CO-ORDINATED SCIENCES

Paper 0654/01
Multiple Choice

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

Comments on specific questions

Questions 1 to 13

Question 1

This was a very straightforward question on an equally straightforward topic, but whilst it may not have been too demanding, it may have provided a gentle introduction to stiffer challenges ahead.

Question 3

Two significant misunderstandings were exposed by this question, namely that the retina is involved in the focusing of the light rays and that the cornea is not. It is, of course, possible that there was also some confusion of the terms used in the anatomy of the eye.

Question 8

This was the easiest of the Biology questions with all but 6% impressively avoiding the suggestion that iron is required for the formation of bone. Perhaps the question was made a little easier by there being only one option offering blood as a substance requiring iron.

Question 9

This was, by far, the most difficult of the Biology questions. Candidates appeared not to recognise the significance of the positions of letters **P** and **R** on the diagram. Instead, well over a half of them seemed to believe that **P** related to the eye and **R** to the muscle. It was significant that this error was not made by candidates who performed well in the paper.

Question 10

Somewhat surprisingly, almost a third of candidates believed that the prostate produces hormones that control adolescence or, maybe, they did not read the question carefully enough and simply linked adolescence with activation of the prostate. With no candidates believing that the vas deferens produces hormones, the question did not perform as well as was hoped.

Questions 14 to 27

Question17 was found to be quite easy but did not discriminate very effectively.

Question 18 was found to be yet easier but also with low discrimination.

Question 20 It was disappointing that this question was found so hard, only 27% answering correctly. Over 40% across the ability range chose response **A**, rather than the key **(C)**. Temporary hardness appears not to be well understood by these candidates.

Question 22 was found hard by the lower-scoring candidates. Indeed, for these candidates, the key **(D)** was the least popular choice and response **B** the most popular.

Question 23 Nearly half of the lower-scoring candidates went for response **D** and just over a quarter of the higher-scoring candidates also chose this response. This points to simple faulty memory of the effect of acids and alkalis on the colour of litmus.

Question 26 Responses **A** and **D** each attracted about a third of the lower-scoring candidates, leaving only a fifth answering correctly. Two sources of confusion appear to be involved. The first is about the order of reactivity of magnesium and copper but the other is perhaps a little more fundamental: The masses of the atoms of different elements differ so that even though 1 atom of magnesium is replaced by 1 atom of copper, a change of mass is involved.

Question 27 Over half of the lower-scoring candidates chose response **B**, this same response also attracting a third of the higher scoring candidates. This points to a significant misunderstanding of the structure of a metal.

Questions 28 to 40

Items which candidates in general found relatively easy (over 70% facility) were **Questions 28**, **30**, **33**, **34**, **37** and **39**. Items which had a low facility (i.e. a low proportion of candidates answering correctly) were **Questions 31**, **35**, **36** and **38**. The following comments about individual items might prove to be instructive.

In **Question 29**, it was depressing to see that a third of candidates believe that mass is measured in newtons - the distinction between mass and weight still confuses candidates. The means by which energy sources deliver electricity is not well understood (**Question 31**). A big majority thought that hydroelectricity uses steam, with only a third of candidates answering correctly.

As is often the case, ray optics showed itself to be a topic which is not well understood. In **Question 35**, for instance, only a third of candidates knew what the angle of reflection would be. A larger number thought it would be the angle with the surface.

The statistics indicated that candidates probably did not read **Question 36** carefully. It was asking about the measurement of two voltages, but about half answered **C**, it would seem that they just made the assumption that this was an “Ohm’s Law” type measurement. Nearly one-third thought a force meter would be involved, presumably because of the mention of electromotive force. In **Question 38**, only a third answered correctly, and a similar number thought that thicker insulation would reduce the heat produced.

In **Question 40**, almost all realised that gamma-rays are electromagnetic radiation, but they were not so sure about the nature of alpha-particles.

CO-ORDINATED SCIENCES

Paper 0654/02

Paper 2 (Core)

General Comments

Most candidates were able to attempt most questions. Many gained good marks on one question but then gained few marks elsewhere. **Question 5** in particular was poorly answered by many candidates. **Questions 1** and **4** were generally well answered. Many marks were lost by a lack of precision in giving answers. 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.

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 well answered especially part **(a)** where many candidates gained all four marks.

(a) Candidates generally either got full marks here showing that they understood the idea of keys or else they gained zero marks showing that they did not understand the concept.

