many candidates gained one mark here, most commonly for part **(ii)**.

Question 10

(a) Few candidates were able to correctly suggest how sound might travel through water.

(b) Many candidates correctly answered transverse but few could correctly explain why these waves must be transverse.

(c) Most candidates gained at least one mark here. There were a number of marking points available.

(d) (i) Many candidates got this right and many more gained at least one mark. A number had the refracted ray incorrectly bending back to the left after leaving the water.

(ii) Most candidates correctly identified this process as refraction. Diffraction and reflection we common wrong answers.

Question 11

This question was not well answered. Answers given suggested that many candidates were not familiar with these parts of the syllabus.

(a) Hydrogen and oxygen were not well known as two of the elements found in cellulose.

(b) (i) The idea that nitrogen was unreactive was not given by many candidates.

(ii) Few candidates appreciated that amino acids link together to form long chains of protein. Many candidates thought it was the other way round with proteins joining together to make amino acids.

(c) It was clear that most candidates knew something about physical weathering but few could describe it in sufficient detail to gain both marks. A number of candidates described acid rain and chemical weathering.

(d) (i) Most candidates correctly named a metallic ion present in hard water.

(ii) This was well answered with many candidates gaining both marks and only a few candidates failing to gain any marks.

CO-ORDINATED SCIENCES

Paper 0654/03
Extended Theory

General comments

This paper tested a wide range of material from both the Core and Supplement topics within the syllabus, and it was clear that a large number of candidates were unfamiliar with the material from the Supplement.

Most candidates now present calculations as required, giving the formula and showing working. Most also give correct units with their answer. However, they should be reminded that formula triangles are not accepted for the 'formula' mark, and that the formula must be complete. For example 'V = IR' is correct, but just 'IR' is insufficient. They should also remember to use suitable symbols or terms for each quantity within the formula, and not the symbol for its units. For example, 'V= IR' or 'voltage = current × resistance' is correct, but 'volts = amps x ohms' is not acceptable.

Comments on specific questions

Question 1

(a) Only about half of the candidates answered this correctly, the remainder choosing wire **C** because it 'carries the highest voltage'.

(b) This was generally answered correctly.

(c)(i) The formula for calculating power was less well known than that for calculating resistance in **(b)**, and many candidates did not know that power is measured in watts. However, the question was often answered correctly.

(ii) Numerous candidates were not able to make a link between heat and the power consumption of the wire.

(d) The formula Q = It was not well known, and this was the least well answered part of the question. Even those who carried out the calculation correctly often did not know that charge is measured in coulombs.

Question 2

(a)(i) This was mostly answered correctly, although numerous weaker candidates suggested 'cracking'.

(ii) Very few candidates recognised that the butane should be both cooled and pressurised.

(iii) Most candidates appeared to understand what was required here, but not all were able to work out the number of carbon atoms in the alkane. A few drew a double bond between the two carbons.

(b)(i) This was generally answered well, although some candidates suggested that t… *conduct heat* more than thermosets.

(ii) It was rare to see full marks in this part. Most candidates drew diagrams, but they did not sta… the lines represented molecules, and indeed their explanations often indicated that they did … know that this was what they had drawn. A few drew suitable cross-links in their diagra… representing thermosets, and explained that these were strong bonds between the different chains. Even fewer went on to explain how the presence or absence of these cross-links results in the ability of thermoplastics to melt when heated, or vice versa for thermosets. Some incorrectly tried to explain the difference in properties in terms of the bonds *within* the polymer chains, often stating that one type of plastic had double bonds and the other only single bonds.

(c)(i) Most candidates attempted to draw a series of regularly arranged particles, although some tried to draw too many too quickly so that it was not clear that they were intended to be all the same size and arranged regularly.

(ii) Some correctly explained that the layered arrangement of the regularly-sized particles allows layers to slide over each other when a force is applied. Weaker candidates apparently did not know what 'malleable' means, and described what happens when the metal is heated.

Question 3

(a) This was generally answered correctly, and most candidates made it clear that the change was an increase for the selected line and a decrease for the control line. Some lost a mark because they did not give units. A few tried to read off each point on the graph and calculate the differences between each one.

