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COMBINED SCIENCE

Paper 0653/01
Multiple Choice

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4	**D**	24	**D**
5	**B**	25	**A**
6	**A**	26	**D**
7	**B**	27	**C**
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17	**C**	37	**C**
18	**A**	38	**A**
19	**D**	39	**A**
20	**C**	40	**D**

General comments

The mean score on this paper was around 60%, which is less than some recent mean scores on this paper.

Comments on specific questions

Question 6

Although less than half the candidates selected the correct response, this question played a valuable part in the overall assessment process since it identified those who wrongly believe that the water needed for photosynthesis enters a plant through its leaves (almost a third).

Question 11

This question demanded careful thought and it was a credit to well over half the candidates that they did so accurately. Graphs are notoriously difficult for candidates to interpret and, in this case, there was also the need to couple interpretation with the knowledge of what happens to sugar after it has been absorbed into the blood. Almost a quarter failed at this second hurdle and opted for graph **B**.

Question 12

This question perhaps demanded information which simply did not come to the minds of any but the very best 13%. That the male nucleus is found in a pollen grain was understood, but that, at the stage in fertilization shown in the diagram, the nucleus would be in the pollen tube proved too much of a challenge.

Question 13

Simple confusion over technical terminology proved the downfall of over half the candidates in this question. Only the best candidates knew precisely what the placenta is.

Question 14

This question was found to be slightly hard by many candidates. This was probably because nearly 40% of the lower-scoring candidates chose response **D** rather than the key **A**. These candidates evidently merely counted the 7 electrons without remembering that the top left-hand number in an atomic symbol is the total number of particles in the nucleus of an atom.

Question 15

This question was also quite hard with response **A** being quite popular across the ability range: the question is clearly within the syllabus and one of the characteristics of carbon is its tetravalency.

Question 19

It is a little surprising that the percentage of correct answers was not higher than the 62% achieved. After **D**, the key, response **C** was the fairly popular choice amongst the lower-scoring candidates. The topic is explicit within the syllabus but in the nature of things candidates are unlikely to have seen potassium and sodium added to dilute acid and they many have been attracted by the vigour of magnesium's reaction.

Question 20

The lower-scoring candidates tended to avoid response **D** but then appeared merely to have guessed between **A**, **B** and **C**. It is rather surprising that steel was not more readily identified as being an alloy.

Question 21

Only 53% of the higher-scoring candidates chose the key, **B**. This value was not all that much higher than the 37% achieved by the lower-scoring candidates. As a consequence, this question did not discriminate all that well. Response **A** was quite popular across the ability range, implying that candidates either forgot or did not realize that boiled tap water has lost its dissolved oxygen, an essential ingredient for rusting to occur.

Question 23

This was found decidedly hard, with only 56% of the higher-scoring candidates opting for the key, **A**. Response **C** was the most popular choice amongst the lower-scoring candidates. The most likely explanation for this seems to be that such candidates did not know that aqueous sodium chloride has pH7 and therefore does not affect litmus.

Question 25

Another decidedly hard question but with good discrimination. Amongst the lower-scoring candidates, responses **B** and **C** were both more popular than the key, **A**, implying some difficulty in interpreting graphs.

Question 26

This had excellent discrimination. The relative evenness of choice across the responses amongst the lower-scoring candidates seems to suggest guessing.

Question 28

Candidates showed little grasp of the units appropriate for a measuring cylinder. The only thing they agreed upon was that the units are not cm^2.

Questions 30 and 31

These showed that most candidates are uncertain about mass and density which really are two basic concepts in Physics.

Question 34

Candidates seemed to find this question particularly hard, and guessing was widespread.

Question 35

It really is unforgivable for over two-thirds of the candidates to be unable to identify angles of incidence and refraction.

Question 36

Most candidates knew that voltmeters are connected in parallel with something but a third did not spot that the question asked about p.d. across a cell, not a resistor.

Question 40

This was poorly answered with a third of the candidates not even knowing the alpha particles are positively charged.

Paper 0653/02

Paper 2 (Core)

General comments

In view of the availability of the full grade range on Paper 3 of this syllabus, the number of candidates attempting this component was, as expected, rather small. The marks gained by the candidates tended to lie towards the lower end of the mark range with the majority of candidates scoring below half marks. There was no evidence that candidates were running out of time although many of them were unable to provide any answers for some of the questions. Performance across the three Science disciplines was fairly even although candidates in general may have done better on two of the three Biology questions.

