COMBINED SCIENCE

Paper 0653/01
Multiple Choice

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

Comments on specific questions

Questions 1 to 14

Question 3

This was the easiest of the Biology questions, but remained sufficient of a challenge for it to make a meaningful contribution to the paper. It was, perhaps, surprising that 8% of the candidates believed that water travels in the midrib of a leaf in the form of water vapour.

Question 8

This was clearly the most challenging of the Biology questions and it certainly demanded careful thought. Option **C** was very popular, but it indicated a failure on the part of candidates to understand that a low blood glucose level does not require a high level of insulin.

Question 10

Terms for the female reproductive structures in plants are often a cause for confusion, and this question highlighted the problem. Even some otherwise very competent candidates believed that an egg, rather than an ovule, becomes a seed after fertilisation.

Question 13

A relatively high percentage (42%) believed that *species diversity* means the number of variations within a species **(D)**. Since this term is specifically mentioned in the syllabus, then candidates should be expected to be able to recognise a scientific description of it.

Questions 15 to 27

Question 15 was found marginally hard but the high discrimination factor may be a record!.. The lower-scoring candidates tended to avoid the key **(C)** and appear to have largely guessed between the other responses. Perhaps more attention may be given to helping candidates' interpretation of atomic notation.

Question 18

A third of the lower-scoring candidates chose response **B** and responses **C** (the key) and **A** were equally popular with these candidates. The basis of this question is that elements in the same group of the Periodic Table tend to have similar properties so that only Sn and Pb would be expected to be similar to carbon in having an XO_2 oxide.

Question 20

From the relative popularities of the responses, the lower-scoring candidates seemed to have no difficulty in recognising the oxygen present in the element, water and carbon dioxide but 40% of them chose response **C**, evidently not recognising nitrogen as a diatomic molecule.

Question 21

Nearly a third of the lower-scoring candidates chose response **B** as against a quarter answering correctly. As in previous years, it seems almost impossible to convince everybody that copper does not react with dilute (non-oxidising) acids.

Question 22 discriminated well, probably because the lower-scoring candidates were evidently guessing. However, since the question indicated that the copper(II) oxide is reduced, the key **(D)** ought not to have been a difficult conclusion.

Question 24

Amongst the lower-scoring candidates, the key **(A)** was the least popular response and nearly 40% of them favoured response **D**. There is no obvious explanation for this unless sodium chloride is the only aqueous salt that they have considered for electrolysis.

Question 25

Of the four choices offered, only an element would be expected to give a single combustion product but coal is a mixture and is not pure carbon as over 40% of the lower-scoring candidates appeared to think.

Question 27 As for **Question 24**, the key **(D)** was the least popular response amongst the lower-scoring candidates and about a third of these candidates chose either response **B** or **C**. Choice of the latter is rather perplexing, methane being a simple molecule, not a plastic.

Questions 28 to 40

There were several items which large numbers of candidates answered correctly (facility greater than 70%). These were **Questions 28**, **30**, **33** and **34**. Items which had a low facility (i.e. a low proportion of candidates answering correctly) were **Questions 31**, **35** 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. Although **Question 32** performed reasonably well, there was still a lot of guessing amongst those candidates who answered incorrectly.

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 four electricity items all gave the candidates some trouble. There was a lot of guesswork in **Question 36**; in **Question 37**, although nearly two-thirds answered correctly, a lot thought that lamp **C** breaking would cause the others to go out; in **Question 38**, only a third answered correctly, and a similar number thought that thicker insulation would reduce the heat produced; in **Question 39** it was clear that most did not understand the function of a step-down transformer.

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

COMBINED SCIENCE

Paper 0653/02

Paper 2 (Core)

General comments

The general performance of candidates in this limited grade component was much as expected. Only a small number of Centres seem to have entered candidates who may have been more suited to Paper 3 in which they may well have achieved grades above C. As in previous years there was evidence of candidates who did not appear to have acquired much examination technique as shown by many well-expressed answers which did not address the questions being asked. There was no evidence that candidates were having difficulty finishing the paper in the allotted time.

Comments on specific questions

Question 1

(a) (i) Candidates tended to jump to the conclusion that this question was about alternative energy sources and did not write the name of a fuel. Virtually any combustible material known to be used as fuel in any culture could score this mark. The mark was gained by very few candidates.