(b) Many candidates understand artificial selection, and were able to give clear descriptions of selecting the cows with the highest milk yields and breeding them. Some also correctly explained that this would be done over many generations. Relatively few, however, recognised that cows cannot be bred without bulls which, of course, cannot be selected for their high milk yields. Some candidates attempted to describe genetic engineering or the use of hormones to increase milk yield.

(c) This was a difficult question, but better candidates often made sensible suggestions, such as the action of different selection pressures in the control line (however described) or the possibility of an illness. Some misunderstood the question and explained why a control line was used.

(d)(i) Relatively few candidates made a link between the very large increase in milk production in the selected line and the ensuing health problems resulting from the higher volumes of milk carried in the udder and the heavier loads placed on the legs. Some made the good suggestion that inbreeding in the selected line might have resulted in an increase in genes increasing the risk of these problems.

(ii) This was not well answered on the whole, although some candidates did explain that the large volumes of milk produced would mean that the cows would eat more food to provide energy or materials for producing milk.

Question 4

(a)(i) This was answered entirely correctly by almost all candidates.

(ii) Candidates who knew the formulae for momentum and kinetic energy generally scored all the available marks. Some, however, either did not know these formulae or did not recognise that they were relevant. A common incorrect answer was that the kinetic energy increased by a factor of four because the car had four wheels.

(b)(i) This was generally answered correctly, although some candidates did not state the [illegible] suitable form, or failed to give units.

(ii) This question was testing the understanding that power is a measurement of the energy con[illegible] per unit time. Those who understood this simply used the statement that the headlamp ha[illegible] power rating of 60 W and gave the correct answer of 60 J. Many, however, carried out long, unnecessary and frequently incorrect calculations.

Question 5

(a)(i) This was surprisingly poorly answered. Relatively few candidates explained that nitrogen molecules in the air are very unreactive. Answers often stated that plants could not 'absorb' nitrogen molecules, or that the molecules are too big to get into the plant.

(ii) This was as poorly answered as **(a)(i)**. Only a small minority of candidates recognised that nitrogen fixation involves converting nitrogen into a compound.

(iii) This was slightly better answered than **(i)** and **(ii)**, but again there were many incorrect answers. Some candidates had so many attempts that it was difficult to tell what their final answer was meant to be. If this happens, it is best to redraw the diagram from scratch.

(b)(i) Most answers were correct, but quite a few candidates did not attempt it at all, suggesting that they did not notice this part of the question.

(ii) This was usually answered correctly. Incorrect suggestions included water and iron.

(iii) Most candidates understood that this was to give maximum surface area of the catalyst.

(c) Most candidates struggled with this. A few were able to work out the correct formula, but found it difficult to explain the need for the negative and positive charges to be balanced.

Question 6

(a) Almost every candidate correctly identified the pollen tube. However, several did not answer at all, suggesting that they had simply missed this question.

(b)(i) This was often incorrect, most candidates stating that the 'pollen grain' travels down the tube.

(ii) There was much confusion about what happens inside **Y**. However, many candidates correctly stated that fertilisation takes place here, despite the rest of their answer being wrong. Better candidates simply stated that the male and female gametes fuse to form a zygote.

(c) This, too, showed considerable confusion about reproduction in flowering plants. Many wrongly thought that this was asexual reproduction, 'because there is only one parent'. Others correctly stated that it is sexual reproduction, but then incorrectly explained that 'there are two different parents'. This is not true, as the male and female gametes have come from the same plant.

(d) Most candidates were able to make at least one correct statement here, generally relating to the size or colour of petals, or the positioning or shape of anther or stigma. Some wrote about the pollen itself, which did not answer the question.

(e) Most answers included a drawing of a fruit that had features adapting it for dispersal by animals, although a few candidates drew flowers or pollen grains. The best answers named the fruit, and included annotations explaining why the animals would want to eat it, or how it would attach itself to them, as well as how this would help the fruit or the seeds inside it to be spread to new areas. Some candidates, however, made no attempt to answer this question.

