CO-ORDINATED SCIENCES

Paper 0654/01
Multiple Choice

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

Comments on individual questions (Biology)

General comments

The biology section contained questions spread across an acceptable facility range.

Comments on individual questions

Question 2

Even many of the better candidates failed to think carefully enough before answering this question. The question stated that the cell was in a concentrated solution and it was therefore disappointing that almost half the candidates believed that region Y contained air.

Question 4

Candidates should be aware that cilia and mucus line the trachea and bronchioles, not the alveoli. Thus they should have been able to eliminate **D** from their deliberations, especially as 'pumping' is not a function of cilia.

Question 5

'Excluding the lungs' appeared in bold print in the question, but that did not deter just under 50% of the candidates opting for the sequence that sends blood to, and receives blood from, the lungs. Reading and understanding a question before answering it is always sound advice.

Question 7

Perhaps the same advice should apply to this question as well, since a third of candidates mistook the large intestine for the small intestine.

Question 12

A significant misunderstanding was exposed by this question with a sizeable proportion of the candidates not appreciating that there is an extremely high loss of energy between the Sun and photosynthesising plants.

Comments on individual questions (Chemistry)

The chemistry questions performed well and were of approximately the same difficulty as those for biology and physics.

Questions 17,**19**, **21**, **23**, **25** and **27** proved to be the easiest and were correctly answered by well over half the candidates.

Questions 14, **20**, **24** and **26** proved to be more difficult with under half the candidates answering them correctly.

Comments on individual questions in Chemistry.

The following responses were popular **wrong** answers to the questions listed.

Question 20 Response **A**. Candidates knew about hard water but confused the tests for chloride and sulfate.

Question 22 Response **B**. Candidates clearly knew that nitrogen (as fertilizer) helps plants to grow, but did not understand the notion of weathering.

Question 26 Response **A**. This response was more popular with weaker candidates than the correct response. They clearly decided on carbon as the correct element and disregarded the information, concerning damage to trees.

Comments on specific questions (Physics)

Physics items showing a facility of 60% or lower were **31**, **32**, **34**, **36**, **37** and **38.**

Comments on individual questions

In **Question 28** many candidates chose option **A** which was very close to the correct value. Straightforward recall was required in **Question 29**, and, perhaps predictably, a belief that mass is measured in newtons was the most common error. Although the density equation was well known in **Question 30**, some candidates forgot to subtract the mass of the empty box. Widespread confusion between speed and acceleration was evident in **Question 31**, with **C** being the most popular response. **Question 32** showed that convection was frequently not understood clearly, but much more widespread knowledge was evident of the meaning of wavelength in **Question 33**. Candidates found **Question 34** on lenses very taxing, with all distractors working well. The correct equation for resistance was identified by two out of three candidates in **Question 35**, but **Question 36** showed that more than one in three thought that a longer and *thicker* wire must have a higher resistance – the link between thickness and resistance is not well known. Similarly, nearly half the responses to **Question 37** were incorrect, many lacking the knowledge that the current at every point in a series circuit is the same. In **Question 38** a common mistake was to believe that using thicker insulation would reduce the amount of heat being produced in the wires. **Questions 39** and **40** on radioactivity showed the majority of candidates to be well prepared.

CO-ORDINATED SCIENCES

Paper 0654/02

Core Theory

General comments

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

Question 2 seemed to be the most difficult for the candidates to answer successfully. **Question 1** was the best answered by the candidates.

It was 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. In some cases it is necessary to refer back to previous parts of a question to find the correct data. Quite often the candidates made up a formula or equation to confirm this. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided.

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

Comments on specific questions

Question 1

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

(a) (i) and (ii) Most candidates were able to score marks here.

(b) Most candidates answered this exercise well, gaining full marks.

Question 2

Most candidates gained marks on some parts of this question, but few answered the whole question consistently well. The greatest areas of difficulty were in parts **(b)** and **(d)**.

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

(b) Although many candidates showed that they had an understanding of oxidation and reduction, few were able to fully answer the question and explain why the reaction quoted showed oxidation and reduction.

(c) Many candidates correctly labelled two of the four parts but few could label all four correctly.

(d) (i) Weathering and erosion were not well known.

(ii) Colloid and sol were also not well known.

(iii) Although many candidates suggested heating the clay, few stated that it must be to a high temperature.

Question 3

Several parts of this question were not answered well.

(a) (i) Few candidates gave an answer relating to an advantage for the soy bean plant. Most suggested why the plants should be eaten.

(ii) Many candidates gained full marks here.