(ii) The required answer 68**%** was hardly ever given by candidates, who needed to recognise which of the fuels in the table were fossil fuels. The most common incorrect answer was 28% suggesting that these candidates did not recognise natural gas as a fossil fuel.

(iii) This was well answered across the ability range and many candidates scored both marks.

(b) Electricity generation by the processes in this question is a very frequently visited part of the syllabus, and many candidates coped well, scoring all of the marks by giving the expected responses, heat, water and turbine. Thermal was accepted as an alternative to heat.

(c) This is also frequently asked and yet candidates remain generally unaware that this is about reducing energy losses. This mark was rarely scored even by better candidates.

Question 2

(a) (i) Common mistakes included suggesting carbon for carbon dioxide and suggesting hydrogen for the product from sodium hydrogencarbonate.

(ii) This should be a simple recall question and so marking is strict. Many candidates lost the mark because they did not write a lower case *l* in HC*l*. Many others embedded the correct formula in an equation. This also did not gain the mark.

(iii) Generally, gas tests are well known and in this case an error carried forward from part **(ii)** was allowed provided the test matched the gas.

The remaining parts of this question proved generally difficult for candidates, drawing as it does from experiences best learned through practical work.

(b) The wording of the question requires more than a definition of the term exothermic. Candidates needed to make some attempt to bring the thermometer or the measurement of temperature into their answers.

(c) (i) The award of both marks for answers to this question was rare. Very few candidates mentioned the need to measure time.

(ii) A common response here was to suggest that *less* solid or acid could be used. These answers were not allowed. Any action which would reduce temperature, dilute the acid or increase the surface area of the solid was accepted.

Question 3

(a) This was one of the best answered questions on the paper. Candidates across the ability range usually scored two or three marks. Oviduct was the least recognised structure and umbilical cord was often labelled as artery.

(b) The word *explain* here implies that candidates need to be discussing the process of diffusion of nutrients through the placenta from the mother's blood. Diffusion was very rarely mentioned although many candidates gained marks for one or more of the other points. Statements such as *the placenta provides the nutrients* did not score unless it was clear that nutrients originate from the mother.

(c) Many highly detailed descriptions of childbirth were seen but many of these scored no marks because they lacked any scientific content. The key points required included dilation of the cervix, contraction of uterus muscle and passage through the vagina. About two thirds of candidates picked up at least one mark for their answer.

(d) This deals with a subject of global importance and the responses to it were largely disappointing. The majority of candidates had not learned the key ideas about HIV/AIDS which were needed in this question. Any mention of inheritance of the condition usually meant that no marks were awarded. It was essential for candidates to show that they knew that HIV is passed from mother's blood to the fetus through the placenta. Marks could be gained for a discussion of HIV being passed on during childbirth provided the candidate clearly stated that this was the result of blood mixing.

Question 4

(a) (i) Many candidates were able to draw the rays correctly, although some had inverted versions in that they drew the refracted ray bending away from the normal. However, a consistently incorrect set of rays did score one error carried forward mark. A common mistake was to draw reflected, rather than refracted rays.

(ii) This was generally poorly answered even by candidates who had scored both marks in part **(i)**. Any unambiguous method of indicating the angle of refraction was accepted.

(b) Candidates needed to include the formula speed = distance ÷ time or a symbolic version using sensible symbols. A correct numerical; answer without the formula and working scores only one of the two available marks. The answer is 333.3(recurring) m/s although 333 m/s was accepted.

Question 5

(a) (i) Candidates need to give the full term *fractional distillation* (or *fractionation*) in order to score the mark.

(ii) The most common incorrect responses were **A** and **E**. This mark was not scored by many candidates.

(b) (i) There were no alternatives to the expected answer, oxygen. A wide variety of suggestions were made which included fractions of petroleum and other compounds. Rather surprisingly this mark eluded large numbers of candidates.

(ii) There was a variety of acceptable responses to this question and most candidates picked up at least one mark. Candidates could choose a relevant polluting compound for one mark and then go on to discuss its effect and environmental consequence. For example, carbon dioxide is thought to cause increased global warming which is likely to cause catastrophic climate changes. The other markworthy pollutants mentioned by candidates were carbon monoxide, sulphur dioxide and carbon (particulates). On this occasion the use of the word *carbon* when candidates clearly intended carbon dioxide, was not penalised. However, candidates should recognise that the term carbon as it is used in the media is not precise enough in chemistry examinations.