Question 7

(a)(i) It was expected that most candidates would know a brief definition of the term 'isotope', and many this was true. However, there were almost as many who struggled, often demonstrating they had a vague idea that they were unable to put into precise words. Some very w candidates wrote answers that related to electron numbers or even molecules.

(ii) This question required a fairly detailed response. Many candidates were able to pick out the two differences between the two isotopes of iodine in terms of their half-lives and the type of radiation emitted, but to get the second mark in each case they also needed to explain how this would affect the safety of the patient. There were numerous full answers, but also many that simply stated the differences without an accompanying explanation. Several candidates did not read the information properly, and thought that iodine-123 has a longer half-life than iodine-131.

(b) This proved difficult, and only a small proportion of candidates gave both numbers correctly.

Question 8

(a) A surprising number of candidates gave the answer 'leaf', clearly not recognising that this is an organ and not a tissue. The other most common incorrect answers were xylem and epidermis.

(b) This was generally well answered, with many candidates mentioning chloroplasts, chlorophyll and the absorption of light energy.

(c)(i) Most candidates answered this correctly.

(ii) There was much confusion here over the term 'concentration'. Unless the candidates made it clear that they were talking about 'water concentration', it was assumed that the term 'concentration' in their answer referred to the concentration of solute. Many seemed to think that water moves from where there is little water to where there is more water.

(d)(i) This was poorly known. Many answers unnecessarily described how water enters the roots. Many also described water moving by 'active transport' (which is not even on the syllabus). Those who did correctly mention xylem often spoiled this by adding 'and phloem' or suggesting that water moves through xylem by osmosis. Relatively few mentioned that water is drawn up xylem vessels because of a lowered pressure at the top, caused by the loss of water from the leaves through transpiration.

(ii) This was better answered than **(i)**, and even candidates who had not mentioned transpiration pull in their answer to **(i)** frequently mentioned it here.

(e) This question tested part of syllabus ***section B3***, but it was rare to see a correct answer. Some candidates did mention turgor (or gave a description of it), xylem or lignin.

Question 9

(a)(i) Although most candidates recognised that the waves are transverse, not all could explain why this is so.

(ii) Those who knew the formula generally got this right, although several gave λ as the unit. The commonest error was to get the formula wrong, for example wavelength = frequency × speed.

(b) This was usually calculated correctly, although some answers did not include the formula.

(c) There were very few good answers to this question. Many managed to avoid mentioning particles at all. Even those who did often described boiling rather than evaporation, and it was very rare to see the idea that some particles move faster (or have more energy) than others. Some did mention particles escaping from 'their bonds', but did not make clear that they meant bonds between molecules rather than within them.

(d) Most answers were correct. A common error, however, was to show the ray emerging at angles from the surface of the water. Some drew the ray reflecting back down into the water; others showed it emerging to the left of the normal. Some simply moved the ray along a little to the right and then showed it emerging from this new point at the same angle as the ray as shown.

Question 10

(a) This was usually well answered. Most candidates recognised that carbon dioxide was given off when substance **A** was added to the acid, and were able to link this to what they would expect to happen when a carbonate reacts with acid. They also realised that the reaction shown for copper oxide indicated that no gas was given off, and correctly related this to substance **C**.

(b) (i) Many answers indicated that candidates had no idea what was happening in the context described. Some did recognise that limestone would react with the acid, but it was rare to see any more information that could gain a second mark – for example, that limestone is calcium carbonate, that it would neutralise the acid or that igneous rocks would not neutralise the acid. Frequent errors were to get the lakes or rocks the wrong way round (suggesting that lake **X** is surrounded by limestone, or that lake **Y** has the higher concentration of acid), or to try to explain the differences in terms of the permeability of the rocks.

(ii) The majority of candidates gained one mark for multiplying the volume of the lake by the concentration of the acid in it. Some were also able to calculate the relative molecular mass of sulphuric acid correctly, and a small number then used this to work out the total mass of sulphuric acid in the lake.

(c) This question was not answered well. Many left it blank, and many gave entirely inappropriate answers. Some wrote about enzymes in biological washing powders. Even in answers where some understanding was shown, there was confusion about which end of the molecule was attracted to grease and which to water. Nevertheless, there were some excellent answers, often including clearly annotated diagrams describing the interaction between grease, detergent and water.

