# CO-ORDINATED SCIENCES

**Paper 0654/01**
**Multiple Choice**

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

## General comments on whole paper

At 67%, the mean on this paper is very satisfactory and shows that candidates for this paper appear to have been well prepared.

## Comments on individual questions (Biology)

### Question 1

It was, perhaps, surprising that this proved to be the most difficult of the biology questions. The root of the problem was a failure to understand the precise meaning of the term ‘species’, since, apart from option D, there was otherwise a good deal of guess-work in evidence.

**Question 5**

Less than a half of the candidates were successful with this question, but that may well be accounted for by the fact that there is traditionally a confusion between urea and faeces. A quarter of them believed that urea is removed via the small intestine.

**Question 8**

This was not a successful question since so many (96%) opted for the correct answer. Perhaps most would know that joints need lubrication to work smoothly, and Option C failed to attract any interest at all. However, for a question with such a high facility, it is rare to find that those very few who did not select the correct answer were, with some precision, the same few who performed least well in the test as a whole.

**Question 11**

There was a hint in this question that even some of the otherwise reasonably sound candidates were attracted by the traditional misunderstanding that blood crosses the placenta from mother to fetus.

**Comments on individual questions (Chemistry)**

**Question 14**

Nearly two-thirds of the lower-scoring candidates and one-third of the higher-scoring candidates chose key (B) rather than the key (D). This is thought somewhat surprising: the fact that nitrogen is diatomic does not make it a 'compound'.

**Question 15**

This time, it was only the lower-scoring candidates (two-thirds of them) who were tempted by key (D) rather than the key (A). These candidates seem merely to have mis-translated the numbers into the wrong formula, an indication of some misunderstanding of using combining powers.

**Question 16**

Guessing seems to have been prevalent with the lower-scoring candidates and nearly one-third of the higher-scoring candidates chose response D. However, this question should have been a matter of simple recall.

**Question 18**

Another question in which the lower-scoring candidates may have been guessing. However, for these candidates, response D was very nearly as popular as the key (C), i.e. about 33%.

**Question 20**

Similar comments apply here as for **Question 18** with responses C and D again being very nearly equal in popularity at 33%. As well as faulty recall, perhaps some lack of understanding of redox helps to explain these percentages.

**Question 21**

Another question in which guessing by the lower-scoring candidates seems to have occurred but with no clear favourite amongst the responses.

**Question 24**

With the lower-scoring candidates, response D was a little more popular than the key (C). Such candidates may have been misled by the subscipt 2 after the 'ammonium' formula.

**Question 26** proved to be the easiest of the Chemistry questions and, as such, did not discriminate very well.

 

**Comments on individual questions (Physics)**

In general, the Physics questions on this paper were well answered. The questions which candidates found easy (facility ≥ 70%) were 28, 29, 30, 31 and 33. Questions where the facility showed that candidates found the topic particularly difficult were 32 and 34. The following comments on selected questions may be of help to teachers.

Question 32 caused candidates difficulty, with over one third thinking the answer was B (i.e. greatest KE at the top) and the rest being equally undecided about the other options. Properties of waves often cause candidates difficulties, and it would be wise for teachers to spend as much time dealings with wave diagrams as they do with ray diagrams. So, it was perhaps not surprising to find that less than one third of candidates answered question 34 correctly (A), with almost as many choosing each of C and D. Question 35 should not have caused problems, even without the aid of the diagram, but there were a lot of candidates who thought that ultra-violet caused the heating effect. There was a lot of candidates who chose B or D, as well. It was pleasing to see that over half the candidates answered question 36 correctly, as it is unusual to have a question on this paper that involves two lenses. The most common problem was in recognising which distance was the focal length of lens Y. Question 37 posed no problem to nearly two thirds of the candidates, but it should be noted that a quarter of candidates chose the options which claimed the voltmeter would read 12 V when $S_2$ was open. In question 38, well over three quarters of candidates realised that the purpose of the anode was to attract electrons, but some of these thought that a negative charge would do this. In question 39, many candidates thought that gamma-rays carry a charge, and in item 40 a sizeable proportion thought that two different-sized samples of the same radioactive material would emit the same amount of radiation per second. There were even 12% who believe that 1 g of uranium has the same number of atoms as 2 g of uranium. However, the better candidates all correctly identified the half-life as the answer.

# 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 sometimes 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 3**, **6**, **9** and **12** seemed to be the most difficult for the candidates to answer successfully. **Questions 5** and **8** were well answered by the majority of candidates.

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 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 not well answered.

**(a)** Many candidates produced a long list copied from left to right across the diagram. Many other candidates failed to gain the mark because they included iris in an otherwise correct list.

**(b) (i)** Few candidates referred to refraction or focus. A significant number of responses confused the action of the lens with the iris.

**(ii)** Only the better candidates were able to explain that the retina converted light energy into a nerve impulse and fewer referred to the type of cells present in the retina which did this.

**(c) (i)** Many candidates showed that they did not understand the meaning of the term phenotype.

**(ii)** Candidates who did well on this part often drew their own genetic diagrams to deduce their answers. The nature of recessive alleles was not well understood.