Comments on specific questions

Question 1

(a) Most candidates scored some marks in this question with many gaining all three. In general, candidates across the ability range are able to learn the rules of atomic structure and interpret atomic diagrams.

(b)(i) It was very common for candidates to gain one mark for stating that air contained other substances in addition to oxygen, but few could go on to suggest why this caused the difference between air/hydrogen and oxygen/hydrogen mixtures on ignition. A common misconception was that the hydrogen reacted with the other substances in the air making less of it available to react with oxygen in air.

(ii) Since hydrogen oxide was not accepted in place of the correct product, water, the majority of candidates did not gain this mark. Many weaker candidates clearly did not seem to know what the term word equation meant.

Question 2

(a) This was relatively well answered and many candidates scored both marks. Candidates were not credited for stating the often used model that the nucleus is the *brain of the cell* unless they qualified this by reference to control. Some lost marks by confusing the function of the nucleus with that of the cell membrane. Many candidates made correct references to DNA.

(b) The majority of candidates had learned how to draw excellent plant cell diagrams and this was one of the most accessible questions on the paper. Many scored all four of the available marks. Unfortunately some candidates wasted time for no marks by drawing extremely good diagrams of the general cell structure of a leaf.

(c) In this question candidates needed to focus on the constant availability of sunlight and the continuous transfer of energy into the new wood. In general candidates did not appreciate the significance of the term renewable energy in this context and many suggested that once burned and the energy released, the tree could be replanted. Some candidates discussed renewable in terms of the range of uses to which wood can be put such as furniture or paper making.

Question 3

(a)(i)(ii) Candidates could usually interpret the graph and the accepted answers were 2 and 15 km/h although answers in the range 2 to 2.4 were allowed.

(b) Most candidates recognised electrical energy but far too many are still tending to suggest erroneous terms such as wind energy. Kinetic or movement energy was required.

(c)(i) In general this was well answered although vague statements such as *there may be no wind* without the qualifying idea that electricity production is therefore unreliable were not credited. Other acceptable answers referred to visual or noise pollution.

(ii) The expected answers oil or gas were very often seen but candidates were penalised if they suggested crude oil.

(iii) This was answered correctly in most cases. Hydrogen and carbon were accepted.

Question 4

(a) This was not as well answered as expected. Usually the common gas tests are a reliable source of marks for most candidates. The correct answers were seen fairly often although limewater was not as familiar to candidates as had been anticipated.

(b) There was much evidence that candidates had learned how to define a compound correctly. They were supposed to refer to the diagram but correct definitions which discussed different types of atom chemically combined scored both marks.

(c)(i) About half the candidates could produce the correct formula for sulphuric acid.

(ii) This was obviously a familiar part of the syllabus for the majority of candidates. Very many scored two for providing carbon dioxide and water and a pleasing number could also name the salt produced.

(iii) This eluded most candidates. One or two only realised that effervescence would not be observed if more reagent was added to the spillage. In view of the way the question was worded, references to litmus or other test papers could not score the mark.

(iv) It was very encouraging to see most candidates scoring this mark. They had learned of the dangers of adding alkali metals to acid.

Question 5

(a)(i) Most scored one mark on this question by stating that the more cigarettes smoked the more the chance of a low birth weight. The second mark was rarely awarded and was for recognising that the effect was greatest up to 15 cigarettes smoked per day.

(ii) This was a difficult question and tested the important idea that correlation does not prove cause and effect. Some of the best candidates recognised this but the majority did not gain marks on this question.

(b) The three marks were for reference to diffusion of carbon monoxide from the mother's blood through the placenta. This had been learned very well by many candidates and the majority picked up some or all of the marks. The most common serious misconception is the recurring one that the mother and fetus have a common circulatory system.

(c) This required discussion of the damage to the cilia and subsequent build up of mucus and bacteria in the lung. This had not been learned by the majority of candidates. Many wrote at length about tar and lung cancer and the general problems caused by smoking.

Question 6

(a)(i)-(iv) The majority of candidates scored two or three marks on these questions. The least well known was the ionising nature of gamma rays and the best well known was the use of X-rays.

(b)(i) Candidates often lost a mark for carelessly presenting the formula distance = speed x time or for omitting it altogether even though they went on to apply it correctly. Of those who correctly applied the formula, the majority missed the point that the distance to the aircraft would be half the calculated distance of travel of the radar signal. The correct answer was 6000 m although two marks could be gained for 12 000 m.