CO-ORDINATED SCIENCES

Paper 0654/04

Coursework

(a) *Nature of tasks set by Centres*.

Only one large Centre submitted coursework for the November examination. All the assessments set were appropriate to the requirements of the syllabus and the competence of the candidates.

(b) *Teacher's application of assessment criteria*.

The assessment criteria were understood and applied well for all of their activities. No Centre tried to assess both skills C1 and C4 in the same investigation.

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

The large Centre recorded marks and justified their award on the candidates' scripts.

(d) *Good practice*.

The large Centre also demonstrated excellent organisation.

CO-ORDINATED SCIENCES

Paper 0654/05

Practical Test

General comments

All three questions were readily accessible and in the majority of Centres levels of achievement were slightly better than last year. Full marks for **Question 2** was not uncommon. Supervisors generally played their part well and ensured candidates were not unduly penalised where the occasional difficulty arose. However, it should be stressed that preparation for the examination is crucial and it is too late after the examination to discover that a particular reagent did not work. All candidates were able to complete three questions suggesting no shortage of time.

Comments on specific questions

Question 1

Drawings were frequently very small and few candidates used the full space provided. It was important to show raisin **A** much larger and rounder than raisin **B** even though there was opportunity to record this in part **(ii)**. Many candidates were confused about osmosis and thought that the sugar solution was able to pass through the membrane. There was considerable confusion between high concentrations of sugar and high water potentials.

The results of the tests in **(b)** were very variable. Some failed to record a colour at all, simply reporting no reaction. This did not score. Some thought the mixtures were colourless and others recorded a precipitate. It appeared that some candidates were not very familiar with the tests and did not know what they should be looking for. Many answered **(iii)** correctly, even if the answers did not match the results of the tests. The majority correctly described the chloride test although a small number are reluctant to use the word precipitate. The test is printed on the back page of the question paper.

Question 2

The majority of candidates answered this question very well. Errors such as failing to use a spread of values for length, incorrectly calculating **R** and inconsistency in calculating ***I*R** to at least two decimal places, were all observed. A good spread of length should have included a value of 85 cm or more. Some supervisors were rightly worried that candidate values of current varied. There was never an intention to mark individual values. The mark was awarded for the correct trend showing a decrease. On the whole the graph was well done although again there were errors such as reversing the axes, selecting a very bad scale and drawing a poor curve. Each of these errors were penalised. In part **(g)**, although most drew a similar curve to the experimental one, above it, many were unable to give a sensible explanation. It was not unusual to report a change in resistance even though the wire was the same. The minimum requirement was to recognise that the increased voltage meant an increased current, thereby increasing the value of ***I*R**.

Question 3

The main problem in this question concerns the use of what are considered common terms in chemistry. Candidates are clearly uncertain as to what constitutes a precipitate, the meaning of soluble in excess and the use of the word colourless. The tests described on the last page of the question paper are a useful guide. Part **(a)** caused few problems, although occasionally solutions **Y** and **Z** were described as bases. This was not acceptable. The majority correctly identified the acid as hydrochloric but a good number lost a mark in the description of the test. It was made clear that the test was to be carried out and phrases such as 'if silver nitrate is added' did not indicate that it had. Other errors included a failure to report a white precipitate with the silver ions and naming the acid 'chloride'. Part **(c)** was poorly answered. Far too many reported a clear solution when the examiners required a colourless solution. The pink solution is both clear and transparent and the addition of the acid results in a colourless solution. The solutions of most transition

metal salts, like any other solutions, are clear but certainly not colourless. In part **(c)(ii)** fe r recorded the formation of bubbles. Without this information it was impossible to identify **Z** as a Part **(d)** again displayed some poor observational skills and a lack of appropriate terms. Both test **(ii)** produced white precipitates, the first one soluble in excess, whilst the second was insoluble in e Clearly these phrases were not well understood and marks were lost for a description such as 'cloudy reasonable number were able to suggest the name 'sodium hydroxide' for solution **Y** but very few indeed gave 'sodium carbonate' for solution **Z**.