### Question 2

Many candidates gained good marks on this question, showing good data manipulation skills.

**(a)** A number of candidates inverted the formula for density

**(b)** Weaker candidates used the density value calculated in **(a)** as the mass in this part.

**(c) (i)** This was well known.

**(ii)** Many candidates mistakenly used the formula work = mass x distance.

**Question 3**

This question was not well answered by most candidates.

**(a)** The idea that rock A was the igneous rock was not well understood.

**(b) (i)** The idea that rock B was sedimentary was better known.

**(ii)** There was a lot of confusion between weathering and erosion. Many candidates were able to identify (acid) rain as a weather agent but then explained it in terms of the rain breaking pieces off the rocks.

**(iii)** This part was linked to the candidates' answers to **(ii)** and required a sensible explanation in **(ii)**.

**(c) (i)** Few candidates gave the correct answer colloid here. Many candidates failed to give any answer.

**(ii)** The confusion which many candidates clearly have about sols, emulsions and colloids was very apparent here. Few candidates gained even one mark.

**(iii)** The test for sulphate ions was not well known. Few candidates gave a sensible suggestion.

**Question 4**

This question was fairly well answered.

**(a) (i)** Many candidates gained at least one mark here. Usually it was the palisade layer which they correctly identified.

**(ii)** Many candidates gained both marks here.

**(iii)** Many candidates correctly labelled the location of the stoma. However many other candidates managed to draw their arrows on nearly every section of the diagram.

**(b)** Many candidates correctly identified that xylem tissue carried water or minerals, but few mentioned the idea of support.

**Question 5**

There were many good answers to this question.

**(a) (i)** The idea of the horizontal portions of the graph being areas where the dolphin was moving at constant speed was well understood.

**(ii)** Many candidates showed good data handling skills here. The correct answer was usually given.

**(b) (i)** Many candidates knew the meaning of frequency. A number of candidates tried to give a general dictionary definition of frequency rather than relate it to the sound waves in the question.

**(ii)** and **(iii)** These parts were well answered.

**(c)** Most candidates knew the correct formula and correctly substituted in the correct numbers but few remembered to divide the answer by two.

**(d)** A high number of candidates scored two or more marks. The most common error was to fail to indicate the direction of the light rays correctly either by missing out the arrow altogether or commonly by having the arrow showing the wrong direction.

**Question 6**

This was not well answered.

**(a) (i)** Few candidates scored marks here. Answers focused on describing the differences between the electron diagrams in terms of shells and electrons. Few answers related to the physical properties of the metals.

**(ii)** Few candidates drew a correct diagram for a sodium ion. Most diagrams showed one or two electrons in the outer shell for sodium.

**(iii)** Few candidates were able to relate the electron structure of the rubidium atom and ion and explain the presence of the single positive charge on the rubidium ion.

**(b) (i)** This part was well answered. Many candidates were able to take the information from the table to explain the suitability of magnesium sulphate as an electrolyte.

**(ii)** There were few correct answers here. Although many candidates seemed to realise that they needed to replace the metal electrodes with different metals, they were unable to explain this clearly. Many answers referred merely to changing the electrodes.

**Question 7**

**(a) (i) & (ii)** This was well answered by most candidates. Almost all candidates were able to interpret the graphs.

**(b) (i)** Most candidates were able to describe at least one effect of increasing the nitrate concentration in the field.

**(ii)** Many candidates were unable to suggest the addition of fertiliser.

**(c) (i)** Most candidates successfully drew a food chain and drew the arrows in the correct direction.

**(ii)** The idea of energy flow being represented by the arrows was not well known. The commonest answer was ‘gets eaten by’.

**(d)** The role of decomposers was not well known. There were few suggestions at all here.

**Question 8**

This question was well answered.

**(a) (i)** Many candidates gained one or both marks here.

**(ii)** and **(iii)** Most candidates knew that neither plastic filler nor aluminium were not magnetic.

**(b)** Most candidates gained high marks on this part.

**Question 9**

This question was not well answered.

**(a)** This was surprisingly badly answered by many candidates. Many just tried to rearrange the information given.

**(b)** Although many candidates correctly identified carbon dioxide as being produced and in some cases managed to describe global warming, many candidates additionally mentioned damage to the ozone layer and acid rain formation. Candidates should not expect to gain marks if they provide a list of all environmental problems both correct and incorrect.

**(c) (i)** Many candidates knew the limewater test. A number suggested the test for hydrogen.

**(ii)** Some candidates realised that biogas from the digester contained a higher percentage of methane, but few were able to explain why this meant more heat energy was produced.

**Question 10**

**(a)** Most candidates were able to explain that a catalyst speeded up a reaction. Fewer were able to explain that the catalyst was not used up during the reaction.

**(b)** Most candidates found this difficult. There were few correct answers, although many candidates gained one mark.

**(c) (i) & (ii)** There were only a small number of responses that showed an understanding of the nature and role of dietary fibre.