(b) (i) The idea that the binomial indicated the species was generally well known but not that the other word indicated the genus.

(ii) Homo sapiens was a common answer, predictably. Some candidates ignored the instructions and gave the binomial of one of the birds mentioned in part **(a)**.

Question 2

This question was answered reasonably well, with most candidates able to gain two or three marks.

(a) (i) Many candidates correctly identified the ammeter, although there are still candidates who are calling it an ‘ampmeter’. Voltmeter was the predictable wrong answer.

(ii) Few candidates knew the connection between amperes and coulombs. Six coulombs was a common answer.

(iii) Six ohms was the most popular answer but again there many others with twenty four being quite common.

(iv) Most candidates were able to draw two lamps in series. There were very few parallel circuits.

(v) Many candidates knew that the total resistance of two resistors in series was the sum of the resistances, even if they had not calculated the original resistance correctly in part **(iii)**.

(b) (i) Surprisingly few candidates were able to correctly place the switch. Many seemed to misunderstand the question and labelled the switch already on the diagram with an S.

(ii) Forty four watts was a much more popular answer than the correct one. Many candidates assume that calculations have to be division rather than multiplication.

Question 3

All parts were accessible to many candidates, with some candidates gaining good marks. Data handling skills were often not demonstrated.

(a) (i) Many candidates were able to explain that tube **A** would not rust as there was no water/moisture in the tube. However in tube **B** there was confusion as to the role of the nitrogen. Many candidates assumed that as nitrogen was in the air and in everyday terms it often said that it is air that is required for iron to rust, then the nail would rust. Few candidates stated the obvious – that both water and oxygen are required for iron to rust. Many thought it was water or oxygen.

(ii) Most candidates knew that paint was used on car body panels and many were able to give a reason.

(b) (i) Many candidates correctly answered three elements, although four was a popular error.

(ii) The idea that oxidation meant gaining oxygen was well known, but many candidates were unable to apply this to a reaction they had not used before. Frequently the candidates gave answers suggesting that the carbon monoxide was being oxidised and the ferrochrome was being reduced.

Question 4

There were some good answers to this question.

(a) (i) Only the most able candidates correctly identified all four structures, although most candidates gained at least two marks.

(ii) The places where synovial fluid is present was well known.

(iii) The function of the synovial was also well known.

(b) (i) Although most candidates realised that the hot object was part of the answer, many did not suggest that it was the touching of the hot object that was the stimulus.

(ii) The biceps was well known. Weaker candidates simply stated muscle.

(iii) Far too many answers were very vague. The brain and central nervous system were frequently mentioned but few candidates focused on the electrical impulses, the nerves and the motor nerve cells.

(iv) The idea of the triceps relaxing was well known.

Question 5

This question was not well answered.

(a) Many candidates were able to give vague answers in terms of the penetration properties of these types of radiation, but few were able to focus on why their penetration or lack of it was relevant to this situation. For example stating that gamma was only partly stopped by lead or that alpha did not pass through air did not answer the question.

(b) (i) Only the most able candidates could handle the data in the table to complete the three empty boxes.

(**ii)** Many candidates showed their confusion here. Although many realised that the count rate was increasing they then suggested that the paper was getting thicker. Some candidates even thought that the increase in radiation would damage the paper and make it thinner.

(c)(i) Further misunderstanding was shown here. The majority of the candidates suggested that either the photographic film shielded the wearer from radiation or because it would be better if the technician took photographs of what was happening.

(ii) There were very few sensible suggestions as to why the photographic film should not be kept in the technician's pocket. Most answers suggested that the radiation would burn the technicians pocket or skin.

(d) Most candidates gained at least one mark here. The commonest error was to confuse the turbine and generator.

(e) Many candidates gave a sensible answer here to gain the mark.

Question 6

(a)(i) This part was not well answered. Few candidates answered in terms of atoms. Most talked about molecules combining to make molecules.

(ii) Hydrogen was the commonest answer here.

(b)(i) Alanine, glycine and lactic acid were identified as **X**, **Y** and **Z** by many candidates, but few could explain how they did it.

(ii) Few candidates could explain that new substances had been made.

(iii) Proteins or polypeptides were not well known, although there did not seem to be a popular wrong answer.

(iv) Most candidates managed to gain the mark here.

Question 7

(a)(i) The position of the cell wall was well known.

(ii) Many candidates correctly answered chloroplasts but many others suggested chlorophyll, which was not accepted.