(c) Generally, polymer chemistry had not been learned at all well in most Centres. The award of two marks for answers to this question was extremely rare and large numbers of candidates did not score. Marks were available for describing the difference in size between polymer and monomer molecules, for describing polymers as long chains, for stating that the chains were composed of linked monomers. Candidates could also gain marks by relevant statements about saturation and unsaturation.

Question 6

(a) (i) The majority of candidates correctly divided 10 by 100 to obtain the correct answer 0.1 dm^3 .

(ii) The majority of candidates correctly described that the longer the race the greater the volume of oxygen used. However, some candidates noticed that the longer the race, the less oxygen is used per metre, and this was also credited.

(b) (i) Candidates needed to discuss the role of red blood cells and haemoglobin in their answer. The majority were distracted into a discussion, fully correct in many cases, of the action of the heart. This often meant that some of the better candidates failed to score these marks.

(ii) Full marks here required candidates to give a fairly detailed description of respiration. Only the best candidates were able to do this fully and the award of three marks was rare. Candidates could have gained marks for using the term *respiration* in a sensible context, for stating that in this context the process occurs in muscle and for stating that the oxygen combines with glucose to produce carbon dioxide and water.

(c) Many candidates were distracted into incorrect answers which described, in some detail, the inability of heavily intoxicated athletes to complete the race. Others wrote at length about a stimulating effect which implied that the athlete's time would be improved. The candidates who scored both marks described the effect on reaction time and the likely slower start.

Question 7

(a) (i) The majority of candidates scored two or three marks on this question which was one of the better answered on the paper. Electrical symbols had been generally well learned. Common mistakes included drawing circuits containing branches and careless mistakes in not showing three cells correctly.

(ii) The correct answer, 4.5 V, was given by the great majority of candidates across the ability range.

(b) (i) Any reasonable source of infrared was accepted and many candidates scored one mark. However, the second and third parts of this question rarely gained marks. Any simple device such as a thermometer would have been acceptable for the second part and any use of infrared e.g. for night vision cameras would have done for the third part. Large numbers of candidates wrote the single word *Bluetooth* for the third part. This could not be accepted since it does not describe a use and Bluetooth technology specifically avoids infrared.

(ii) Most candidates had learned their electromagnetic spectrum regions well and gained this mark.

Question 8

(a) This was generally well answered with the majority of candidates gaining both marks.

(b) (i) Most candidates gained this mark although some were penalised if they carelessly wrote AL.

(ii) The majority of candidates correctly gave the answer 13.

(iii) The expected answers included reference to lack of reactivity and malleability. Candidates were not awarded the mark if they referred to rusting.

(c) This is a commonly asked question and candidates need to refer to the presence of more than one type of atom or element and that these are bonded together. The question was relatively well answered and many candidates gave clear, accurate answers.

(d) (i) It was not enough for candidates simply to say that the aluminium oxide had to be heated. They needed to make it clear that melting is necessary. Only a minority scored the mark.

(ii) This was well answered and many candidates showed that they had learned that electrolysis splits compounds into their elements.

Question 9

(a) The majority of candidates gained one mark here, usually for stating that the root hair cell would contain no chloroplast. Reference to the lack of chlorophyll could not be accepted. Although many stated that there is a shape difference between root and palisade, it was necessary to give more detail. Candidates could also gain a mark for discussing that the root hair cell has a larger surface area.

(b) (i) The required answer, two, was given by many candidates. There was no particular pattern to the variety of incorrect responses given.

(ii) Candidates needed to make it clear that water has to pass across the root itself before entering the xylem. Most candidates referred to xylem, but many used the vaguer term, *stem*, which did not score. One mark was the most common score on this question.

(iii) Many candidates had learned the photosynthesis equation well and scored both marks, which were essentially awarded for correct reactants and correct products. The most common way for marks to be lost was for the four key components to be mixed up, suggesting partial learning. The terms, glucose, starch and sugar were all accepted.

(iv) There were a number of ways candidates could score this mark. They could have referred to increased rate of photosynthesis or increased transpiration and/or evaporation from leaves. It was important for the candidates to write their answer comparatively, and to avoid incorrect statements such as *there is no photosynthesis on a dull day*.

Question 10

(a) Candidates answered this question well and most were able to link the conductivity if water with the risk of electrocution.