**(iii)** This part was badly answered. Meat and milk were commonly given as sources of fibre.

**Question 11**

This question was not well answered. Answers given suggested that many candidates were either not familiar with these parts of the syllabus or found it difficult to cope with the structure of the question.

**(a)** Few candidates correctly identified the three elements carbon, hydrogen and oxygen, and fewer were able to follow the instructions and state the chemical symbols of these elements.

**(b) (i)** The idea of nitrogen fixation was not well known. Many candidates simply rearranged the information given in the question

**(ii)** Ammonia was not well known as the gas released. There was no common wrong answer here.

**(iii)** Many candidates seemed to know what a nucleon number was, but many had difficulty expressing it in words. Additional incorrect information often meant that correct ideas elsewhere in the answer gained no credit.

**(c)** Most candidates gained at least one mark here, but many did not read the question carefully and gave answers relating to food.

**Question 12**

This question involved a lot of data handling and many candidates found this difficult.

**(a) (i)** Less than half the candidates gained the mark here. A common wrong answer was predictably voltmeter. Candidates need to be aware that they will not gain credit using the term ampmeter.

**(ii)** This was generally well answered.

**(iii)** Most candidates who answered this part got it right. There were many papers where there was no response at all.

**(iv)** It was particularly obvious in this part that candidates were not referring back to the table and diagram for information. 3 W was a common wrong answer gained presumably by multiplying the two numbers in the question together.

**(b)** It was encouraging to see so many candidates correctly attempt and get right the final question on the paper.

# CO-ORDINATED SCIENCES

**Paper 0654/03**

**Extended Theory**

## General comments

This paper tested a wide range of the curriculum content of the syllabus, including many areas contained within the supplement. It was clear that many candidates were not familiar with all of this material, and did not have the knowledge to enable them to answer several questions demanding recall of some of these sections.

Several questions also required candidates to analyse data presented in tables or on graphs, and it was clear that while some knew how to study and interpret data, others are much less able to do so.

Many candidates wasted time by rewriting the question before beginning their answer. For example, they might begin an answer to **4(c)(i)** by writing: 'The function of cartilage at the knee joint is...'. If this is repeated throughout the paper, then it is likely that not enough time is being spent on reading questions and writing appropriate answers, so it is suggested that candidates are discouraged from doing this.

## Comments on specific questions

### Question 1

**(a)** This was generally answered well. However, many candidates did make errors, the commonest being confusion between the cell wall and cell membrane. Weaker candidates often placed the chloroplasts in the cell wall, while others drew the nucleus or chloroplasts inside the vacuole.

**(b)** This, too, was well done, with most answers stating that xylem transports water and mineral ions to the leaf, with some also mentioning its role in support. The transport of 'nutrients' was not credited, as this could include organic substances such as sugar.

**(c) (i)** The most common suitable suggestions here were temperature and water supply, but there was a wide range of accepted responses. Answers that were not appropriate included the wavelength of the light, and wind speed.

**(ii)** Almost all answers to this question were correct.

**(iii)** This proved harder than expected. Good candidates explained that carbon dioxide is used in photosynthesis, to produce glucose or other carbohydrates which have mass and are used in growth. However, many answers looked at the issue from the other end, suggesting that because the leaves had a larger mass they used more carbon dioxide. A surprising number suggested that leaves were *producing* more carbon dioxide, suggesting that they had not read or understood the headings in Table 1.1.

**(iv)** It was rare to see good answers to this question. Very few candidates mentioned chlorophyll, and even fewer recognised that it is able to absorb only some wavelengths or colours of light. Better candidates mentioned that chlorophyll is green, and therefore reflects green light (which therefore cannot be used) or that it absorbs only red and blue light.

**Question 2**

**(a) (i)** This, too, was less well done than expected. Although many correct answers were seen, there were also many who wrote a formula (such as $C_6H_{12}O_6$) rather than giving the chemical symbols of the *elements* as asked. Several wrote the names rather than the symbols, despite the emboldening of 'chemical symbols' in the question. Weaker candidates often suggested other elements, generally N, P and K.

**(ii)** Some answers were excellent, providing a short and correct statement that nitrogen fixation is the conversion of nitrogen gas into nitrogen compounds (or naming a compound), and often also stating how this is achieved – lightning and nitrogen-fixing bacteria were the most common correct answers. However, many gave vague or incorrect answers. A common idea was that plants cannot 'absorb' or 'take up' gaseous nitrogen, which is not true. Nitrogen diffuses readily into leaves along with other gases from the air, but it is too unreactive to be *used* by plant cells.

**(b) (i)** Most candidates were able to do this calculation, and showed appropriate working.

**(ii)** This was a more demanding question than **(i)**, and provided a much wider range of answers. Candidates who tried to calculate the relative molecular masses of anything generally got nowhere. Better candidates used the equation to show that the ratio of ammonia to acid should be 2:1, then calculated the number of moles of acid used and finally compared this with their answer to (i) to explain that too much acid had been used, or to state how much should have been used.