(ii) This was not answered very well. Candidates needed to discuss energy loss leading to lower energy entering the receiver after reflection from the aircraft or they could refer to divergence or scattering of the signal beam. Many suggested that aircraft motion was the cause of the reduced signal strength.

(iii) Candidates needed to state clearly that the signal would be reflected from the aluminium strips or that a false image of the aircraft would be detected. Many candidates simply reworded the question although a significant number did gain the mark.

(c)(i)(ii) Generally, candidates were much better at indicating wavelength although a significant number lost the mark because of the very careless way they had labelled wavelength. Candidates must be very clear that wavelength is measured between identical points on the cycle. Vague double headed arrows hanging somewhere between peaks did not score. The correct labelling of amplitude continues to be difficult for many candidates with the majority indicating peak to trough distance.

(iii) Candidates had to refer to the value 10 in order to gain the mark. Hence it was necessary to indicate that 10 Hz means 10 waves or oscillations per second. This mark was lost by significant numbers of candidates, with many discussing the effect of frequency on the pitch of sound.

Question 7

(a) In general, candidates were quite good at recalling the properties of metals. Chemical properties could not be accepted and it was also important that candidates clearly indicated whether the properties they had written referred to metals or non-metals.

(b)(i) This was generally well answered.

(ii) The reaction in this question seemed to be fairly familiar and many candidates scored both marks.

(c) This question was also answered quite well with many candidates recognising the ionic and the covalent compounds.

(d)(i) While very many candidates were keyed into the main answer of the unreactivity of aluminium, any mention of rusting was penalised as it always is in this context.

(ii) The majority of candidates were able to supply the name of a noble gas and a significant number could also give a correct use.

Question 8

(a) This had been very well learned by the majority of candidates and three marks was a common score across the ability range.

(b) A surprising number of candidates made no mention at all of the missing heart valve in their attempt to answer this question. In order to gain the marks candidates needed to discuss that some blood would flow in the incorrect direction and re-enter the left atrium.

(c)(i) The majority of candidates identified the lungs as the place where blood is oxygenated and a good number could supply further detail e.g. reference to diffusion and so gained the second mark.

(ii) There were several marking points which could allow candidates to score two marks. Acceptable answers included reference to the need for oxygen in respiration and the role of respiration in transferring energy to muscles. Candidates could also discuss the lack of oxygen causing the onset of anaerobic respiration and muscle pain. In general this question was answered fairly well by about half the candidates.

Question 9

(a) This addresses a difficult concept for weaker candidates and is often the subject of questions in this examination. Candidates must discuss weight as a force which depends on gravity. A safe way to deal with mass is to refer to the amount of matter in an object. Vague statements about weight being something which changes but mass stays the same do not explain why mass and weight are different. Some marks were gained by about a third of the candidates.

(b) This part of the syllabus had not been very well learned by the majority of candidates. The required answer deals with the high voltage allowing reduced current and consequent reduction in energy loss.

(c) This question was also not well answered with many of the weaker candidates seemingly unsure of the meaning of the word vacuum. Candidates needed to refer to the role of a medium in the transfer of sound or they could be more specific and discuss the vibration of particles. Generally the question was not well answered.

(d) Candidates were reasonably successful in this question. A mark could be gained for the general idea that beta radiation could penetrate metal although candidates then found it difficult to express the idea that the amount of beta radiation getting through the metal would be controlled by the thickness.

Paper 0653/03

Paper 3 (Extended)

General comments

This was the first year of the new assessment pattern, in which candidates are entered for either Paper 2 or Paper 3. On the whole, most candidates did manage to find some questions that they could answer in the paper, but a minority were clearly inappropriately entered and could not even achieve 10 marks. It was very pleasing to see some high marks, although even the best candidates were fully stretched by some parts of some questions.

Comments on specific questions

Question 1

This question was intended to give candidates a relatively straight-forward start to the paper, and most were able to answer at least some parts of it correctly.

(a)(i) The expected answer was that a hydrocarbon is a compound containing hydrogen and carbon only. Quite a few failed to include ‘only’ in their answers. There were also numerous answers referring to containing hydrogen and oxygen molecules.

(ii) Some candidates did suggest that the fire might be short of oxygen, and a few mentioned incomplete combustion. Relatively few mentioned the production of carbon (or soot); many wrongly identified the smoke as being carbon monoxide.

(iii) This was usually well answered, as candidates were able to explain that combustion requires oxygen, and that carbon dioxide blocks air from the fire.