(iii) Many candidates knew the biuret test. Some stated the chemicals used in the test, for which credit was given. Many more candidates were able to remember the correct colour change without remembering the correct test.

(b) (i) Many candidates showed good data handling skills and gave the correct answer.

(ii) Again many candidates showed good data handling skills and gave the correct answer.

(iii) Many candidates were able to link the high carbon dioxide concentration to more photosynthesis.

(iv) The significance of this question was missed by the majority of candidates. The answer needed to make reference to the significance of the increasing concentration of carbon dioxide in the Earth's atmosphere.

Question 4

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

(ii) Although most were able to answer this correctly, some candidates were unable to explain why it was phosphorus. The answer required more than stating that it had the electron pattern shown in Fig. 4.1.

(b) (i) This was surprisingly poorly answered, with more candidates suggesting phosphorus than nitrogen.

(ii) Few candidates were able to refer to proteins or explain how they were produced.

(c) (i) A number of candidates correctly described the difference between an element and a compound, but few really answered the question by referring to the chemical formulae shown.

(ii) The majority of correct answers described the test with moist red litmus. A few candidates correctly described the reaction between ammonia and hydrogen chloride.

Question 5

(a) (i) Fewer candidates than expected correctly identified carbon dioxide as the gas in fizzy drinks.

(ii) Despite giving an incorrect answer for part **(i)**, many candidates correctly described the test for carbon dioxide.

(b) (i) Many candidates gained full marks on this calculation by stating the correct formula and working out the correct answer.

(ii) Surprisingly few candidates were able to complete the box for the solid by correctly drawing a number of equally sized atoms in a regular arrangement in the box. Even fewer were able to complete the box for the liquid.

(c) Answers needed to relate to either obesity or tooth decay. Few candidates managed to give either answer.

(d) (i) Most candidates were able to correctly deduce that the temperature rise was proportional to the energy input.

(ii) Many candidates were able to correctly show their working on the graph and calculate the energy needed.

(iii) A few candidates knew this, but the majority of answers showed great confusion.

(iv) A number of candidates knew that power could be calculated by dividing the energy by the time, but few successfully completed the calculation.

(v) Very few candidates were able to calculate that the maximum current would be 5.5 A and that therefore the 10 A fuse would not melt.

(e) (i) Few candidates understood the question and the relevance of the relative penetrating powers of alpha, beta and gamma radiations. The correct answer was rarely identified. However, many of the candidates who did correctly identify it, were also able to explain their answer.

(ii) The use of lead as a shield for stopping radiation was well known, although a number of other metals were also suggested.

Question 6

(a) (i) Most candidates were able to correctly identify at least two of the bones, but few gained full marks.

(b) (i) The idea of the biceps muscle contracting and pulling the ulna were well known and many candidates gained full marks here.

(ii) This was well answered with many candidates correctly explaining that the tendons connect muscles to bones and consequently forces can be transmitted from muscle to bone.

(c) (i) This was not well answered. Artery, vein and capillary were all common answers to both parts of this question.

(ii) Most candidates gained at least one mark here by identifying either an increase in breathing rate or heart rate, and many candidates identified both.

Question 7

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

(ii) Many candidates confused the term “property” with “use”. Where candidates did correctly identify a suitable property, they frequently gave incorrect statements such as “gasoline has a higher boiling point than fuel oil”. A number of candidates clearly thought that gasoline was a gas.

(iii) The connection between carbon being present in the dead animals forming the crude oil was missed by most candidates.

(b) (i) Cracking was a process recognised by many candidates.

(ii) The connection between alkanes being saturated hydrocarbons and alkenes being unsaturated hydrocarbons was known to many candidates. However, few candidates gained both marks here.

(c) Sulfur dioxide was not commonly recognised as a pollutant produced by burning fuel oil. Most candidates mentioned the usual environmental hazards, e.g. carbon dioxide, global warming, damage to ozone layer, and then concluded with acid rain.

Question 8

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

(a) (i) Homeostasis was not well known.

(ii) Some candidates correctly identified the duodenum, others the small intestine, but most suggested the stomach.

(iii) Secreting insulin was not well known.

(iv) Diabetes was very well known.

(v) Many candidates made correct references to the umbilical cord and placenta thus gaining full marks. Few candidates referred to the role of the mother's blood.

(b) (i) **Aa** was well known, although many candidates who had correctly identified **Aa** were unable to produce the correct gametes, with many chosing **a** and **a**. Most candidates correctly identified the correct genotypes of the offspring, but very few were able to translate this information into identifying the phenotypes of the offspring.