(b)(i) A surprising number of candidates did not know this test and suggested putting out a lighted splint as a suitable test for carbon dioxide.

(ii) Many candidates knew that respiration was taking place but failed to gain the second mark by stating that it was the yeast respiring.

Question 8

(a)(i) Some candidates were able to name both the other primary colours.

(ii) Colour addition was also not well known.

(iii) Few candidates appreciated that the light was being reflected.

(b)(i) About half the candidates could do this calculation correctly. The rest reversed the mass and volume.

(ii) This was well known.

(c) A few candidates could do this calculation. Most however forgot to use force or weight and used mass instead. Considering that most of the candidates did part **(b) (ii)** correctly, they did not carry this knowledge forward to the next part of the question.

(d) Many candidates knew that heat would make the particles move faster. However they could not carry on and explain how this meant that some particles could evaporate.

(e) Many candidates could give at least one property for nylon.

Question 9

(a) Few candidates managed to identify the two fossil fuels. Both were required for the mark.

(b) Many candidates gained one mark here but surprisingly few gained two. Many candidates included carbon monoxide as one of their answers.

(c) Many candidates gained some credit for realising that the product water was not a pollutant, but few gave a clear explanation of why using hydrogen as a fuel was advantageous.

(d) (i) Few candidates managed to gain either mark here. The concept of electrolytes was not well known. Magnesium sulphate was often chosen because it contained magnesium, which was a metal and so would conduct electricity.

(ii) Most candidates knew which pair would be suitable but failed to explain that the electrodes had to be two different metals. A common wrong answer was **B**, based on the idea that copper is the best electrical conductor.

Question 10

(a) Most candidates managed to circle the example of sexual reproduction in part **(i)** but usually chose another example of sexual reproduction in part **(ii)**.

(b) (i) The answer ovary was well known.

(ii) Many candidates showed some understanding of the idea of competition but did not successfully elaborate on this.

(iii) Water was a well known condition for germination, but warmth and oxygen were not. Light was a common error.

Question 11

(a) (i) To gain full credit here, candidates were required to show that there were only water particles present in stages 2 and 3 and also to represent the correct state of matter in their diagram. To do this they needed to show a few particles (between three and five) in stage 2 arranged randomly, and at least eight particles in stage 3 arranged randomly with most particles touching each. Few candidates managed this.

(ii) Few candidates knew the test for a chloride.

(b) (i) Many candidates answered this correctly although a number confused large particles with insoluble ones.

(ii) Chlorine was well known. Chloride was not accepted as an answer.

(iii) Many candidates realised that the compound used would need to be an alkali to neutralise the acidic water, but few were able to correctly name a suitable compound.

CO-ORDINATED SCIENCES

Paper 0654/03
Paper 3 (Extended)

General comments

This Paper was accessible across the whole ability range, with even the weakest candidates usually able to pick up least 15 marks, whilst some of the more able scored above 90. There did not appear to be any major problems in interpreting the questions, and all candidates appeared to be able to work through the Paper in the time allowed.

Comments on specific questions

Question 1

(a) Almost all candidates made creditable attempts at writing a key. They successfully followed the format given for the first pair of choices, and most were able to choose paired statements that allowed each of the species to be keyed out, completing the key with no more than four pairs. However, a common error was to use subjective statements such as 'has long beak / has short beak'. Better candidates used descriptions such as 'beak half as long as body', which a person would be able to use if only one of the specimens was in front of them.

(b) This was not well answered on the whole, although some candidates were able to explain that the first word gives the genus and the second the species. There were many answers that referred to 'family' or 'group'.

(c) There were many excellent answers to this question, describing the processes by which random variation and natural selection might bring about the evolution of birds that could fly. However, candidates many appeared to have no knowledge at all of natural selection, and there were many answers which described how the birds might keep trying to fly because they could see other birds doing it, or that stated that the genes would change in order to allow the birds to fly.

Question 2

(a) A surprising number of candidates could not identify the two fossil fuels. Most did correctly choose coal, but methane eluded many. A large number chose wood or animal dung.

(b) (i) This was generally well answered, although some candidates clearly had several tries at the calculation before arriving at the correct answer.

(ii) This was more difficult than **(i)**. Many candidates did gain a mark for calculating the relative molecular mass of carbon dioxide, and some multiplied this by 7. However, only the better candidates then also multiplied by 6.84 (or their answer to **(i)**). Some multiplied by 20 (the number of km).

(iii) The most common appropriate responses here related to possible incomplete combustion of the gasoline, or the possibility that this would vary according to the speed of the car.