**(iii)** There were many entirely correct answers to this, including a statement that the formula of the ammonium ion is $NH_4^+$ and a statement that the charges on the ions must balance in order to achieve a neutral compound. 'Explanations' in terms of 'exchanging valencies' or 'swap and drop' could only get one mark for stating the charge on the ammonium ion. Some tied themselves in knots trying to work out what the charge would be on the ion by thinking about the hydrogen and nitrogen atoms in it.

**Question 3**

**(a) (i)** Surprisingly few answers were correct, with many giving the current through $M_4$ as 2 amps.

**(ii)** This was generally answered correctly, although a few forgot to give a unit with their answer.

**(iii)** Many candidates did not know how to calculate the sum of resistors in parallel. Of those who did, quite a few failed to arrive at a correct answer, although they often gained some marks for their working. Those using the formula $R = \frac{R_1 \times R_2}{R_1 + R_2}$ often got it the wrong way up, while others wrongly gave a formula such as $R = \frac{R_1 \times R_2 \times R_3}{R_1 + R_2 + R_3}$. Those using $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ were often unable to add the fractions, or forgot that they had calculated the reciprocal of $R_T$. Several treated the three resistances as if they were all in parallel, not remembering that they had already calculated the total resistance in the top branch of the circuit in their answer to **(ii)**.

**(b)** Although most candidates knew the formula *charge* = *current* × *time*, not all recognised that time must be in seconds. Many did calculate the value correctly, but did not know the correct unit.

**(c)** There were many excellent answers to this question, but at least an equal number from candidates who appeared to have almost no understanding of static electricity. 'Positive electrons' appeared quite frequently. Once a candidate realised that friction was producing a transfer of electrons, they were usually well on their way to full marks.

**Question 4**

**(a) (i)** Although there were some good answers to this question, many candidates were able to give only vague suggestions, rather than a clear description, of a reflex action. Relatively few made clear that it is a response to a stimulus, and that it happens automatically, without conscious thought. Several said that it does not involve the brain, which is not correct; many reflex actions use nerve pathways that pass through the brain (for example the iris reflex).

**(ii)** This was answered better than **(i)**, and many correctly explained that the speed of response of a reflex action may help an animal to avoid danger. Very often, though, this was not at all clearly stated, but had to be picked out from a rather rambling description of a particular reflex action, rather than a general statement about reflex actions (in the plural) as asked in the question.

**(b) (i)** This proved surprisingly difficult, athough most were able to label the spinal cord as being part of the central nervous system, either with a label line to the diagram, or written next to the label already there. Some, however, drew a disconnected brain and labelled that, which was not credited. Many labelled a spinal nerve.

**(ii)** Many candidates were able to place arrows correctly on the two neurones, although some had them going the wrong way. A surprising number drew arrows in completely irrelevant places, such as on the kneecap. Some drew a single arrow halfway between the two neurones.

**(c) (i)** This was very well answered, with almost all candidates able to explain that cartilage reduces friction and acts as a shock absorber.

**(ii)** This, too, was done well, the most frequent difference relating to the hardness of bone and its function in support.

**Question 5**

**(a) (i)** This was generally well answered.

**(ii)** Most candidates recognised that plastic filler is not magnetic.

**(iii)** Fewer candidates answered this correctly than **(ii)**. The commonest error was to suggest that aluminium is a metal and therefore is magnetic.

**(iv)** The most common correct answer was that aluminium is 'lighter' than steel. Others correctly stated that aluminium does not rust, or that it corrodes less than steel. The statement that 'aluminium rusts less than steel' is not correct, as aluminium does not 'rust' at all. Only iron forms rust. Suggestions that aluminium is cheaper or more malleable than steel were ignored, so if a correct response was given alongside these it was still credited. Weaker candidates often suggested that aluminium was used so that the car was not affected by magnets.

**(b) (i)** Most candidates could not convert a temperature in °C to kelvins.

**(ii)** Many different errors arose here. A large number of answers did not give a correct formula relating the two pressures and two temperatures. Several tried to work this out using a formula such as pressure = force / area. Of those who did produce a suitable formula, most did not substitute temperatures as kelvins, continuing to use the Celsius values, even if they had answered **(b)(i)** correctly. If they then went on to calculate an appropriate answer, with units, from this wrong substitution, they lost only one mark.

**(iii)** This is generally well-known, and there were many entirely correct answers. However, some candidates described the particles as 'vibrating more' rather than moving faster or having more kinetic energy, and many described them colliding more frequently with each other rather than with the tyre wall.

**(c) (i)** Most candidates knew the correct formula to use here, substituted the values correctly and arrived at the right answer with the unit joules. However, some gave the right formula but then failed to square 12.

**(ii)** Although most answers correctly suggested that this would reduce the chance of the person hitting themselves on part of the car, few went further than this. Credit was given for the idea that the seatbelt reduces the speed, kinetic energy or momentum of the passenger. Several answers wrongly suggested that the collision *transfers* kinetic energy to the passenger, apparently not recognising that they already have this energy before the collision.