(b) While candidates generally discussed the harmful effects of alpha inside the body the reasons for the decreased danger when it is outside the body was not so well understood. A wide range of harmful effects within the body was accepted including damage to organs, cells, DNA. When outside the body candidates could refer to the poor penetrating power of alpha particles meaning they would be absorbed by air or stopped by skin. The majority of candidates scored one mark.

(c) The purpose of expansion gaps had not been learned very well in many Centres and a wide variety of incorrect reasons for their inclusion in bridge design was given. The mark could be gained for referring to the expansion of bridge material and/or the role of the expansion gaps to prevent damage to bridge/road on expansion.

COMBINED SCIENCE

Paper 0653/03
Paper 3 (Extended)

General comments

It was pleasing to see many candidates showing confidence in tackling almost all of the questions on this paper. They showed good knowledge and understanding of the whole breadth of topics covered. At the other end of the scale, some candidates appeared to have been entered who had not had any experience of the topics in the supplement of the syllabus, and who were out of their depth in most of the questions. No candidate is likely to show their best performance when they can only even try to answer around one tenth of the questions on the Paper.

Comments on specific questions

Question 1

(a) Candidates found this more difficult than had been expected. Many candidates did not fully appreciate that they were being asked to name a *fuel*, and named other sources of energy such as geothermal. The calculation in **(ii)** also caused problems because many were not able to identify all of the energy sources that come from fossil fuels.

(b) (i) Most candidates understand that this is done to reduce energy losses. Some incorrectly stated that it prevents *electricity* loss.

(ii) Better candidates were able to get at least one mark here, explaining that transformers only work with a.c. However, many did not know this, and there were some very inventive answers – for example, that this allows unused electricity to go back to the power station.

(iii) This was well done on the whole, although weaker candidates often drew curves with widely varying amplitudes, or that were always above the 0 V line.

Question 2

(a) This was generally answered well, although the oviduct was sometimes mistaken for a blood vessel, and the amniotic fluid for the amnion.

(b) Again, this proved accessible to most candidates. The most common error was to state that the mother's blood flows into the fetus. Many candidates failed to mention the placenta, apparently not having noticed that it was labelled on Fig. 2.1.

(c) The most commonly seen correct answers related to the provision of antibodies in breast milk and the formation of a bond between mother and baby. Some candidates also mentioned that breast milk is always at a suitable temperature, and that there is less risk of bacterial contamination than with bottle feeding. However, many incorrectly stated that breast milk contains more nutrients than milk made up from a formula.

(d) It was worrying to see large numbers of candidates who are under the impression that AIDS is an hereditary disease, passed from a mother to her offspring in her genes. Despite their large numbers, however, these candidates were in the minority, and many answers showed an understanding that the *virus* is passed from mother to offspring, and gave a brief suggestion of how this might occur – for example, during contact of body fluids during the birth process.

Question 3

(a) (i) Better candidates usually named all three gases correctly, but many had no idea and named substances that were not even gases, such as calcium chloride. The last of the three, involving nitric acid, proved to be the most difficult.

(ii) Some knew the correct chemical formula for nitric acid, but many did not.

(iii) A surprisingly large number of candidates were not able to link the information about pH in Table 3.1 to the concentration of hydrogen ions.

(b) (i) This was almost always answered correctly, and most candidates were given full marks.

(ii) The most common suggestion was that experiment 6 had been heated, and this was then explained in terms of particles moving faster. However, many answers stated that this would mean 'more collisions', whereas the required answer was that there would be more *frequent* collisions or more *energetic* collisions. Some candidates correctly suggested that the calcium carbonate could have been in powered form, or that the acid could have been more concentrated. Again, a statement referring to frequency of collisions was required.

Question 4

(a) Both parts were generally answered correctly, although **(ii)** was a little more difficult that **(i)**.

(b) (i) Few candidates appeared to have learnt a definition of this term.

(ii) This was often answered well, with reference to the width of the base and the height of the centre of mass. A few candidates drew excellent diagrams showing how a vertical line drawn from the centre of mass would lie inside or outside the base with the torch tipped over at an angle.

Question 5

(a) (i) Most candidates recognised that respiration was involved in this process. Some correctly described how oxygen would be transported in the blood to the muscles, and then described respiration, or wrote a word equation.

(ii) This was often calculated correctly, but numerous candidates failed to include a unit with their answer. Units are always expected with numerical answers on this paper, and marks are lost if they are not included.

(b) (i) This was generally answered correctly, although a few candidates appeared not to see this part of the question and gave no response.