(b)(i) All but the best candidates were unable to translate Fig. 1.2 into a balanced equation. Common errors included writing $2CH_2$ or 6O, but there were many other mistakes made as well.

(ii) Most answers suggested that the candidates had some understanding of the meaning of 'balanced' in this context, but were not sufficiently precise to be awarded the mark. The expected answer was that there are equal numbers of each type of atom on each side.

(iii) Where candidates recognised that the lines represented bonds, they had no trouble with this.

(iv) However, many answers did not use label lines as instructed, so it was not possible to determine to what the letters that they wrote down referred. Others bracketed entire molecules together, or indicated an atom rather than a bond.

Question 2

There were some excellent answers to this question, although many candidates surprisingly had difficulty with part **(c)**.

(a) Most candidates recognised that lake **Y**, with its larger number of species, had the higher species diversity.

(b)(i) This was usually well answered, as candidates picked out the information that there was a higher pH in lake **Y** or that there was a higher species diversity. Some weaker candidates did not understand the term 'evidence' and attempted to describe the effect of the limestone rock, which was not appropriate here.

(ii) Once again, this was often well answered, with many candidates explaining that the limestone would react with the acid and neutralise it.

(c) It was surprising to find relatively few candidates able to explain that, when fossil fuels are burned, sulphur in them can be released into the air as sulphur dioxide.

(d) Most candidates were able to gain 2 or 3 marks here, although those who attempted to describe eutrophication could not usually be rewarded for their descriptions. The Examiners looked for reference to a reduction in photosynthesis (because less light was passing through the water), resulting in less production and therefore less food for herbivores, consumers or animals. 'Organisms' and 'creatures' were often mentioned, but these terms are too vague in this context to be given credit.

Question 3

Many candidates gained full marks on this question.

(a)(i) The majority knew that work = force x distance, and were able to use this to arrive at a correct answer. Units sometimes went astray, and it was essential to give a correct unit in order to get the second available mark.

(ii) This was less well known than **(i)**. Some candidates also ran into difficulties when attempting to divide by 0.5. Units were not always correct.

(b)(i) This was well answered.

Answers: **(a)(i)** 3200 J, **(ii)** 6400 W.

Question 4

(a) Some candidates knew that chlorine is toxic, or could describe its effects.

(b)(i) The expected answer was that chlorine displaced iodine, or simply that chlorine is more reactive than iodine, but it was relatively rare to see these answers.

(ii) Better candidates correctly explained that a darker colour indicates that more iodine has been produced, which in turn indicates that there was more chlorine in the bleach. Some were distracted by the term 'bleach' and suggested that the more chlorine there was, the more it would bleach the iodine and so produce a lighter colour.

(c)(i) This was well answered.

(ii) Candidates were given credit for 'covalent' here even if they had not drawn a covalent bond (or, in some cases, any type of bond at all) in **(i)**.

Question 5

(a) Only a small minority of candidates knew what a 'test cross' is and how it can be used to determine the genotype of an organism showing the dominant trait. Most correctly gave the answer AA to part **(i)**, but the attempts at genetic diagrams in **(ii)** were almost always very disappointing. Marks were given for stating or showing that you would cross the unknown organism with one with the genotype aa, and then indicating how the results of this cross could be used to determine the genotype of the other parent. Some credit was given to candidates who showed any cross correctly, but it was rare to award 4 marks here.

(b) Many candidates understood that asexual reproduction would be sure to produce genetically identical offspring, whilst sexual could produce some individuals which did not have the same (desired) characteristics as their parents.

(c) There is a great deal of confusion about the roles of vitamin C in the diet. Many suggested that it is a good source of energy, of glucose, of proteins or even of roughage. Some knew that a lack of it could result in scurvy, but others just listed everything they could think of, such as making strong bones or helping eyesight.

Question 6

For many candidates, this was their most mark-yielding question.

(a) The diagram showing the particles in a solid should have shown the particles arranged regularly and touching one another. Candidates frequently made things more difficult for themselves by drawing tiny particles, which took a lot of effort to fill the box. Nevertheless, this was often well done. The diagram representing the gas was also often well done, although some candidates drew too many particles.

(b)(i) This was usually well known, and most candidates explained that the bridge may expand in hot weather and that these gaps allow that to happen without structural damage to the bridge. Some, however, were more inventive. A common idea was that the gaps slowed the cars down to prevent them speeding.

(ii) Almost all candidates stated the formula and calculated the time correctly.