**Question 6**

**(a) (i)** This was generally answered correctly.

**(ii)** There was much confusion here between weathering and erosion, with the most common answers, (unfortunately incorrect), describing how flowing water would carry away particles of the rock. A wide range of answers was accepted, of which the most common were a description of the effects of acid rain, or of biological weathering such as is caused by the growth of plant roots. Descriptions of erosion by wind or water needed to explain that it is the tiny solid particles carried by the moving air or water which abrade the rock surface.

**(b)** Most answers gained at least one mark, for the idea that light rays cannot pass directly through the colloid. The second mark was for a more detailed explanation, for example that many of the rays are reflected off the solid particles. Many drew on the diagram and annotated it, which often secured them a mark. Weaker candidates, however, often failed to mention light at all.

**(c) (i)** A very infrequent incorrect answer was that chlorine is more reactive than iodine. The answer needed to state either than chlorine is more reactive than bromine, or that iodine is less reactive than bromine. Some answers stated that chlorine is ‘above bromine in the periodic table’, which did not quite go far enough.

**(ii)** Almost all candidates were able to complete the diagram for the chlorine atom, but it was rare to see eight electrons in the outer shell of the bromide ion. One reason for this appeared to be that not all candidates appreciated that this was an *ion* and not an atom. Another was that they did not recognise that bromine, like chlorine and all elements in this period, has seven electrons in its outer shell, and instead tried to use the atomic number to count up electrons in each shell. This invariably produced an impossibly high number of electrons in the outer shell.

**(iii)** Relatively few candidates answered this entirely confidently, describing briefly how an electron would transfer from the bromide ion to the chlorine atom. Many wrongly suggested that the bromine and chlorine would share electrons. Many unnecessarily involved the sodium ion in their descriptions. Candidates should be reminded that it is important not to use the word ‘bromine’ when referring to a bromide ion.

**(d)** This was generally well-known, and most answers scored full marks. However, some descriptions of single and double bonds were very shaky, suggesting that candidates did not really understand what they were trying to describe. For example, some said that saturated hydrocarbons have ‘a single bond’ and that unsaturated hydrocarbons have ‘many bonds’. Some weaker candidates had no idea, and tried to explain in terms of solubility in water.

**Question 7**

**(a) (i)** This was usually answered correctly. The commonest error was to omit the unit. Some candidates did not use the graph at all, simply suggesting 37 °C.

**(ii)** Answers to this were very disappointing. Most did not attempt to explain the shape of the curve, but only to describe it. Of those who did explain, relatively few used their knowledge of particle theory to explain how temperature affects the rate of a reaction, in terms of increasingly frequent collisions as temperature rises. Many answers implied that enzymes ‘try to work harder’ as the temperature increases, or just said that they could not work as fast when they were cold but made no attempt to explain why this is so.

**(iii)** This was slightly better done than **(ii)**, as many answers correctly stated that enzyme molecules are denatured at high temperatures, but few went further than that to explain how this causes the reaction rate to decrease. Weaker candidates often stated that the enzyme was ‘killed’ or ‘died’.

 

**(b) (i)** This was not well-known. Many candidates wrongly suggested that lipase is made in the liver.

**(ii)** This, too, was not well known. Some did recognise that lipase digests fats, but did not know the products. Glucose frequently appeared.

**(c)** Answers to this question were very disappointing, and it appears that this part of the syllabus had not been adequately addressed by many Centres. Candidates studying the supplement should be aware of some of the specific roles of proteins in the body, rather than just the blanket statement that they are involved in ‘growth and repair’. The easiest ones to use as examples are haemoglobin and insulin, as these are already dealt with elsewhere in the syllabus. Better candidates did often cite these and gained full marks. Other examples included antibodies and keratin.

**Question 8**

**(a)** This was generally well answered.

**(b) (i)** Most answers were correct. The commonest errors were to fail to write in the symbols of the elements, or to include extra electrons in the shells of the hydrogen atoms.

**(ii)** This proved surprisingly difficult, with relatively few candidates able to balance the equation correctly and even fewer able to explain their answer. Many correctly wrote ‘3’ in the equation and then stated the number of oxygen molecules as ‘6’. Their subsequent explanations made it clear that they did not know the difference between an oxygen molecule and an oxygen atom. Several candidates knew how to approach the problem, but miscalculated the number of oxygen atoms on the right hand side of the equation. Weak candidates often tried to give lengthy explanations in terms of the reactions taking place.

**(iii)** Good answers identified the high percentage of methane as an advantage, and the higher percentage of hydrogen sulphide as a disadvantage, and gave brief and suitable explanations of each of these. Many, however, thought that the high quantities of hydrogen sulphide would be a disadvantage because they would require more oxygen when they burnt. A very frequent error, seen mostly amongst weaker candidates, was to not appreciate that the question asked about the *burning* of these gases. This led to incorrect answers such as the high percentage of methane being a disadvantage because of its effects as a greenhouse gas.

**(c)** This was a demanding question, but there were some very good answers. Many, however, simply described how bonding occurs between nitrogen atoms. Others wrote their answer in such a way that it was impossible to tell whether they were describing forces between atoms or between molecules.