(ii) Many candidates answered this correctly even though they had not correctly identified the genotypes or phenotypes in **(i)**.

Question 9

This question was quite well answered.

(a) (i) This was surprisingly badly answered by many candidates, who did not know the correct formula to use.

(ii) Few used the correct formula.

(b) (i) This was surprisingly poorly answered with most candidates attempting to calculate the work done.

(ii) This was generally well answered. Many candidates, however, tried to use the formula mass × distance rather than force × distance.

(c) This was well answered by many candidates although many forgot to determine the pressure using all four of the elephant's feet.

(d) Many candidates made suitable suggestions.

(e) (i) The term frequency was not well known.

(ii) and (iii) These were well answered, showing good data handling skills.

CO-ORDINATED SCIENCES

Paper 0654/03
Extended Theory

General comments

The majority of candidates were able to make creditable attempts at most questions, and it was very pleasing to see significant numbers of candidates scoring highly throughout the paper.

Calculations were often well done, and most candidates made their working sufficiently clear for the Examiner to follow and to credit, even if the final answer was not correct. However, there were many instances of an entirely correct calculation failing to score every mark because either no unit was provided, or the unit was incorrect. Better candidates often showed that they were deriving the unit from those of the values used in the calculation, and this clearly helped out in instances where the correct unit is not always easy to remember, such as specific heat capacity.

Many candidates waste much time and answer space by repeating the question before they begin their answer. For example, an answer to **2(c)(iii)** might begin: "The mass of leaves and seeds per plant was greater at high carbon dioxide concentration than at normal carbon dioxide concentration because...". This would take up almost all of the answer space, leaving little space and little time for the candidate to actually answer the question. Teachers should ensure that candidates understand that they should not do this, and should use the whole of the answer space for their answer, and not for a repetition of the question.

Comments on specific questions

Question 1

(a) Surprisingly few candidates gained all the available marks for this diagram. Most (but by no means all) correctly drew a reflected ray at an appropriate angle, but fewer than half of all candidates were able to label the angle of incidence and angle of reflection. It was expected that an arrow would be drawn on the reflected ray.

(b) (i) About three quarters of the candidates wrongly gave the answer red. The rest mostly gave blue (or violet or indigo), with a very few suggesting other colours such as yellow or green.

(ii) This was generally correctly answered, with a statement referring to the fact that different colours have different wavelengths.

Question 2

(a) This was not well known. A small proportion of candidates did know that the bacteria use nitrogen (from the air) and convert it to nitrogen compounds, which can then be used by the plant to make amino acids or proteins. A common misconception is that the nitrogen compound made by the bacteria is nitrate ions, but this is not correct – the bacteria produce ammonium ions.

(b) There were many good answers to this question. However, many lost marks by giving a generic answer rather than tailoring it to this particular context, such as by saying they would choose the plants with 'the desired characteristic' rather than choosing plants that gave high yields of seeds. Relatively few answers indicated that the selection and breeding process would continue for many generations.

There were large numbers of answers that showed no understanding at all of artificial selection. Many of these began by saying that you would choose a plant that was homozygous dominant for having high yields of seeds, and then continued to describe the genetics of the crosses that would be made. Artificial selection (and selective breeding) does not require any knowledge of the

genetics underlying the trait being selected for. There were also numerous answers that appeared to be attempting to describe genetic engineering. Some described ways in which yields might be increased by different cultivation methods or the use of fertilisers.

(c) (i) This was almost always answered correctly.

(ii) This, too, was almost always correct.

(iii) Most candidates correctly stated that the plants would be able to photosynthesise more rapidly. Further credit was given more rarely, either for statements relating the greater rate of photosynthesis to the production of more glucose or other carbohydrates ('food' was not credited), or for saying that carbon dioxide is a limiting factor for photosynthesis. Some answers said that plants use carbon dioxide for respiration.

(iv) Relatively few candidates appeared to be aware that the carbon dioxide concentration in the atmosphere is rising. Of those who did, they often had cause and effect the wrong way round. Statements such as: 'Global warming is increasing the concentration of carbon dioxide in the air' were very common.

Question 3

(a) This was generally well answered. Most candidates correctly identified the atom as phosphorus (though a few wrongly thought it was nitrogen), and were able to give a full explanation for their identification. The statement that it had 15 electrons was not enough on its own; further reasoning from this was required, such as the number of protons being the same as the number of electrons, or statements about the number of electron shells, or the group or period to which the atom belonged.