COMBINED SCIENCE AND CO-ORDINATED SCIENCES

Papers 0654/06
Alternative to Practical

General comments

The Alternative to Practical paper aims to test candidates' skills in laboratory procedure. A thirteen-point description of the questions can be found on the relevant page of the syllabus. The paper set in November 2007 covers most of the points. To adequately test the whole range of abilities, each of the six questions in the paper contained easy items and also harder ones. As described below, some of the questions included subtly difficult parts that were comprehended and answered only by the most able candidates. Some Centres are to be highly commended for the very good scores awarded to their candidates. The time allocated for the paper seems to have been adequate for the vast majority.

Comments on specific questions

Question 1

This question concerned the passage of water into raisins (dried grapes). The concentration of sugar in a raisin is much higher than in the dilute sugar solution in which it is left overnight, therefore water passes into the raisin by osmosis. Candidates had to record the appearance and mass change of the raisin and then answer questions about the processes by which water passed into it.

(a)(i) It seems that many candidates had not seen a raisin in its uncooked state, so when asked to "describe what has happened to the shape" of a soaked raisin, it did not occur to them that it had simply swollen or increased in size, despite the adjacent diagram of an unsoaked raisin. Others failed to answer the question and described osmosis, when all that was needed was a simple statement about its change of size.

(ii) The balance scales for the masses of the soaked and unsoaked raisins were shown. It was a simple matter to record the masses, but some weak candidates failed to place the decimal point in their answers.

(iii) Subtractions to find the changes in mass were usually correct.

(iv) Now came the much harder question, to explain the change in mass of the soaked raisin "by referring to the concentrations (water potentials) of the raisin cells and the solution in which it was immersed".

The first type of error was to suggest that it was the sugar that had entered the raisin cells. This meant that no marks were gained in this section. Many other candidates confused the concentration of the sugar with the concentration of water. In this case, they could gain all the available marks by saying that water entered the raisin by moving from a high concentration (of water) to a lower concentration, by osmosis. The better candidates pointed out that a low sugar concentration in the solution meant that it had a high "water potential" so that water passed down a concentration gradient into the raisin where the water potential was low.

(v) The unsoaked raisin lost a little mass overnight, so it had lost water by evaporation.

(b) Candidates had to suggest the procedure for finding out which of two sugar solutions is more concentrated, using a modification of the experiment already described. A few answers described procedures involving the change of length of potato sticks rather than the change of mass of raisins, so these gained no marks. Other candidates assumed that "concentration" referred to water rather than to sugar. Where this happened, as long as the answer was clear, marks were gained. Far too often, candidates said that the raisin gaining more mass indicates that the solution in which it is placed is more, rather than less, concentrated. It was not clear whether they were referring to sugar or water concentration. Teachers need to remind students that the "water potential" of a solution and its "solute concentration" are inversely proportional. It is better not to refer to the "concentration of water" when dealing with this topic.

There was a very wide variation of marks awarded for answers to this question. High marks indicated that students had undertaken a thorough study of osmosis.

Question 2

This question was based on the corresponding question in Paper 5, the Practical paper. Practical candidates had to carry out simple experiments on three solutions. Two of them, solutions **Y** and **Z** were alkaline and one, solution **X**, was acid. Also, the colours of indicator **P** were given in acid and in alkali. Finally they had to show the presence of hydroxide ions in one alkaline solution and carbonate ions in the other.

(a) Given the colours of an indicator in the three solutions, the candidates had to state whether they were alkaline or acid. Candidates who got this wrong had not read the first paragraph where the responses of indicator **P** had been given.

(b) (i), **(ii)** and **(iii)**
This was a slightly different way of asking how to show the presence of sulphate ions in solution. Having stated that a soluble barium salt must be added, giving a white precipitate, the name of an acid containing sulphate ions had to be given. Only the better candidates scored well here.

(c) In this part of the question, candidates had to imagine that the acid, solution **X**, was being added drop by drop to a mixture of indicator **P** and the alkaline solution, **Y**.

(i) The examiners were looking for a clear statement that alkali **Y** was still in excess so that the end-point of the reaction, and the change of colour of **P**, had not been reached. There were many vague answers, including, too often, that "no reaction takes place until enough acid has been added".