(c) Where candidates remembered to use the terms conduction, radiation and convection, all three parts of this question were often answered well. Part **(i)** caused few difficulties, but in **(ii)** they often made the error of suggesting that the black shirt 'attracted' heat. Another common error was to explain that the black shirt absorbed sun*light* rather than heat. Part **(iii)** was the most difficult of the three parts, with relatively few able to describe convection currents within the fridge.

Answer: **(b)(ii)** 2.5 s.

Question 7

This question was not well answered, and it appears that most candidates are not familiar with the experiment shown in Fig. 7.1.

(a) Most knew that the formula for oxygen is O_2, but they did not know the formula of nitrogen and N_3 appeared in many answers. Less than half of candidates could state the approximate percentage of these two gases in the air.

(i) The answers to this question were very disappointing. Many candidates did not read, or did not understand, the requirement of the question to 'describe how the apparatus is used'. Marks were awarded for stating that you would push the air from one syringe to the other, that you would do this several times until the volume of air showed no further change, that you would then leave the apparatus to cool and calculate the decrease in volume. Some did say that you would push the syringe, and rather more explained how you would use the measurements to calculate the percentage of oxygen, but the other marks were only very rarely seen.

(ii) Diagrams were often correct, although by no means always so. Weaker candidates often drew an oxygen molecule in the second box.

(iii) Many simply stated 'negative', rather than also stating the magnitude of the charge.

(iv) Some candidates appeared to be attempting to describe *why* gain of electrons is referred to as 'reduction'. All that was required was the statement that the oxygen atom gained electrons as it changed to an ion.

Question 8

(a) Correct answers here were very rare indeed. If candidates did not understand that osmosis refers to the movement of *water*, then they were very unlikely to obtain either mark. Many wrote about the concentrated solution moving into the cells, or even about the cells moving into the higher concentration. In the few instances where candidates did describe the movement of water out of the cells, some then failed to gain the second mark because they stated that the cells would become 'plasmolysed', which is only true for plant cells.

(b)(i) Those who knew this could gain three marks in two lines of their answer, correctly explaining that the pancreas secretes insulin that causes the liver to remove glucose from the blood. A surprisingly large number suggested that you had to have an injection of insulin, apparently not understanding that insulin is normally produced within the body.

(ii) A large variety of terms appeared here, but many did correctly use the term homeostasis.

(c) Most did gain at least some marks here. Credit was given for stating that starch is digested to glucose, naming the enzyme involved, and then stating that glucose is absorbed from the digestive system into the blood.

Question 9

(a) Less than half of the candidates correctly stated that the voltmeter across CD would read 3V and that across FG 6V.

(b) The circuit diagrams were not always well drawn, and many candidates did not know the correct symbol for one or more of the components. They were given marks for using at least four symbols correctly (so even if the motor symbol was wrong they could still get full marks), for showing the variable resistor in series with the motor and the lamp in parallel with it.

(c) A pleasing number of candidates were able to answer both parts of this question correctly.

Answers: **(a)** 3 V, 6 V; **(c)(i)** 2 Ω and 4 Ω in series, **(ii)** 2 Ω and 2 Ω in parallel.

Paper 0653/04

Coursework

General comments

Nature of tasks set by Centres

A small number of Centres submitted coursework for the June examination. Most have provided coursework in previous years and have acted on advice given. In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates.

In only one Centre was there some minor confusion about a few tasks. The standard of candidates' work was comparable with previous years with candidates covering the whole mark range.

Teacher's application of assessment criteria

In all Centres the assessment criteria were understood and applied well for all of their activities. One Centre tried to assess both skill C1 and C4 in the same investigation. Advice has been set to help them for future years

Recording of marks and teacher's annotation

Following suggestions made encouraging the use of annotation on candidates' scripts many more Centres are using this technique to indicate or justify marks awarded. Many Centres have developed very comprehensive recording systems. Tick lists remain popular with particularly skill C1.

Good practice

Some Centres make very useful comments about individual candidate's performance on a summary sheet.

Paper 0653/05

Practical Test

General comments

The standard of candidates was very similar to that of last year and a good spread of marks was achieved. The only slight problem appeared to be the preparation of the leaf samples for a small number of Centres. Where this was reported it was possible to take into account the difficulties such that candidates did not suffer. In all cases, Supervisors were cooperative in completing their own set of results. These are invaluable to the Examiners and help greatly in ensuring the candidates are treated sympathetically. There was no apparent shortage of time.