(b) This was not answered as well as expected. Although many candidates did correctly list the three elements, many others were not able to do so. Carbon dioxide often appeared instead of carbon. Nitrogen, potassium and phosphorus also appeared quite frequently.

(c) (i) Most candidates were able to balance the equation correctly.

(ii) Many answers correctly gave hydrogen and nitrogen as the gases in the mixture leaving the reaction vessel, and then often went on to explain that these had not reacted. Incorrect answers often included other gases, for example carbon dioxide, or suggested something that had been derived from the iron catalyst.

(iii) Not all candidates were able to interpret the information in the graph, but most did so successfully. Incorrect answers tended to get things entirely the wrong way round, suggesting you would use high temperature and low pressure. Some appeared to have homed in on the steepest part of the curve, perhaps relating this to a high rate of reaction.

(d) It was pleasing to see the majority of candidates able to tackle this calculation with some success, and many did it entirely correctly in just a few lines of working. Credit was given for each step of the calculation (converting kg to g, working out 17% of something appropriate, finding the M_r of ammonia and dividing this into the mass), so even if something went very wrong in one step, or if one step was omitted, credit could still be given for the others. Surprisingly large numbers of candidates, however, were unable to calculate the M_r of ammonia correctly, and values of 15 and 34 cropped up very frequently.

Question 4

(a) (i) Where enzymes were thought of, the rest of the answer tended to flow from this. Only a very few candidates now suggest that enzymes are 'killed', and the term 'denatured' is well known, with some candidates also explaining clearly what it means. Quite a few answers suggested that candidates believe enzymes are involved only in digestion, and do not appreciate their universal role in metabolism.

(ii) This, too, was well answered, and the majority of answers gained full marks. However, many candidates confused sweating with vasodilation, or stated that heat is lost by radiation. A common error is to suggest that the sweat is cold and cools the skin off as it lies on top of it.

(b) It was very pleasing to see many more full and entirely correct genetic diagrams than in the past, with relatively few candidates now offering only a Punnett square. Most were able to give the genotypes of the two parents, and also of their offspring. Not all candidates also showed the genotypes of the gametes, and not all showed which genotypes in the offspring would give rise to which phenotypes. Credit was also given if the expected ratios of phenotypes were stated, but a common error was to say that 'three of the offspring would be able to smell, and one would not', rather than stating the expected outcomes in terms of ratios, probabilities or percentages.

Question 5

(a) (i) By far the most common answer, which unfortunately was incorrect, was that temperature was directly proportional to the energy supplied. This is not so, as the line does not pass through the origin. It is, however, correct to say that the temperature *increase* is directly proportional to the energy supplied.

Quite a few answers indicated that the entire experiment had been misunderstood, with candidates not appreciating that the energy supplied was increasing the temperature of the block.

(ii) This was usually answered correctly. The most frequent error was to read values from the wrong axis, so that what was actually being found was the temperature increase when the energy supply was increased from 25 to 45 kJ. Others misread the scales. Not all gave a correct unit with their answer.

(iii) It was expected that candidates would use the answer they had obtained in **(ii)**, but many began all over again, often using an energy value of 70 kJ and calculating the temperature rise from the start to end of the graph. This was perfectly acceptable (but obviously took unnecessary time). There were frequent problems in rearranging the equation. However, by far the greatest difficulty that candidates had with this question was providing a correct unit with their answer, and this was seen relatively rarely.

(iv) Here, it was clearly essential that a previous answer was used in the calculation. If this previous answer was incorrect then, as always, full credit was given for using that answer correctly in this new question part. The greatest problem here was in recalling the equation linking power, energy and time – once this had been written down correctly, all else followed easily, and most were also able to give an appropriate unit (kJ/s, J/s or W).

(v) The key to a good answer to this question was appreciating that the current in the circuit needed to be calculated, using the power value from **(iv)** and the information about the voltage given in the question. Again, earlier errors could be carried forward without further penalty. There was also credit available for a statement about the fuse itself, such as saying that it would not melt or blow or break (because the current in the circuit was less than 10 A). Some candidates said that it would not 'blow up', which was not credited.

(b) (i) This was often well answered, many candidates correctly identifying the radiation as beta and explaining clearly why it could not be alpha or gamma. However, all types of radiation, including ultraviolet, featured in numerous answers.

(ii) Most correctly gave lead, but there were many other suggestions, of which gold was perhaps the most common.

Question 6

(a) The majority of responses used the terms oxidation, reduction or redox somewhere, but not all were able to explain their answer successfully. They needed to include a clear statement about what had been oxidised or reduced, and what that actually meant. In this case, the loss or gain of electrons was ignored, and statements about loss or gain of oxygen were expected. Quite a few candidates were not able to identify the type of reaction, however, and 'exothermic' and 'displacement' cropped up frequently.