(ii) What was the colour change occurring when enough of solution **X** had been added? For many candidates this part of the question was too far away from part **(a)**, so many implausible answers were given.

(iii) Those who had followed the logic of the question were able to state that the reaction was neutralisation.

(d) **Fig. 2.2** gave details of tests **1** and **2** carried out on solutions **Y** and **Z**. From the results, candidates were asked to deduce the names of the solutions. Test **1** showed that solution **Y** could have been sodium hydroxide or aqueous ammonia. Test **2** showed that there was a soluble carbonate present, which could be sodium carbonate. Most candidates suggested that a carbonate was present but failed to name a cation which was necessary for the mark.

Answers to **Question 2** were often very disappointing and showed that many candidates had a poor knowledge and understanding of simple tests for acids and alkalis.

Question 3

This question was based on the physics part of the Practical examination, in which candidates had to record the current flowing along, and calculate the potential drop across lengths of resistance wire. Then they plotted a graph of the potential drop against the length of wire.

(a)(i) Three ammeter readings were shown. The second decimal place of each reading had to be found by interpolation. The second reading was more difficult than the first; many candidates suggested 0.51 A when it was clearly at least 0.52 or 0.53. The third reading was similar.

(ii) The formula for calculating the resistances of the 25 and 60 cm lengths of wire was given. A mark could be gained by correct calculation of one of these resistances.

(iii) Three values of **V**, the potential drop, were calculated from the resistances in ohms and the current in amps. Two marks were allowed for any two correct answers, not one mark as shown on the question paper. Errors were carried forward in marking.

(b) A graph of the potential drop was plotted against the length of the wire. The clear instruction to plot the length of the wire on the horizontal axis was ignored by some candidates who lost a mark. The axes had to be correctly labelled, including at least one of the units (volts or centimetres). There were errors in using consistent increments in the scales. At least four of the five points, correctly plotted, were necessary for the second mark. Then a smooth curve, passing through the origin, had to be drawn for the third mark.

There were many completely correct answers for this demanding part of the question. Whole groups of weaker candidates could not draw a graph, showing failure to cover the necessary mathematics.

(c) Finally, candidates were asked to deduce the shape of the graph when a larger voltage was applied to the circuit. The question asked “explain how you decided this” but no answer lines were provided for the answer, although space was available, so a maximum of one mark was awarded for a line drawn and labelled, above the line drawn in **(b)**. This compensated for the change of marks in part **(a)(iii)**

Question 4

This question was based on the experiment undertaken by candidates for the Practical examination, Paper 5. They had to carry out tests on solutions containing respectively a reducing sugar, albumen, sodium chloride and a yellow dye, as though they were urine samples. The object of the exercise was to correctly identify the “patients” who supplied the urine and their illnesses.

The question required a knowledge of the relevant food tests and tests for ions in solution. Candidates also needed to carefully read and understand the question. Very many weaker candidates did not score any marks at all because of shortcomings in one or both of these essentials.

(a) Candidates had to complete a table to show the colours of the mixtures after the samples had been tested with Benedict’s reagent or by the biuret test. If the colours blue and red (or orange) appeared in the first row of the table, a point was scored; if the colours were in the correct places, the second mark was given. Similar marks were given for the colours blue and lilac (purple) in the second row.

The question demonstrated a lack of experience of food tests.

(b)(i) and **(ii)** The test for aqueous chloride is the addition of silver nitrate. This was more often correctly given, and a white precipitate indicated as the result.

(c) The presence of a fake sample in the set was a control, to ensure that the tests were fair. Another suggestion given was that the volumes of the samples tested was always the same.

Overall, the answers to **Question 4** were most disappointing and show that practical experience in this important aspect of the biology section of the syllabus is often lacking. However, whole sets of candidates answered the question well.

Question 5

This question is based on a familiar experiment, the production of carbon dioxide from p marble and hydrochloric acid. However, there were some subtle twists to the procedur caught out many candidates. The experiment was carried out at measured temperatures and time taken to collect a test-tube full of gas noted.