(ii) Better candidates were able to state the relationship between these two values, but found it difficult to suggest a reason for it. The most common appropriate suggestion was that the athlete ran more slowly over the longer distance. Some misunderstood the question, and simply explained how they had calculated the value in **(b)(i)**.

(c) This was often answered well, and many candidates gave clear and full explanations of anaerobic respiration, the build-up of lactic acid and the need for extra oxygen to remove it.

Question 6

(a) Both parts of this question were often answered correctly. However, weaker candidates often suggested that product **F** would be at the highest temperature, and some inexplicably chose products in the mid-range, such as **E** or **C**.

(b) (i) This proved to be unexpectedly difficult. Even the better candidates were often confused by the 2 in front of H_2O in the equation, and doubled the value for the relative molecular mass of water, giving 36 instead of 18.

(ii) Candidates who saw the easy way through had no problem with this question, adding together 44 and 36 and then carrying out a simple proportion calculation. Some, though, took a much longer and more tortuous route through, sometimes involving molecular masses. A very common error was to calculate the mass of water and the mass of carbon dioxide separately and then fail to add them together to give the final answer of the *total* mass of products.

(c) (i) This discriminated well. Better candidates gave either methane or oxygen, but many made suggestions that did not appear to have any relationship to the combustion reaction.

(ii) Almost all candidates were able to use the information in the table to give a correct answer.

(d) This question proved easy for some candidates, but many others seemed to be unfamiliar with the concept of addition polymerisation. A simple diagram often scored both available marks.

Question 7

(a) Although most candidates were able to draw the path of the light ray in the optical fibre, relatively few could give a correct answer to either **(ii)** or **(iii)**. Some appeared to believe that *sound* travels down metal wires, and suggested that optical fibres would be better because light travels faster than sound.

(b) (i) This was usually done correctly. A few candidates doubled the distance and so obtained a value for the speed of sound that was twice as large as it should be.

(ii) Almost all candidates scored at least some marks for this, and it was pleasing to be able to give full marks to many. A few, however, simply described how to measure volume, and then stated that this was the density of the bell. Some incorrectly suggested filling the bell up with water and measuring the volume of the water. Others suggested that you should ring the bell and see what kind of sound it gave.

Question 8

(a) (i) Candidates often knew that the phloem tubes are close to the surface of the stem, and so within easy reach of the aphid. Weaker candidates, however, simply copied out the information below the diagram, saying that they use their needle-like mouthparts.

(ii) It was pleasing to see that most candidates know that xylem transports water, but there was some confusion about what is transported in phloem. Some correctly stated sugars or sucrose, but starch and glucose were common incorrect answers.

(b) (i) Most candidates did appear to at least be familiar with the concept of systemic insecticides, but answers to this question were very varied. The most common correct answers were that only insects that feed on the plant will be killed (so there is less damage to beneficial insects), and that the insecticide reaches all parts of the plant, so you do not need to 'hit' an insect with the spray. Some also correctly suggested that the insecticide would be less likely to be washed off by rain.

(ii) The expected answer was 'biological control', and it was surprising to see a large proportion of candidates unable to give this term.

(c) Most candidates were able to give a correct answer. Some, however, were sidetracked and tried to describe the structure of phloem.

Question 9

(a) This was almost always correctly answered.

(b) Again, all but the weakest candidates gave a correct answer.

(c) (i) Many answers were entirely correct. Frequent errors were to draw the aluminium ion with three electron shells (with various numbers of electrons in it) or to give the charges on the ions as simply plus or minus. Some missed out this entirely, presumably having failed to read the question carefully.

(ii) A great deal of misunderstanding was shown here. Many candidates described the *loss* of electrons by the aluminium ion, even when they had correctly drawn it and shown its charge in **(i)**.

(iii) The skill of balancing an equation varied widely, but most candidates were able to complete this equation correctly.

Question 10

(a) Where candidates appreciated that they needed to describe the behaviour of particles, as stated in the question, most were able to score at least one mark. They needed to state that there would be more frequent collisions with the walls of the container. However, there were numerous answers that described the particles 'trying to get out'.

(b) Most candidates were able to give a suitable description of the difference between speed and velocity.

(c) There were many good answers, explaining that alpha particles outside the body pose little danger because they cannot penetrate skin, but that once inside the body they can do great harm to cells, for example by causing mutations. However, many candidates did not answer the question, instead comparing the properties of alpha radiation with other types ('it is less penetrating and more ionising') and not including any reference to the danger to the human body.