(c) (i) Candidates from many Centres knew this topic well, and were able to choose magnesium and copper as the two metals furthest apart in the reactivity series, and to state that these would provide the largest potential difference (or voltage). Others, however, simply chose one metal, usually copper, and gave their reason as its ability to conduct electricity.

(ii) Most candidates correctly stated that a car battery is recharged when the engine is running, but few were able to explain that the chemicals in the torch battery are used up.

Question 3

(a) (i) This was a very accessible question, and even the weakest candidates generally scored at least one of the two marks available.

(ii) Most knew that density is calculated as mass divided by volume, and many gave correct answers. Quite a few candidates, however, tried to change the units and made errors in converting, for example, from dm^3 to m^3.

(b) This was generally well answered, although some candidates did not give correct units. Any of J, W or Nm were accepted, but not N/m.

(c) This, too, was often well answered. Answers were accepted that referred to electrons moving either from the tent to the clothing, or in the other direction.

(d) Few candidates were able to describe how evaporation happens. Many did correctly explain that water particles would gain kinetic energy as a result of heat (perhaps from the Sun), but the descriptions that followed were often very confused. Even the better candidates usually described boiling rather than evaporation. References to increased 'vibration', rather than increased movement, were not credited.

Question 4

(a) Most candidates were able to name at least two structures correctly, but there was often confusion between the radius and ulna, and the tendon was often named as a ligament.

(b) There were some clear and entirely correct descriptions of the contraction of the triceps, which pulls on the ulna, while the biceps relaxes. Many began their answer by describing how the arm is *bent*, before going on to describe how it is straightened. Weaker candidates often wrote about the muscles 'pushing' on the bones.

(c) (i) Almost all candidates correctly labelled **F** in either the elbow or shoulder joint.

(ii) Again, almost all answers were correct, generally stating that the synovial fluid acts as a lubricant, or that it reduces friction.

(d) (i) This was not well known. Many answers referred to 'in the muscles'.

(ii) This also proved to be poorly known by the majority of candidates. Many answers indicated that candidates had no idea what a motor neurone does, with several suggestions that it has a long tail so it can move quickly around the body. Credit was given for mention of the long axon, which allows the impulse to be carried rapidly over long distances. Some candidates also mention the dendrites or the myelin sheath. In general, however, very few had the vocabulary required to answer this question well.

Question 5

(a) (i) Most correctly gave hydrogen.

(ii) This was well answered, with almost all candidates able to write the appropriate symbols in the right places, and to show the three shared pairs and also the remaining two electrons in the outer shell of the nitrogen atom. The most common error was to omit these two unshared electrons.

(b) (i) Almost all answers correctly identified the three compounds on the chromatogram, but many of the weaker candidates stated that they had looked for spots of the same *shape*, rather than at the same *position* or distance from the 'starting line'.

(ii) Where candidates knew what a ' molecular formula' was, they generally answered this correctly, although some made simple errors such as counting only two carbon atoms instead of three.

(iii) Weaker candidates often simply repeated the question. Stronger answers referred to each of the three compounds and stated from which one nitrogen, carbon and oxygen were derived.

(c) Although many of the better candidates did correctly explain that the amino acids join up in long chains, relatively few also mentioned that water is produced.

(d) This was not well known, with only the better candidates able to answer appropriately. Many gave formulae, despite '**word**' being written in bold, and the equation being partly written in words to give them a starting point.

Question 6

While some candidates answered this question well throughout, others appeared to be entirely unfamiliar with the topic.

(a) This was not well known, and the most common (incorrect) answer was 'electrons' or 'electron orbits'.

(b) This was generally answered very well.

(c) (i) Once again, most candidates answered this well; for some of the weaker ones, it was the only part of the question that they attempted. There were, however, numerous answers where the numbers 90, 100, 100 were incorrectly given.

(ii) The majority of answers correctly stated that the paper was getting thinner, but some of the weaker candidates gave the reason as the damage to the paper caused by the beta radiation.

(d) While some candidates were able to complete the flow diagram entirely correctly, many others could not gain more than one mark, usually for the use of the words 'energy' or 'heat' in the second box. There was much confusion between turbines and generators.

(e) Most could correctly substitute into the equation they were given, and calculate the answer correctly. Some candidates did not have calculators and got into some confusion with their arithmetic.

Question 7

(a) Almost all candidates got at least one mark here, and most gave two correct responses.