**Question 9**

**(a) (i)** Most were able to give a correct version of the formula relating speed, frequency and wavelength, and generally calculated a correct value for the wavelength. However, not all of these gave the correct unit.

**(ii)** There were some very good answers to this, explaining that the particles in water are closer together than those in air, and therefore the vibrations are passed on more quickly from one particle to another. Weaker candidates, however, were not able to make any appropriate suggestions. Some appeared to think that there are ‘sound particles’.

**(b)** This was usually done well, with a high proportion of answers being entirely correct and showing working. The commonest error was to simply write the formula, distance = speed $\times$ time, and use the maximum speed from the graph in the calculation. Some calculated the entire distance covered, not just that in the first 25 seconds.

 

**(c)** A wide range of responses was seen here. Many obtained full marks, but many others made at least one significant error. The commonest of these was to draw arrows on the light ray going *from* the eye to the dolphin. Others were to show the ray bending towards the normal as it emerged from the water, or for the rays not to touch (or at least come very close to) the dolphin and the eye. Quite a few answers included a ray coming into the water from the right hand side (presumably from the sun) to hit the dolphin, before being reflected upwards towards the eye. This was ignored so long as it did not interfere with the relevant part of the drawing. Equally, several used their diagram to show where the image of the dolphin would appear to the observer, which once again was ignored.

# CO-ORDINATED SCIENCES

**Paper 654/04**

**coursework**

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

19 Centres submitted coursework for the June examination. In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. Most Centres have established a portfolio of well tried practical activities, which they base most of their assessments upon.

New Centres were well prepared and offered a suitable selection of practical tasks. The standard of candidates work was of a similar standard to previous years.

**(b)** Teacher’s application of assessment criteria

The majority of Centres have a good working understanding of assessment procedure. The improvement seen in the Centres’ application of assessment criteria in recent years has been sustained. Distance learning seems to act as a good preparation for coursework assessment.

For the third year no Centre tried to assess both skills C1 and C4 in the same investigation.

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

This is an area where improvements can be made by many Centres. As in previous years suggestions have been made to encourage the use of annotation on candidate’s scripts. Most Centres write thorough summaries to support the mark given to each candidate. There is still scope for further improvement with some Centres writing little other than a final mark. Tick lists remain popular with particularly skill C1.

**(d)** Good practice.

Many Centres have developed a booklet of tasks and dedicated assessment criteria in previous years.

 

# CO-ORDINATED SCIENCE

**Paper 0654/05**

**Practical Test**

## General comments

The overall performance was probably down on previous years. One of the chief reasons for this was due to the failure of candidates to carefully read the question. For example, **question 1 part (a)** indicates that at least two leaves should be drawn, and any candidate drawing one leaf would inevitably be penalised. In addition, assuming the specimen provided had leaves attached to a stem, many failed to draw the stem. **Question 2 part (e)** asks for an experiment to be described, not a statement from the text book. **Question 3 part (e)** showed very little thought in trying to use the tests to identify the three solutions.

## Comments on specific questions

### Question 1

The minimum requirement for full marks in **(a)(i)** was a drawing showing a stem with at least two leaves and some clear indication that the leaves had started to wilt. Most candidates referred to lack of water in **(ii)**, but fewer attempted to explain why there was a lack of water. A large number totally ignored the stem and could not score in **(iii)**. **Part (iv)** was poorly answered. The answer needed a mention of the woody stem (lignin) and the support this provided even when water is scarce. It was surprising to find many candidates did not know the meaning of a transverse section. Of those who did, most knew the name of the tissue to be xylem. There were several possible answers to **part (c)(i)**, although one-word answers such as 'light' or 'wind' were not acceptable. Several marks were lost in **part (c)(ii)** because the question was not answered. The sentence begins 'How would you…..' and hence a theoretical answer was not acceptable. Many stated that the celery would be placed in conditions of different temperature, basically repeating what was written, but failed to then make any reference to a fixed period of time or what would be done to determine the transpiration rate.

### Question 2

The diagram clearly shows the ruler with the zero at the bottom. Despite this, many candidates assembled the apparatus with the ruler the other way up. Likewise, the readings indicated that measurements should be given in millimetres, not centimetres. Some failed to record a value for $h_0$, yet produced some figures for the extension. Graphs were generally acceptable, although few appeared to plot (0,0), which was a valid coordinate in this experiment, given in Fig. 2.2. Despite this, most drew a straight line passing through the origin. A few reversed the axes, and some plotted the mass rather than the force. **Part (c)** was usually correct. **Part (d)** required an answer based on the results, not a theoretical answer. Examiners were simply looking for a reference to a straight line. **Part (e)** was poorly answered. Again, the words 'Describe an experiment' were often ignored. A good answer would have described the experiment carried out earlier, using much larger masses. A graph would be plotted to see whether or not a straight line was produced. Very few realised that once the elastic limit was reached, the extension would be much larger for a small increase in force.