(b) (i) This answer required reference to aluminium *ions* being positive, and therefore attracted to the negatively charged cathode. Very many answers said that aluminium was positive, and this was not credited.

(ii) Candidates who had answered **(b)(i)** correctly were often able to describe the gain of electrons by aluminium ions, gaining a second mark either by stating that three electrons would be gained (by each ion) or that the ion would lose its charge. However, many were not able to do this, and struggled to make any correct or relevant statement.

(c) Many candidates appeared to be thinking about this for the first time, or at least were unable to explain what they wanted to say. Some sensibly helped the Examiners to understand their meaning by drawing light rays being reflected from the clay particles in Fig. 6.2.

(d) This is undoubtedly a difficult topic at this level, and it was pleasing to see quite a few candidates able to give entirely correct explanations that demonstrated clear understanding. Others were less sure of themselves, and many had no idea at all. Quite a few tried to explain the difference in terms of the atomic structures of silicon and carbon, which was an impossible task.

Question 7

(a) By no means all candidates were able to name all four bones correctly. The ulna and radius were often the wrong way round, and leg bones (tibia, femur or various permutations such as tibur or femula) appeared regularly.

(b) (i) Most knew that the biceps muscle contracts to bend the arm, but not all went on to describe the effect of this, that is exerting a pulling force that raises the lower arm, or brings the bones of the lower arm closer to the humerus or the shoulder.

(ii) The majority of answers simply stated that tendons join muscles to bones, which is correct but does not answer this particular question. Candidates needed to state that the tendon allows the force produced by the muscle to be applied or transmitted to the bone.

(c) This is a difficult concept, but it is clearly required by the syllabus so it was a little disappointing that relatively few candidates appeared to have ever thought about it. The best answers included diagrams and explained that this is a lever system – a distance multiplier – in which the pivot is the elbow and the biceps produces a turning force. Unfortunately, many of the diagrams incorrectly showed the biceps apparently pushing downwards on the bones, or showed it attached on the opposite side of the fulcrum to the load. The mark scheme was made very wide-ranging to allow credit to be given to a variety of approaches or relevant statements, but it was still relatively uncommon to give full marks.

(d) (i) There were plenty of good answers here, linking statements about energy for contraction, respiration, and the supply of oxygen and glucose. However, there were also many answers that scored no credit.

(ii) Most candidates knew something about capillary structure, and many were able to link a correct statement about its structure with a clearly worded function. If the function was diffusion, then they needed to mention something that would diffuse (for example oxygen or nutrients). 'Thin cell walls' was not allowed as a statement about the structure, but of course 'one cell thick wall' was credited. A sizeable number of candidates appeared to think that blood passes through the walls of the capillaries.

Question 8

(a) (i) By no means all candidates knew the relationship between momentum, mass and velocity, and those who did could not always give the correct unit.

(ii) As in several other questions, many candidates lost marks by giving generic answers rather than ones that applied specifically to this context. For example, the answer for momentum might be that 'momentum is conserved', rather than clearly saying that the total momentum of the elephants, or the momentum of each elephant, would become zero. In general, statements that two things 'cancel out' (such as momentum cancelling out, or speed cancelling out) should be avoided, as this rarely results in a full answer that can be credited.

(b) A surprisingly large number of candidates failed to gain marks here. Many wrongly wrote that 'work = mass × distance'. Even those who knew the correct relationship often used the value 300 in their calculation.

(c) (i) Most candidates knew how to find the volume of an irregular object, although not all of them were able to describe this clearly. Some managed to answer the whole question without ever using the term 'volume', for example by saying that they would measure the 'amount' of water. Some were clearly answering a different question, explaining how they would find the density of the object; the Examiners were usually able to find appropriate statements within such answers, but it is not a good idea for candidates to spend unnecessary time in this way.

(ii) This was usually answered correctly, and most candidates were able to give appropriate units. Some made things more difficult than necessary by attempting to convert m^3 to cm^3 or dm^3, in which they rarely succeeded.

(d) (i) The majority of answers gave an appropriate definition of frequency. It is valuable for candidates to learn such definitions, so that they do not have to try to invent one for themselves, when they are likely to find it difficult to choose appropriate wording.

(ii) This was well known.