(b) (i) The test for carbon dioxide is well known.

(ii) In general, candidates appreciated that the carbon dioxide was being produced by the yeast, and many also mentioned respiration or fermentation.

(c) (i) and (ii) These were almost always answered correctly.

(iii) This proved to be much more difficult, with most candidates choosing a point somewhere around D on the graph, where it levels out. They were asked to select a point where a limiting factor *began* to affect the growth of the population, which is much earlier. Any point between 4.4 and 6 hours was accepted.

(iv) There were many correct answers, generally referring to either glucose or oxygen.

(v) Many candidates incorrectly suggested testing for glucose (or oxygen) to find out if there was any left. This would not indicate the role of that factor as a limiting factor.

Question 8

(a) This was very poorly answered. A surprising number of candidates clearly did not appreciate that both oxygen and water are required for rusting, and therefore suggested that either or both of the pieces of iron wire would rust. A number thought that the water would provide oxygen; if they explained that the water might contain dissolved oxygen this was acceptable, but in most cases the meaning was obviously that the oxygen in water molecules would react with the iron.

(b) This, too, was poorly answered. Relatively few candidates picked out the information that an alloy was formed, which would require the metals to become molten.

(c) (i) Only the better candidates answered this well, giving the charge on the ion as Cr^{3+} and explaining how this would produce a neutral compound. Many were not able to work this out, and others did so using 'swap and drop' or 'criss-cross' techniques, which do not *explain* the answer.

(ii) Relatively few answers were correct. A few candidates did name chromium sulphate, but it was rare also to see water given as a product.

(iii) There was much confusion shown here, with only the better candidates stating that chromium ions have a positive charge and would be attracted to the cathode. Some failed to mention the word 'ions', while others gave very muddled answers referring to properties of steel and why it would 'be negative'.

Question 9

This was often the highest-scoring question on a candidate's paper.

(a) (i) This was usually answered correctly. However, it is important that candidates learn to use appropriate symbols in formulae. Here, for example, it is not correct to use C for current, as this symbol is used for the unit of charge. Candidates should be familiar with the symbols and units listed in the section 'Symbols, Units and Definitions of Physical Quantities' in the syllabus. The correct symbol for current in this formula is I.

(ii) This was rather more difficult than **(i)**, and only the better candidates were able to choose an appropriate formula, substitute into it and give an answer with suitable units.

(iii) This was generally answered correctly.

(b) (i) Almost all candidates correctly drew a straight line on the graph.

(ii) Relatively few gained any marks for this section. Most simply stated that 'it did not obey Ohm's Law because it is not a straight line', which does not answer the question. Better candidates explained that as the lamp heats up its resistance increases, so that the increase in current for a given increase in voltage would be less than expected.

(c) Both parts were generally answered very well. The most common error occurred in **(i)**, where weaker candidates often drew the switch in the lower half of the circuit, often close to **X**, **Y** and **Z**.

CO-ORDINATED SCIENCES

Paper 0654/05

Practical Test

General comments

The question paper was of a similar standard to last year and gave ample opportunity for candidates to demonstrate their skills in following instructions, measuring, making observations and deductions. **Questions 1** and **2** were well answered but both observations and deductions in **Question 3** were poor. Failure to recognise common tests, most of which could be found in the notes on page 12 suggested a lack of practice of these reactions. Overall the performance of candidates was about the same as in previous years.

Comments on specific questions

Question 1

Many candidates lost unnecessary marks in this question by failing to carry out a simple instruction. A thermometer was to be placed in each tube and a reading taken from both thermometers at the same time. Had this been done, the starting temperatures would have been very similar and a rapid fall in tube **B** would have been observed. Those who failed to carry out this instruction produced very different starting temperatures, tube **B** much lower than tube **A** and the fall in temperature in each case was similar. A few thought the starting temperature was room temperature. Although most deduced tube **B** to cool faster than **A**, the graphs in many cases did not support this, mainly due to the large difference in starting temperatures. The curves were frequently similar and only differed in respect to starting temperature. Too many candidates cannot draw smooth curves and fail to understand that a cooling curve is not completed by joining the plotted points. This is a bad error and will always be penalised. Although many did correctly explain the answer to (**b**)(**iii**) in terms of trapped air, some simply explained the shape of the graphs. The commonest sources of error were different amounts of water, different amounts of cotton wool and different starting temperatures. All were acceptable. Part **(d)(i)** was answered correctly in most cases, as was part **(ii)**, although some failed to say why the loss of oil interfered with the ability to retain heat.