Comments on specific questions

Question 1

The standard of drawings was disappointing. Many were too small and inadequately labelled. Some were not labelled at all. Candidates should be encouraged to come prepared with sharp pencils and take some care with any drawings they are asked to make. A small number made drawings of the whole leaf rather than the leaf section cut from the specimen provided. In some cases the results suggested that the two specimens had become interchanged. Where the original drawings were clearly labelled this did not incur a penalty. Some presumably did not obtain a blue/black colour with either leaf as no mention was made of a blue colour, whilst others reported a dark colour but did not make clear that this was the result of a reaction with iodine. The unchanged iodine is a dark colour! A good number stated the use of Benedict's solution to detect reducing sugars but of these, some forgot to mention that it is necessary to heat the solution. Answers to **(d)(ii)** were mixed. Some thought it was the white parts; others just stated those parts that reacted with the Benedict's solution. Once more it was necessary to include an explanation to obtain the mark. The statement 'green part' required an additional comment such as 'chlorophyll is needed for photosynthesis' to score.

Question 2

Careless recording of the measurement of **h** was very common. Many rounded off the measurement to a whole number, failing to appreciate the importance of the need to record to the nearest millimetre. If 9.5 cm is accurate for one candidate then it should be 10.0 rather than 10 for another. Unless the Examiners were told otherwise, it was assumed that similar cups were given to all candidates and the measurement had to be within 0.4 mm of the Supervisor's value. A few candidates decided to calculate the volume of the cup from its dimensions. This nearly always gave rise to a very silly answer. The volume needed to be within 10 cm^3 of the Supervisor's value. Units caused a problem for a small number when recording the distance **d**. The table clearly indicated the measurement to be in mm. Measured in cm lost a mark. The graphs were usually good although the inevitable few joined up the points. It should be recorded that the correct line would be a curve. However, for simplicity a straight line was asked for and although the reading from the graph was not exactly the volume of the cup it is sufficiently close for the purposes of this experiment. Those who failed to read through the question were caught out by the need to extrapolate and were unable to read the value for **d** = 0. Unless a sensible attempt was made, these candidates inevitably lost two marks. A few were sharp enough to guess that it would be the volume of the cup and simply repeated the number recorded in part **(a)**.

Question 3

Despite the instruction to heat strongly, almost all failed to heat strongly enough. Solid **A** decomposes on strong heating to show charring and the production of an inflammable gas. There is sufficient of the latter to produce a flame at the mouth of the tube. Very few candidates recorded a black solid and almost none observed the inflammable gas. 'Test any gas with a lighted spill' should be interpreted as test when it is clear that a gas is being evolved or test more than once during the heating. Solids decompose at different temperatures and unless testing for a gas is done at the right moment, it can be missed. Hence test at various stages of heating. Part **(b)** was more successful and many correctly recorded that the splint was extinguished. No reaction was not accepted. The solution of **A** is weakly acidic and the colour of the pH paper indicates about pH 3- 4. Values between 1 and 4 were accepted. Although it was hoped candidates would conclude a weak acid, few did and so the word acid scored the mark. Most observed the effervescence when the two solids were placed together with water. Some may not have turned the page to answer the last part of the question, as there were many blanks. Clearly some may not have known what to do. Any brief description indicating that the two solids would be mixed together, water added and the resulting gas collected in a suitable measuring device. The latter could have been an upturned measuring cylinder in water or direct collection in a syringe. A reasonable diagram was required to score two of the three marks.

Paper 0653/06
Alternative to Practical

General comments

As usual, some candidates reached a very commendable standard in this examination, but many entrants showed that they had a lack of experience in laboratory work. The Examiners always try to ensure that the wording of the questions is simple and that sentence construction is not complex. In spite of this, too many candidates seemed to find the descriptions of the experiments very hard to understand; coupled to their ignorance of laboratory apparatus and procedures, this meant that their scores were poor. A praiseworthy aspect of the candidates' work was the even spread of the marks gained in the three disciplines, biology, chemistry and physics.

Comments on specific questions

Question 1

The contrast between the starch content of leaves kept in light and dark conditions was the basis of this question.

(a) This was often well done, and neat diagrams of the leaf strips were drawn and labelled. The word "variegated" was sometimes unknown, but this should not have prevented candidates from labelling the areas containing chlorophyll. Occasionally, the whole leaf was drawn, but the correct labelling still earned one mark.

(b) The colours shown by iodine (brown/yellow) and starch with iodine (black/blue) were sometimes unknown. This revealed that the experiment had not been done, or seen, by the candidate.