(iii) Most candidates struggled with this, although there were some excellent answers – concise and very clear. Many, however, tried to use one term, such as 'travel', to describe both the vibrations and the direction of movement of the wave, which made it difficult for Examiners to understand exactly what they meant. Some got the two types of wave the wrong way round, and many had no idea at all of the differences between them. A few wrote about the vibration of 'sound particles'. Once again, it would be valuable for candidates to have learnt a clear definition that they could present as an answer to such a question.

Question 9

(a) A wide variety of answers was accepted here, and most candidates were able to give a suitable difference. A few did not fully answer the question, for example by writing 'boiling point' rather than saying how the boiling point of gasoline differs from that of diesel oil. Some gave differences that are not 'properties', such as gasoline having fewer carbon atoms in its molecules.

(b) (i) Most candidates correctly gave carbon monoxide, and almost all correctly named it rather than give its formula.

(ii) The use of catalytic converters was not always known. Incorrect suggestions included using biofuels, or using engines in which combustion was always complete.

(c) (i) This caused a surprising number of problems. Although most were able to complete the displayed formula of an alkane molecule, only a minority were able to draw the alkene correctly. Most appreciated that there needed to be a double bond somewhere, but many tried to place this on the carbon atom already given (which, of course, already had three bonds taken). Most molecules ended up with too many hydrogen atoms, and some had double bonds between hydrogen and carbon. Some candidates drew both molecules with the wrong number of carbon atoms, for example two, four or much larger numbers.

(ii) The majority of answers correctly identified **X** as bromine. Most then went on to say that it would lose its colour, but not all stated its initial colour. A few appeared to have misread their own writing when revising and said that **X** was 'brine', often using this term twice or three times in their answer, indicating that it was not just a slip. Potassium permanganate was another acceptable response.

(d) This was well answered on the whole. The most common error was to include oxygen as a reactant, rather than water. Some wrote the formula for water as OH_2.

(e) Many candidates had difficulties with this. They were usually able to mention neutralisation somewhere in their answer, and several also referred to acid rain. However, relatively few answers included reference to sulfur dioxide, nor to a reaction between the calcium hydroxide and sulfur compounds.

CO-ORDINATED SCIENCES

Paper 0654/04

Coursework

(a) Nature of tasks set by Centres.

Only one Centre submitted coursework for the November examination.

All the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates' work was comparable with previous years with candidates covering the whole mark range.

(b) Teacher's application of assessment criteria.

The Centre understood and applied the assessment criteria well for all of their activities. This Centre did not assess both skills C1 and C4 in the same investigation.

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

Tick lists remain popular, particularly with skill C1.

(d) Good practice.

CO-ORDINATED SCIENCES

Paper 0654/05

Practical Test

General Comments

It is accepted that candidates had to work swiftly in order to complete the three questions, although good candidates had no difficulty. Candidates at some Centres may have suffered due to poor preparation by the Supervisors. It is vital that the instructions are read carefully and carried out exactly as written. Whilst some reported difficulty in preparing the specimens for **Question 1**, it is very difficult for Examiners to make allowances, particularly when some candidates at the Centre produced perfect answers. Failure to provide the refractive index for **Question 2** only penalised the candidates. It was evident in **Question 3** that the solutions did not always conform to instructions. Both solutions require some expertise in preparing, but sufficient leeway was given in adjusting the concentrations to produce a set of results.

Specific Comments

Question 1

Although preparation of specimens caused difficulty for some, the commonest reason for losing marks was due to not labelling drawings as instructed. Too many candidates used a pen for drawings and this often produced some very untidy efforts. Part **(d)** was usually answered satisfactorily for tube **A** although mention of the need for chlorophyll was often omitted. Some candidates thought that water was absent in tube **B**, overlooking the fact that a solution was present. Similarly, some failed to see that carbon dioxide was present in tube **C** giving its absence as an explanation for the result in that tube. The majority either knew or deduced that sodium hydroxide absorbed carbon dioxide. The commonest answer in **(f)(i)** was 'to kill the leaves', whilst others wrote 'to soften the cuticle'. Both were accepted. The expected answer in **(f)(ii)** regarding the presence of water, was to act as a control. Answers to part **(g)** varied between no idea or a complete answer.