Question 2

If the shape was measured and carefully cut out, the distance **CE** should have been 70 – 71 mm. Values of **x** were always well chosen and most correctly recorded values of **y** decreasing as x increased. A number measured the distance **GD** (100 – **y**) instead of the clearly marked distance **CG** (**y**). This was a careless mistake and lost three marks. One of the marks for the table and the two marks for determining $\mathbf{y_o}$. Scales for the graph were usually well chosen and the plotting very good. Part **(c)(i)** was well done. Many lost a mark in (**ii**) for not marking point **G** at the correct position i.e. not using the value from (**b**)(**ii**). The last mark was an easy mark and most scored it.

Question 3

As indicated in the general comments, this question was poorly answered. It showed a lack of understanding of simple chemistry and an inability to recognise simple routine tests. Candidates must practice the tests in the notes provided, and as well as being able to carry them out successfully, be able to recognise a test from the observations recorded. Familiarisation with these tests might help candidates to understand the meaning and use of the word precipitate. Cloudy or white solution will not score. Knowledge of the behaviour of acids and bases appeared limited to their action on litmus. Very little use in this exercise. Almost every candidate observed the effervescence of solid **A** with sodium carbonate but very few were able to deduce that **A** therefore must have been an acid. In part **(b)** the majority assumed that a gas was to be given off in each case and therefore convinced themselves, suggesting that litmus was bleached, glowing splints were relit and the gas popped with a lighted splint. In the event, only solid **B** reacted with the ammonium chloride to release ammonia suggesting it was a base. It should be emphasised that negative tests will often be included and candidates should be aware that these are sometimes as useful as those producing a visible reaction. Although many recorded a white precipitate when solid **C** was reacted with aqueous ammonia, few recorded that it was soluble in excess. It was rare indeed for a candidate to associate this test with the reactions on page 12 where aqueous ammonia is used to precipitate various cations as their hydroxide. Part **(d)** was very poor indeed and extremely disappointing as it suggested a lack of understanding of some of the simple reactions in practical chemistry. A good number scored the three marks in (**e**) although again it appeared that the notes on page 12 were not used. At least one Centre reported that candidates would not have made a solution before carrying out these tests. Had these tests been carried out on previous occasions one would have expected that point to have been covered. Indeed, the notes include the phrase ‘in solution’. Although the statement in (**e**) did not specifically rule out a nitrate there was more than a strong hint that the anion was going to be a sulphate or chloride. Were those who reported a nitrate trying to be too clever!

CO-ORDINATED SCIENCES

Paper 0654/06
Alternative to Practical

General comments

The paper followed the usual pattern of two questions about each of the subject areas, biology, chemistry and physics, though some cross-over between the subjects is inevitable and indeed desirable. The Examiners have tried, as usual, to include the three sections of the syllabus devoted to practical work: observation and recording, drawing conclusions from the data and devising extensions of the experiments. In addition to these, it is expected that candidates will know how to carry out well-known laboratory procedures, for example to test for gases and ions in solution. A question can refer to any section that is common to the two syllabuses.

The parts of the questions concerned with observation and recording were usually well done. The Examiners noted that many candidates showed a very poor knowledge of standard tests for gases and metal ions. Answers from candidates who had learned the tests by rote demonstrated that they did not understand the tests. For example, it was rare to find a candidate who knew that the addition of aqueous ammonia to the solution of heavy metal ions produced a precipitate of the metal hydroxide. The A* candidates revealed their superior abilities by such details in their answers. It must be emphasised that candidates are expected to have carried out and learned the practical tests detailed in the syllabus.

Comments on specific questions

Question 1

The insulating properties of fur depend on the air trapped in the animal's coat. The question refers to an experiment to compare the cooling rates of test-tubes of hot water covered in dry and wet cotton wool.

(a) Almost all candidates read and recorded two temperatures to complete a table of data.

(b) (i) Graphs had to be drawn showing cooling curves for the two tubes. The Examiners had carefully chosen the size of the graph grid to be used. Most candidates were able to gain the marks for correctly chosen scales, labelled axes, accurately plotted points and smooth curves. The mathematical ability needed is essential for science examinations at this level.

(ii) The question asks which test-tube cooled faster and seeks an explanation of this faster rate. That there were three marks awarded for this section should have alerted candidates to the need for a full answer, not just the statement that, for instance, "the temperature drop was greater for tube B". References to the insulating properties of dry cotton wool and the greater heat loss through wet cotton wool were needed. Relatively few candidates achieved full marks. Notable were the answers from some candidates that referred to the heat loss because of evaporation of the water; this showed a commendable universal approach to the teaching of science.