(a)(i) A diagram of the apparatus was shown. The names of two essential pieces of apparatus, the thermometer and the source of heat, missing from the diagram, had to be provided. Most candidates managed to suggest at least one of them, although the name of the scientist Bunsen was often misspelt.

(ii) In the diagram shown, gas was being collected in a test-tube over a trough of liquid. This liquid was not named as water (it could have been a saturated solution of carbon dioxide) so the better candidates who knew that carbon dioxide is somewhat soluble in water may have been confused. The question asks "What must the collection tube be filled with, before the experiment begins?" The answer could have been "the liquid in the trough". This answer was almost never provided. The Examiners were looking for a realisation that the tube must contain a liquid before gas can be trapped in it, so the answer "water" (although in practice one would not collect carbon dioxide over water) was awarded the mark. This was the answer given by most good candidates. Those who had no practical experience of collecting gas over water gave a variety of incorrect answers, including "a vacuum" or the name of a gas such as air, oxygen or nitrogen.

(iii) Far too many gave "hydrogen" as the answer here.

(b) Two digital clocks were shown, displaying two missing times for the evolution of a test-tube of gas. The times had to be recorded as seconds. A few candidates could not translate 02:05 into seconds.

(c) One change to the method, to give a more accurate result, was asked for. Measurement of the volume of acid and the mass of marble, or the use of a gas syringe to collect the gas, were the most frequent correct answers. At least one candidate suggested collecting the gas over oil. (See **(a)(ii)** above). "Repeat the experiment and find the average times" also earned a mark.

(d) The time taken to fill a tube of gas decreased as the temperature of the acid was raised, and this misled some candidates into thinking that the reaction rate slowed down. Candidates had to show that the time decrease meant a faster rate of reaction. Some candidates stated that "the time taken was faster" at high temperatures, an answer which makes no sense.

(e) Finally, an explanation of **(d)** in terms of the higher kinetic energy, increased speed of movement or greater collision frequency of the reacting particles was asked for. Some candidates stated that the reacting particles "vibrated more" at higher temperatures. This answer was rejected.

A completely correct answer to **Question 5** was rarely seen, but there was a good proportion of thoughtful answers to the subtleties of the question.

Question 6

The experiment on which this question is based concerns the thermal conductivity of metals. Candidates were told this in the first sentence, but many lost track of the logic of the question. One end of a metal bar was heated and a dent was made in it. After cooling, a glass bead was placed in the dent and held there by wax dripped from a candle. The other end of the bar was then heated in a Bunsen flame and the time taken for the wax to melt and the bead to fall off was recorded.

(a) Two digital timers were shown for candidates to read and record the missing times. The same errors occurred here as in **Question 5 (b)**.

(b) (i) Candidates had to suggest the property of the bar that enabled a dent to be made [illegible] metal. At this point many candidates confused the two stages of heating of the ba[illegible] completely forgot the concept of thermal conductivity.

(ii) Asked which metal was hardest to dent, candidates correctly chose steel. Unfortunately for candidates, this metal was also the metal taking the longest time to conduct heat to melt the wax. This led many candidates to try to find a reason for choosing steel from the data in the table, which was unconnected with the real reason why steel is the hardest metal; it is an alloy, whereas all the rest are pure metals.

(c) Candles are common enough for candidates to realise that wax is a hydrocarbon and from a petroleum fraction. However, animal fat and beeswax were also accepted as sources.

(d) This question asked for a reason why magnesium should not be used for this experiment. Vague answers such as “magnesium is a dangerous substance” or “It is too reactive” were not accepted. The examiners looked for a clear indication that heated magnesium reacts with oxygen and burns vigorously, or a statement that its melting point is too low.

(e) One way to make the experiment a fairer test was asked for. The use of equal-sized pieces of metal, or of a more controlled form of heating, were accepted as answers. “Repeat the experiment and find the average times” was also given the mark.

(f) The last question asked for a reason, based on the properties of metal and glass, why the experiment did not work with a glass bar. Candidates who had forgotten the purpose of the experiment gave answers that made no sense.

Candidates who had studied the phenomenon of conduction of heat, and whose knowledge included facts about the properties of metals, gave good answers to this question. Many other candidates gave poor answers.