Question 2

Some candidates found this question difficult, whilst others produced excellent drawings and measured the appropriate angles correctly. In part **(a)** some left the space blank, some wrote an angle, whilst some gave a figure bearing no resemblance to the refractive index of glass or Perspex. Many candidates produced a sensible set of figures that either did not match their drawings or could not match their drawing because too few were actually produced. It was unclear as to how these figures could have been obtained and penalties were applied in such cases. Graphs were satisfactory although many drew a straight line. The points were close to a straight line but a good experiment would have shown the two largest angles deviating from a straight line, added to which the instruction was to draw a smooth curve. Very few were prepared to make use of the origin. Answers to part **(g)** were very variable. Some were unable to answer it at all, others failed to use the given table as instructed. It was apparent that some used a calculator as many decimal places were recorded. Part **(h)** was intended to allow candidates to comment upon experimental accuracy rather than a simple yes/no answer. Most appreciated that the angle of refraction would be different for a block of different refractive index but to score the answer needed to say that if the refractive index was greater, then the angle would be smaller or vice versa. Further credit was awarded to those who pointed out that the denser the medium the more the ray is bent.

Question 3

Answers to part **(a)** indicated that either candidates have very little idea of estimating volumes, or some unsatisfactory dropping pipettes were used. A dropping pipette should produce a drop of less than 0.1 cm^3. Answers in excess of this were the norm, often whole numbers being suggested. Answers in part **(c)** were of course going to be different from one Centre to another but should have been consistent within one Centre, even though the size of drop would not necessarily be exactly the same. When performed carefully, the

values should have been x cm^3, x/2 cm^3 and x/4 cm^3. Some candidates reported numbers of drops in excess of 100. If the solutions were made according to the instructions, such answers would have been impossible. In part **(d)**, some explained their answer by saying it took a long time for **A** to become colourless. This was not an acceptable answer. If the experiment was carried out correctly, iron(II) would have been converted into iron(III) and the precipitate in **(e)** a definite brown, not green. All that was required in **(f)(i)** was, 'a white precipitate'. Vague answers such as "white solution" or "cloudy" were not allowed. Notes are provided on the paper and show the accepted answer. However, in part **(ii)** the observation was less precise and Examiners were more lenient in what was acceptable. Silver ions have a slow reaction with iron(II) and the formation of a definite precipitate is less obvious. A response of "no reaction" was not acceptable. A good number correctly gave the name iron(II) sulfate, although many omitted the sulfate. Some produced the name with little or no evidence! A reasonable number of candidates answered **(h)** satisfactorily, counting the number of drops required to produce a measurable volume in a measuring cylinder.

CO-ORDINATED SCIENCES

Paper 0654/06

Alternative to Practical

General comments

As usual, the answers to this examination revealed a wide range of abilities and practical experience amongst the candidates. Papers from those groups who had been well prepared by their teachers stood out as a result, especially in **Questions 1**, **2** and **5**. There were, however, whole Centres of candidates whose preparation did not include much laboratory work. These candidates were at a serious disadvantage compared to others who had spent time doing, or watching, experiments designed to show important scientific principles. Answers to the chemistry questions were rather disappointing.

Comments on specific questions

Question 1

(a) (i) Some candidates omitted to label the area of starch.

(ii) Answers of blue, black or blue-black were all credited.

(b) Few candidates mentioned the importance of the chlorophyll contained in the leaf. There was also much confusion about the photosynthesis reaction, which was variously said to cause the production of carbon dioxide, the breakdown of glucose and the breakdown of chlorophyll. The sodium hydroxide solution in tube **B** also caused some problems and some candidates wrote that no water was available so photosynthesis was impossible. Few candidates obtained full marks.

(c) (i) Tube **B** contained sodium hydroxide solution, the others contained water as a control substance. Few candidates gave the correct answer, showing that the idea of the control experiment is not well understood.

(ii) The next stage in the test was extraction of chlorophyll using alcohol. Many candidates said that the leaf was boiled “to remove the chlorophyll”. This was not accepted as an answer, since its real purpose was to break down the cell walls to facilitate entry of both the alcohol and the iodine solution.

Question 2

Confusion was caused by the inclusion of the data printed on the lamps which gave the recommended voltage and wattage for their use. Another problem arose in part **(c)** when candidates used the word “power” rather inaccurately in comments like “The lamp was supplied with too much power”. Despite the problems, many candidates gained full marks for this question.

(a) Most candidates were able to read and record the values, even though interpolation had to be used.

(b) (i) The equation $V = IR$ had to be rearranged to find R. This was difficult for a few candidates. If they failed to do this and suggested a wrong formula, this error was carried forward to parts **(ii)** and **(iii)**.

(ii) The numbers were not easy to divide without a calculator, so many candidates spent valuable time here.

(iii) Most candidates were able to gain all the marks for this part, and those who could not complete the calculations still gained some credit.

(c) Some candidates were able to suggest that the lamp filament had burned out because too much voltage had been applied, or its resistance was too low. Many candidates could not satisfactorily answer this question.