### Question 3

The key observations in this question were the effervescence when magnesium was placed in solution **B**, suggesting that **B** was the acid, and effervescence when **A** and **B** were mixed, showing **A** to be the carbonate. The milky appearance when carbon dioxide was passed into solution **C** indicated that **C** was limewater. The majority of candidates scored full marks in **(a)(ii)** but far fewer did so in **(b)(ii)**. Both solutions **A** and **C** produced a precipitate, whilst **B** showed no reaction. Many thought that the bubbles in the tests in **(c)** were significant, presumably surprised that when a gas is passed through a solution, bubbles would be expected. The blue precipitate formed when copper sulphate reacted with **A** was not sufficient proof that **A** was the carbonate, as a similar precipitate was formed with copper sulphate and solution **C**. As already indicated, **B** should have been easily identified as the acid, and **B** as the carbonate. Most identified **C** as the limewater, recognising the reaction with carbon dioxide. There were some answers suggesting, for example, that **A** was a zinc solution, **B** a chloride and **C** an ammonium salt. Presumably those candidates had not read the first two lines of the question. A few candidates were able to score full marks in **(f)** by adding the acid to a fixed amount of the two alkalis plus an indicator, and counting the drops of acid used. The majority seemed to think that the colour produced by an indicator would differentiate between two solutions of different concentration. Answers such as 'add litmus and see which one was a darker blue' were very common.

# COMBINED SCIENCES

**Paper 0654/06**
**Alternative to Practical**

## General comments

The examination is designed to test candidates' knowledge and experience in practical Chemistry, and roughly follows the section in the syllabus entitled "Criteria for Assessment of Experimental Skills and Abilities". Inevitably, each question will also contain relevant material from the Biology, Chemistry or Physics sections of the syllabus and sometimes a mixture of one or more of these. The Examiners are always at pains to emphasise that this paper is an alternative to assessment either by coursework or by Paper 5, the Practical Test. Paper 6 is not an alternative to spending time in the laboratory. Unfortunately, there will always be candidates whose schoolwork has contained little or no experimental experience. They are at a serious disadvantage, as the details of this report show.

## Comments on specific questions

### Question 1

This question is based on an investigation of the transpiration stream in a piece of celery standing in water and dye, shown in the first diagram. After a suitable time, a transverse section of the celery, shown in the second diagram, reveals the movement of the dye in the stem.

**(a) (i)** Most candidates were able to name xylem as the vessel through which the dye travels.

**(ii)** This was often poorly answered. Candidates mis-read the instructions and tried to sketch the celery section after a piece of celery had dried out, rather than as flaccid leaves after the first diagram. Marks were available for explaining that the celery had lost water by transpiration and so had become wilted or had lost turgor pressure.

**(b) (i)** The Examiners preferred the answer "wind" or "humidity" rather than "light" as a factor influencing transpiration rate, but any one of these three answers was credited.

**(ii)** It was the intention of the question that a method of comparing transpiration rates at different temperatures should involve dye absorption by celery, as in Fig.1.1. However, candidates could earn some marks for a description of a potometer experiment. Some candidates omitted the dye, then suggested that that the amount of water left in the beaker should be measured. This might work if the surface of the water was covered with oil. Some thoughtful answers were noted but many answers were poor.

Unacceptable answers to **Question 1** showed that candidates did not read the question carefully enough or had no experience of this type of investigation.

### Question 2

This question tested knowledge of transverse waves, including ideas about wavelength, speed and frequency.

**(a)(i)-(iv)** The hardest part of this section was the calculation of the frequency in waves per second (hertz) which turned out to be a number less than 1. Candidates giving the answer 9 (waves per minute) gained some credit.

**(v)** This tested the idea that particles of matter under the influence of a transverse wave move at right-angles to the direction of the wave. Most candidates did not answer this correctly.

**(b) (i)** The same point was tested here, where a ribbon tied on a rope moves vertically as the wave moves horizontally along the rope. Candidates were more successful with this, but many arrows were drawn showing the arrow moving horizontally or at an angle.

**(ii)** To achieve the marks in this part, a candidate had to understand that the energy of waves is increased by changing the amplitude or the frequency. Too often answers referred to the teacher "using more force" or "waving his hand faster". Unless there was some further explanation it was hard to credit such vague answers.

Despite the problems mentioned, most candidates scored well in this question.

**Question 3**

To answer this question, candidates needed knowledge of elements in the third Period of the Periodic Table, their symbols and simple properties.

**(a)** A common error was to confuse phosphorus with potassium (P with K), sodium (kept under oil) with phosphorus (kept under water), sulphur and silicon (S and Si). Often, chlorine was identified as a colourless gas. Three correct arrows, linking symbols with the stated physical properties, was a rare occurrence, and many answers were obviously chosen at random.

**(b)** This caught out a substantial number of candidates who had obviously never connected up common laboratory instruments such as ammeters and voltmeters in a circuit. The mark scheme specifically penalised a mistake in polarity or in connecting the voltmeter in series, but there was worrying ignorance of the idea that wires must be connected to the terminals. Often, wires were drawn passing through (or over) the cases of the instruments. A circuit that would work, using the battery, lamp and sample, was credited, but the other two components had to be connected in some way that would not impede the current.