(c)(i) Leaf A contained no starch, therefore had not been able to photosynthesise and store starch; some candidates added that the starch previously stored had been used up, but this point was not necessary to earn the two marks.

(ii) Areas containing starch, and the green areas shown in Fig. 1.1, were identical. This earned one mark. The second mark was gained by the candidate who mentioned that chlorophyll enables starch formation to proceed. No details of the function of chlorophyll were required; this was often not known and a minority of candidates wrote that chlorophyll was formed by the action of sunlight.

Question 2

The meter reading and graph plotting in this question was deliberately kept simple, in contrast to **Question 6** where a much harder graph plotting exercise was set. The question explored the change in current passing through a lamp as the resistance of the circuit was lowered.

(a) Most candidates achieved all three marks in reading the ammeter and voltmeter dials.

(b) The graph was already shown with the labelling and scales of the axes. Most candidates successfully plotted the two points on the graph and drew a line: the Examiners allowed either a curved line plotted through the points, or a "best straight line" to be drawn. No penalty was incurred if the line did not pass through the origin, but the shape of the line affected the answers to and the marking of part **(d)**.

(c)(i) The idea of electrical resistance is a difficult one, so it is not surprising that a large proportion of candidates incorrectly wrote that the brightness of the bulb decreased when the resistance was decreased. Others correctly stated that the current would increase when the resistance is lowered but failed to answer the question.

(ii) Experience of using a low voltage electrical circuit almost inevitably includes the "blowing" of the bulb when too great a current is passed. Some candidates also suggested that a fuse in the circuit might have melted, which was accepted as an answer here, but most candidates did not realise what could interrupt the flow of electricity through the circuit. Some, having wrongly answered the first question, wrote that the resistance was now so high that no current can flow.

(d) Ohm's Law can be illustrated in the laboratory by the drawing of a graph of **V** against **I** to show that it is a straight line through the origin. If the candidate drew a straight line for **(b)**, the answer that the bulb obeyed Ohm's Law, because the graph was a straight line, was accepted. Just a few candidates knew that the resistance of a conductor increases with temperature, so the bulb does not obey the Law, but this information was not necessary to gain the mark. Various relationships were stated for current, voltage and resistance. The words "inversely proportional" were used for current and voltage, and the words "proportional" with resistance and current, showing that these concepts are poorly understood both in a mathematical and in a physics context.

Question 3

This question took the candidates through the process of preparing a salt using a metal and acid, but with some complications so that a quantitative exercise was involved.

(a) The scales were to be read ascending, but alas, a few candidates read the balance windows in the question the wrong way up. As well as this, the first decimal place was expected to be included in the mass of the beaker and copper, so that it was 60.0 g not merely 60 g.

(b) Some candidates wrote about the "pH" of the gas being lower than 7, but the Examiners wanted the change in colour of litmus paper from blue to red, or of Universal Indicator paper to red, as the experimental observation showing that a gas is acid. Answers describing bubbling the gas through indicator were accepted if the correct colour change was mentioned.

(c) This was a hard mark, for the balance reading had to be correct and then a subtraction made from the mass of the beaker + copper at first, to find the mass of the copper, 3.2 g, that had been used up. A commendable proportion of candidates achieved this mark. If this mass was worked out, then used in a further incorrect calculation, the mark was awarded.

(d) Some candidates incorrectly interpreted the information that "copper(II) nitrate crystals decompose if they are heated" to mean that the solution could not be evaporated by boiling it. However, they could obtain one of the two marks by suggesting that leaving in sunlight or in the air would evaporate the solution. There were some good descriptions of the usual way to obtain crystals of a salt by partial evaporation and then cooling, and some better candidates wrote about the use of a boiling water bath. The poorer candidates described filtering to remove crystals from the solution.

(e) This last weighing was rather more straightforward, and many candidates earned the two marks, finding that 9.5 g of copper nitrate crystals had been formed.

(f) The student making the copper(II) nitrate crystals would not have achieved a good yield if the advice of many candidates had been followed! However, the question dropped heavy hints about possible reasons for a low yield, such as decomposition of the salt due to heating during crystallisation and the loss of some of the water of crystallisation. A few candidates also mentioned that the student might have spilled the solution. Just a handful also pointed out that some of the copper nitrate was left in the solution after crystals had been obtained. The idea that crystals contain water of crystallisation was often poorly understood, and some candidates wrote that the crystals might have evaporated.

Question 4

The combustion of a foodstuff in air was used to simulate the release of energy during respiration. Many candidates gained high marks for this question.