COMBINED SCIENCE

Paper 0653/04

Coursework

General comments

(a) Nature of tasks set by centres.

Only two centre submitted coursework for the December examination. All the assessments set were appropriate to the requirements of the syllabus and the competence of the candidates. The nature of the tasks was well understood.

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

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

The use of annotation on candidates' scripts to indicate or justify where marks have been awarded has been encouraged for the last few examination periods.

Neither centre followed that suggestion.

(d) Good practice.

None noted

COMBINED SCIENCE

Paper 0653/05

Practical Test

General comments

The question paper was of a similar standard to previous years and there was opportunity for candidates at all levels to perform at their particular level. It appeared that some candidates were not well practised in carrying out chemical tests, failing to recognise the tests as shown in the notes on page 12. The mark scheme produced a good spread of marks. All candidates appeared to be able to complete the paper in the time allocated. Supervisors should note that they should not provide additional apparatus without permission. Small measuring cylinders were not required for measuring the approximate volumes used in **Question 3** and candidates should be used to using about 2 cm^3 of solution.

Comments on specific questions

Question 1

The majority of candidates scored well on this question although full marks were not very common. Too many overlooked an important instruction that required a thermometer to be placed in each tube and a reading taken from both thermometers at the same time. Had this been done, the initial temperatures would have been much closer to each other than was the case. It appeared that many performed the measurements on tube **A** then returned to tube **B**. By which time the temperature of the water in tube **B** was often 10 or 20°C lower than tube **A**. Consequently the rapid fall in temperature for tube B was less obvious than it should have been. A small number seemed to think that the initial temperature meant room temperature.

Sensible scales were usually chosen for the graph and plotting was good. However, a smooth curve can seldom be produced by joining up the points on a graph. Almost all candidates lost a mark for failing to draw smooth curves suggesting a lack of understanding of cooling curves. Most deduced that tube **B** cooled faster although the graphs did not always indicate this. In many cases it was simply the result of having a lower starting temperature for tube **B**. The rate of cooling indicated was often about the same. Part **(b)(iii)** was well answered although some tried to explain their answer by referring to the different curves rather than an explanation in terms of air being trapped in the dry wool.

Question 2

A small number of candidates are still confused about units of measurement. The distance **CE** was occasionally recorded in centimetres rather than millimetres. Rather more candidates failed to measure the distance **y** shown on the diagram measuring **GD** (100 – **y**) instead. A few recorded values greater than 100 mm, the size of the card! Values of **x** were well chosen and values of **y** should have decreased as **x** increased, except for those who measured 100 – **y**. This latter error cost three marks. Graphs were generally well drawn and only a small number failed to draw a line of best fit. Although many did not extrapolate the line to cut the **y** axis, the mark for the value of **y** when **x** = 0 was awarded providing it was correct.

Question 3

Sadly this question revealed a poor understanding of some of the fundamentals of chemistry. Very few candidates were able to deduce the nature of each solid. Simple reactions, all shown in the notes on page 12 were not recognised and the observations were made more difficult by trying to anticipate what might happen. Although almost every candidate recorded effervescence in the very first test, very few recognised this as a test for an acid. Does this suggest a lack of practice in experimental chemistry? One would also expect well prepared candidates to know the meaning of the word precipitate. Far too many are vague and use unacceptable terms such as cloudy or white solution. The tests on solids **A** and **B** in part **(b)** produced all manner of incorrect results. Most appeared to think that a gas had to be evolved in each case. Chlorine was the most common gas given, even recording that the gas bleached litmus! Others claimed that the gas popped with a lighted splint. Even the addition of an ammonium compound did not appear to suggest that ammonia might be evolved. Part **(c)** was not well done, again suggesting a lack of practice. Addition of aqueous ammonia ought to suggest the possibility of a precipitate being formed and by reference to the notes provided, the importance of it being soluble or insoluble in excess should have been noted. As already indicated, part **(d)** was very poorly answered. The strong effervescence of solid **A** with sodium carbonate indicated an acid, the formation of ammonia when **B** reacted with ammonium chloride shows **B** to be a base and the formation of a precipitate with aqueous ammonia and **C** suggested **C** to be the salt. The most common answer was **A** is an acid because it turns litmus red.

COMBINED SCIENCE

Paper 0653/06
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.