**(c)(i)-(v)** Knowledge of the chemistry of one of the elements had to be used to explain the colour of the flame on combustion, the name and physical state of the product, and its effect on litmus. Only the best candidates could answer this and then go on to suggest a credible safety precaution.

A completely correct answer to this question was rare, although the separate parts all attracted right answers.

**Question 4**

This question is based on knowledge and experience of the Biology section of the syllabus. Inevitably, candidates focused on the characteristics of yeast as an organism rather than on the chemical reaction, catalysed by enzymes, that was being studied. A more comprehensive outlook on science enabled candidates to score higher marks.

**(a) (i)** A minority of candidates failed to draw a smooth curve through the points they had plotted. Most scored full marks.

**(ii)** This question was rarely fully answered. Most candidates recognised that there was an increase in activity of the yeast as the temperature rose from 30 °C to 45 °C; however, this was not well explained. Some candidates thought that the temperature rise was caused by the increased activity, (and therefore increased energy output), of the yeast, not realising that the temperature was controlled by the student doing the experiment. Very few candidates said that increased activity was caused by the increased kinetic energy of the molecules of sugar in the solution at higher temperature. The Examiners realised that almost all candidates, asked to explain higher reaction rates in a purely inorganic context, would explain them in terms of higher kinetic energy of the particles. There are, therefore, implications for the teaching approach when studying this kind of reaction in a biological context.

The second part of the question was answered better by many candidates, who linked the decrease in evolution of carbon dioxide with the denaturing of the enzyme.

**(b)** A wide range of drawing skills was noted. The answers given full credit either showed a graduated gas syringe or illustrated the collection of the gas over water in a graduated vessel. There were many diagrams of bubbles being collected in a beaker or in a closed test-tube.

**(c)** Some candidates gave a satisfactory account of an experiment in which equal masses of yeast were added to equal volumes and concentrations of glucose and sucrose, at the same temperature. Many merely wrote "Do the experiment again but with sucrose this time". Such a response gained no marks.

**Question 5**

This question was based on the corresponding Paper 5 question in which candidates for the practical test had to find the extension of a spring using a range of masses, then plot an extension/load graph.

**(a)** Conversion of mass to force in newtons was a simple matter for almost all candidates.

**(b)** Similarly, reading the scale of the ruler and so measuring the height of the pointer was easily done.

**(c)** A few candidates failed to calculate the extension of the spring for the three loads. A very few candidates read off the extensions from the graph after they had plotted the maximum extension. This involved an error outside the tolerance applied by the Examiners, so a mark was lost.

**(d)** The Examiners were pleased by the good standard of graph plotting demonstrated by most candidates.

**(e)** The extension caused by a force of 0.8 newtons had to be found using the graph. Some correct figures were written, but the result had to be visible as a line or point on the graph, as the question demanded. Other candidates failed to find the point on the *x*-axis corresponding to 0.8 newtons. The most common error here was giving the value at a load of 0.9 newtons, due to mis-reading of the scale.

**(f)** The last part of the question asked candidates to predict the shape of the graph if the spring were to be "over-stretched" (beyond the elastic limit). Most candidates made the graph bend in the wrong direction.

The Examiners congratulate many Centres for the high standard of answers to this question.

Qu**estion 6**

This Chemistry question is based on the corresponding question in Paper 5. Three solutions, **A**, **B** and **C**, are named as calcium hydroxide, sodium carbonate and dilute sulphuric acid. During the answers to the question, candidates had to correctly identify the solutions.

**(a) (i)** It should have been easy to identify the gas given off when magnesium is added to one of the named substances, but the majority of the candidates named the gas as carbon dioxide and from then on their answers were often muddled and incorrect.

**(ii)** As a result of an incorrect answer to **(a)(i)**, the solution that reacted with magnesium was often named as sodium carbonate.

**(b) (i)** Addition of sulphuric acid to copper sulphate was a "negative result" test, so there should be no precipitate or "no change". If, however, the answer given to **(a)(ii)** was "sodium carbonate", there would be a blue precipitate for which an "error carried forward" mark was available.

**(ii)** The name "copper carbonate" for the blue precipitate stated to occur with sodium carbonate solution was rare.

**(c) (i)** The names of two substances that react to give carbon dioxide were needed here. Surprisingly, this easy question was answered by few candidates.

**(ii)** Carbon dioxide was passed into solution **C**. There was no change when it was passed into solution **A** and **B**, so what would be seen with solution **C**? About half of the candidates could answer “a white precipitate” or “goes white”.

**(d) (i)** The candidates were told that the litmus showed that solution **A** was alkaline, and asked the colour of the litmus. What colour is the litmus? Many candidates gave the correct answer.

**(ii)** Solution **B** was added to the litmus mixed with 2 $cm^3$ of solution **A**. The litmus changed colour when 3 $cm^3$ of **B** had been added. Candidates were asked which of **A** or **B** was more concentrated. Many candidates did not appreciate that a neutralisation reaction was occurring, and merely said that “litmus changed colour quicker (or faster) with solution **A**.” The Examiners required an appreciation that **B** was reacting with **A**.

 