(d) (i) This was found to be the hardest part of the question.

(ii) A commendable number of candidates answered this correctly, showing that they understood the relationship between voltage, current and resistance.

Question 3

Most candidates gained a few marks for their answers to this question, but high marks were very rare.

(a) (i) To make a fair comparison of the three solutions, the same volumes must be used. A clue was given in the diagram of the experiment which showed a measuring cylinder. Despite this, a high percentage of candidates said that the same number of drops of solution **X** must be added each time.

(ii) To make all the reacting particles come into contact, the mixture must be stirred or shaken.

(iii) The description of the reaction of solution **X** with potassium permanganate is given in the first four lines of the question. A candidate who did not read this could not answer how the experimenter would know when to stop adding the drops of solution **X**, i.e. when the mixture became colourless. Some candidates wrote "when the mixture becomes clear", which could not be credited.

(iv) A surprising number of candidates chose the lowest number of drops to identify the most concentrated permanganate solution.

(b) Many candidates, who presumably had no laboratory experience, suggested delivering one drop into the 10 cm^3 measuring cylinder and reading off the volume.

(c) (i) The test for a sulfate was described and an observation asked for. This part was not answered well.

(ii) Any mention of "green" gained credit.

(d) (i) There were very few correct answers to this question, although "iron(III)" was sometimes given as the answer.

(ii) Some candidates were able to answer that the iron(II) ions are oxidised or they lose electrons.

Part **(d)** was even more poorly answered than part **(c)**

Question 4

(a) This was usually well done.

(b) The poorer candidates found it hard to locate the points on the vertical and horizontal axes because each subdivision did not correspond with the units of temperature or time. Two plotting errors were allowed before marks were deducted. There were many points to be plotted, and less able candidates lost time here.

(c) (i) Reference to the steeper gradient was needed, although other explanations were accepted.

(ii) The Examiners looked for the term "conduct" or "conduction" here. Surprisingly, some candidates wrote that copper is a good insulator, or a bad conductor.

(d) The answer needed here must refer to the experimental results, especially as the introduction to **Question 4** begins with a reference to elephants' ears. Those who ignored this made many allusions to the use of ears in listening for enemies and poachers, shading the body from the hot sun and causing cooling breezes by flapping. This question was well answered by the better candidates.

(e) Ways to make the experiment a fair test could include using the same volumes and temperature of the hot water used and the same amount of insulation. A few other suggestions also gained marks.

Question 5

Many candidates were able to score well in this question, revealing that this was an experiment that they had seen or had carried out.

(a) (i) Candidates who had seen or had done this experiment found no difficulty in drawing the path of the light ray. Others did not first draw both of the straight lines through the positions of the locating pins, so the ray through the block was at an incorrect angle to the normal.

(ii) A normal must then be drawn at the point where the ray enters the block. Strictly, this should be at exactly 90° to the block, but the Examiners were less concerned about a slight inaccuracy.

(iii) Candidates who followed the example diagram found labelling easy.

(iv) Those who had drawn a poor diagram, and had no protractor, guessed at the dimensions of the angles, using the other data provided. However, if the candidates' data did not match the actual values of the angles on their diagram, no marks were awarded.

(b) Marks were lost if the scales of the axes were not correctly labelled, if the units (degrees or °) were missing, if any of the points were plotted incorrectly, or if the line through the points was unsatisfactory. Reversal of the axes was also penalised. Some candidates extended the line to the origin although instructed not to do so. Despite these errors, many candidates scored well here.

(c) The construction had to be shown on the graph to earn full marks. This instruction was ignored by many candidates.

Question 6

Even if a candidate had not used a Bunsen burner, most parts of the question could be answered by reference to the chemical reactions of alkanes.

(a) (i) Candidates should have been able to identify the soot as carbon and then suggest that this is caused by incomplete combustion of the butane. This question was badly answered.

(ii) Very few candidates were aware of the structure of the flame.

(b) (i) All that was needed was a statement that the sodium nitrate melts.

(ii) In flame **C**, the sodium nitrate decomposes. This was almost never given as the answer. Most candidates suggested that the sodium nitrate boils or vaporises, and did not go back to change this answer even if they answered part **(c)** correctly.

(c) Many candidates scored full marks for correctly describing the test for oxygen.

(d) The air hole introduces sufficient oxygen for complete combustion of the butane, so the maximum heat energy is liberated. Some candidates simply wrote that a blue flame is hotter than a yellow flame, for which no marks were awarded.

The answers to this question were disappointing. It is this kind of question that poorly-prepared candidates find most difficult.