(a) Candidates read the balance windows with no difficulty here, in contrast to the frequent errors in similar parts of **Question 3**.

(b) Here, some candidates interpreted each division in the thermometer scale as 0.1°C, writing 40.2°C and 30.7°C for the temperatures. This was the most common error in this question.

(c)(i) The temperature rise was marked with errors carried forward, so that the marks were earned for the subtraction of 25° from the answers to **(b)**.

(ii) Common errors in substitution into the given formula for calculating heat energy given out were: the use of 1g as the divisor rather than the 0.8g and 0.5 g from **(a)**; and the use of the actual temperatures rather than the temperature rise. A majority of candidates were able to write J or Joules as the unit. A few gave kJ as the unit, but omitted to divide by 1000.

(d) The correct answer, "respiration", was given by most candidates.

Question 5

This is the question about analytical chemistry that usually forms part of this examination; as usual, there was ignorance of these very basic procedures to test for gases, acid and alkali. The number of candidates scoring full marks in this question was very low.

(a) *Test 1*. What does limewater look like? Of course, some candidates wrote, it is yellow! This question caught out many candidates. Clear or transparent were accepted as correct descriptions.

In *Test 2*, "the flame was extinguished" was a signal to some candidates that hydrogen was present, since when hydrogen is burned by using a lighted splint, the flame goes out with a Pop! Candidates must ensure that the description of the test for hydrogen, mentioned above, is properly understood. When a gas does not support combustion, the presence of nitrogen or carbon dioxide is a possible conclusion; the absence of oxygen is another.

Test 3. Examiners were reminded that in a few countries, a Universal Indicator that does not conform to the colour changes of the BDH Universal Indicator is used. An effort was made to ensure that candidates who were familiar with this product were not penalised. In *Test 4*, only the final colour of the indicator, yellow or green-yellow, was marked.

(b) Most successful candidates drew diagrams of a vessel having a delivery tube leading either to a graduated syringe or to a graduated tube collecting gas over water. Many fanciful diagrams were drawn in poorer answers. Candidates who had never seen an experiment in which gas is collected over water or in a syringe failed to gain marks here.

Question 6

This question, like **Question 5**, corresponded to the question in the Practical Examination, Paper 5. The candidates were invited to find the volume of a drinking cup in cm^3 and then to add a measured number of grams of water to it, while it stood in water, until it sank. The two amounts should be approximately equal if the mass of the drinking cup is ignored, thus illustrating a statement shown at the beginning of the question, that "when the mass in g of a vessel placed in water is just greater than its volume in cm^3 it will sink."

(a) A dropper or pipette or even a burette can be used to place the final few drops of water in the full cup. A diagram, however poor, of a teat pipette, earned the mark. There were references to puppets here!

(b) A simple subtraction of the volume remaining in a measuring cylinder, from its full volume, gives the capacity of the cup, 147 cm^3. Some candidates gave the volume remaining as 100.3 cm^3. Others did not know what to do with this figure to find the volume held by the cup.

(c) A millimetre ruler is used to find, from a full-size diagram, the height of the cup standing out of the water after measured amounts of water have been added. Instead of using the ruler, some candidates guessed these heights; others tried to find them, more or less successfully, from the graph in part **(d)**.

(d)(i) The graph grid was shown with no labelling. The terms "horizontal" and "vertical", as in previous years, were often not known. In the table of data, Fig. 6.3, the volumes were given in the first column, so many candidates automatically plotted these on the vertical axis in contravention of the instruction. This meant that the extension of the graph to cut the horizontal axis did not show the volume in the cup at **h** = 0. There were some poorly drawn graphs. The vertical scale sometimes went up in increments of 6 or 4, which made plotting harder. Occasionally, the horizontal scale chosen did not allow for the extension of the line to the axis. Some candidates, having measured (or guessed) the answers to part **(c)**, found that the graph did not follow a straight line, but they did not bother to check their answers.

(ii) The expected answer for the volume in the cup at **h** = 0 was 147 cm^3, the same as the answer to **(b)**, but the mark was awarded for the correct reading from the candidate's graph.

(iii) The cup sank when **h** = 0, an easy answer.

(e) This was probably the hardest question in the paper. Candidates had to compare the mass in the cup when it sank, taken from the graph, with the volume of the cup. The expected answer was that the two are identical at 147 cm^3, so the statement at the head of the question is correct. However, if they were not identical, the candidate could earn the mark by pointing out this fact. A very few candidates did gain this mark.