(c) This part of the question was well answered by students who, through experience of similar situations, knew what a "fair test" meant in terms of the conditions of the experiment.

(d) Candidates who did not understand the idea of insulation by trapped air were misled into thinking that it was the oil coating the fur that was the insulator. They could not explain why washing the oil off would lead to heat being lost when the animal is wet, despite the evidence of the experimental results.

Many candidates achieved 10 or more of the 14 marks for this question; but relatively few gained all 14 marks.

Question 2

This question, like **Question 3**, was based on the corresponding question in the practical examination, paper 5, where the candidates had to find the centre of mass of an irregular lamina.

(a) Candidates must use a ruler graduated in mm. to find the position of the pin from which the plumb-line and the lamina were suspended, and the point at which the plumb-line crossed the lower edge of the lamina. This could not be done by candidates who, despite the warnings that mathematical instruments would be needed, had brought no ruler to the examination room. Other candidates filled in the values 10 and 15, to match the rest of the **x** distances, instead of measuring them, a bad error.

(b) (i) and (ii) Some candidates misunderstood the command "plot **y** on the vertical axis" despite this use of the mathematical convention. Others adopted scales that were impossible to use, such as "9 millimetres = 10 small squares". The Examiners had carefully chosen the size of the graph grid to suit the range of values given in Fig. 2.2. More practice is needed in plotting graphs using data derived from laboratory investigations. The best straight line had to be drawn and extended to cut the vertical axis. A number of candidates either did not extend the line or extended it to cut the horizontal axis. Many good candidates were able to plot the graph and derive the value of $\mathbf{y_o}$ that was required.

(b) (iii) This value had to be used to draw the position of the plumb-line and so label **M**, the centre of mass of the lamina. Again, a ruler was needed.

(c) Finally, an explanation was asked for the inability of the lamina to balance horizontally on a different point, **N**. The simple statement that "**N** is not the centre of mass" was accepted. The good candidate usually answered that "One side of the card was heavier than the other".

Many candidates achieved high marks in answering this question.

Question 3

The Examiners were disappointed to find that this reasonably simple question about the reactions of acids, bases and salts was often very poorly answered. Rote learning of standard tests for acids, bases, salts and gases should be encouraged, but it is no substitute for actually doing the tests.

(a) Three substances, sodium carbonate, ammonium chloride and aqueous ammonia are to be added to an acid, a base and a salt. Candidates were invited to indicate which pairs of substances would react together. There were 5 possible correct answers from the nine combinations. Alas, few candidates scored the two marks awarded for the four correct answers needed.

(b) Solid **B** reacted with sodium carbonate to give a gas that turned lime-water milky. What conclusion can be drawn? The answer "solid **B** is an acid" was rare indeed, maybe there is a perception that all acids are liquids!

(c) (i) and (ii) Solid **A** reacted with ammonium chloride to give a "strong-smelling" gas. A test to confirm the presence of ammonia was asked for. Many candidates thought that ammonia turned litmus red. What can be concluded about solid **A**? The answer that it is alkaline or basic, thus driving off ammonia from its salt, was rare.

(d) (i) and (ii) Now candidates are told that aqueous ammonia reacts with a solution of **B** giving a temperature rise, and with a solution of **C** giving a white precipitate that will redissolve in excess of ammonia. What kind of reaction occurs between ammonia and **B**? "Endothermic" was given as often as "exothermic" and neutralisation quite rarely. The name of the precipitate "zinc hydroxide" was rarely given. "Zinc" was sometimes given, it is true, but this only reveals ignorance of the weakly alkaline nature of aqueous ammonia and its reaction with metal ions in solution.

(e) The final part of the question asked the candidate to suggest a test that would confirm the presence of a sulphate in solution. Again, only the very good candidates were able to give details of the test for a sulphate using barium chloride or nitrate.

Answers to this question were almost universally poor, and very few candidates scored 10 marks.

Question 4

It could be argued that this question is based on a relatively small part of the syllabus; it is an important section and one that should be familiar to all candidates.

(a) Photographs labelled as "sections through two fruits" were shown. Candidates had to draw one of the fruits in section. There were many poor diagrams showing a lack of practice in drawing, an important skill requiring careful observation as well as manual dexterity.

(b) (i) Most candidates understood the meaning of "dispersed" applied to the seeds of the fruits. There was confusion with "pollen dispersion" so that seeds were described as "blown by the wind". Other candidates suggested that animals (including man) discard the seeds and drop them on the ground while they eat or are deliberately sown in the ground to yield a crop. There was also the problem of what language to use while describing defaecation; many candidates incorrectly used the term "excretion" but this error was not penalised as long as the meaning was clear.

(ii) The fruits are succulent, juicy, fleshy; this attracts animals to eat them. Alas, their attractive colour is not visible in the photographs, so this comment did not deserve a mark.

Some candidates scored very poorly in this question.

Question 5

This physics question seeks to explore understanding of the kinetic theory of gases.

(a) A gas syringe containing air is gradually warmed in a water bath. Two thermometer readings showing the temperature of the bath, and the corresponding syringe scales giving the volume of air, had to be read. Each graduation of the syringe scale denoted 2 cm^3, a fact that misled some candidates. Most candidates recorded at least two readings correctly

(b) Data including these readings had to be plotted, then a "best fit" straight line had to be drawn. The choice of scales and the plotting of the points were harder than in **Question 2**, but many candidates scored well. There was the usual misunderstanding of the term "vertical" axis, and many candidates did not draw "the best straight line" despite the clear instruction to do so.

(c) Candidates had to explain why air expanded as the temperature rose. The Examiners were looking for a more accurate answer than that offered by the weaker candidates, who often wrote that "molecules moved faster and so occupied more space". Equally incorrect were those who wrote that "molecules vibrate more" and so were confusing the behaviour of gas molecules with those in a liquid or solid. Gases confined in a syringe surrounded by the atmosphere are occupying the space because they collide with the syringe walls. Expansion that occurs when the gas is heated is due to increasing energy of the collisions, leading to increased pressure. Candidates should be aware of this type of behaviour of gaseous molecules. This question was well answered by a significant number of candidates.

(d) A graph of volume against temperature was shown for a hydrocarbon gas near its boiling point, and candidates asked to explain why there is a sudden large drop in volume as cooling takes place. Gases usually turn to liquid on cooling, but many candidates wrote that "the gas becomes a solid" and this was accepted as an answer.

Many candidates scored well in this question.

Question 6

A question about four common liquids, designated by the letters **A** to **D**, concluded the examination. The liquids had to be matched with their given names using information about their densities and miscibility with water.

(a) The balance scales showing the masses of 50 cm^3 of each liquid were shown. The masses had to be correctly recorded to the nearest first decimal place. Again as in **Question 5**, each graduation of the scale represented 0.2 g: this posed a problem for many candidates. Others wrote the first three masses correctly but failed to give the first decimal place for the last mass and wrote "50" instead of "50.0".

(b) A simple key showed the true identity of the four liquids. Candidates had to insert, into the first line of the key, the letters of the liquids answering to the descriptions of their densities. Some candidates laboriously calculated the densities of the liquids instead of relying on the mass in grams being numerically more than, less than, or the same as the volume in cubic centimetres. A few candidates tried to write the names of the liquids in the key, instead of the letters, showing that they had not read the question.

(c) A diagram showing the result of mixing the four liquids with water, told candidates that liquid **C** and water are immiscible. This gave them the information to fill in the last line of the key. Some candidates failed to understand the key at this point.

(d) How to tell the difference between an alcohol and a hydrocarbon liquid? This is not found in the syllabus as such, but a very few candidates suggested a test such as "the alcohol will react with sulphuric acid" or "the alcohol can be made into an ester". The most obvious answer is that ethanol (the only alcohol that candidates will know about) burns with a blue flame, but a hydrocarbon burns with a yellow flame. One or two candidates even suggested that alcohol reacts with phosphorus(V) chloride, showing an advanced knowledge of the subject. This question was found to be the most difficult in the examination.

(e) Candidates were asked for a test "to confirm the identity of the salt solution". The term "confirm the identity" was perhaps difficult for the candidates for whom English is their second language to understand. They had already been told that the salt solution contained sodium chloride. The addition of silver nitrate would "confirm" that a chloride was present in the solution. The better candidates were able to give this answer, and a few mentioned the possibility of using a flame test to show the presence of sodium.

Despite the unusual nature of the question, containing a key, many candidates were able to score 6 or 7 marks. It was in parts **(d)** and **(e)** that most marks were lost. There was a relatively small number of candidates who did not complete the examination in the allowed time.