COMBINED SCIENCE

Paper 0653/01
Multiple Choice

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

General comments on whole paper

The mean score on this paper was only 46%, which is even less than the low figure on the last paper. The questions are no more testing than before, and are all questions which are likely to appear on equivalent single-subject papers.

Comments on individual questions (Biology)

Question 1

Perhaps candidates were deceived by the fact that the question was phrased in the negative, though the *absence* of a nucleus is usually well-known as a feature of red blood cells. To arrive at the correct answer, candidates had to link the absence of a nucleus with the absence of DNA which was clearly one step too far for all but the best.

Question 3

This question examined an area of the syllabus that should have been familiar to all candidates. However, there was wholesale guess-work evident with even some of the otherwise competent candidates suggesting that hydrogen is released when catalase is added to hydrogen peroxide.

Question 4

The clues were in the phrase 'plant is exposed to sunlight'. This should have suggested that the question was to do with photosynthesis, but a quarter of the candidates opted for the answer that suggested that oxygen is released as a result of respiration.

Question 6

This relatively standard piece of apparatus succeeded in confusing even a few able candidates. For anyone unfamiliar with its use, then some logical thought was necessary in order to arrive at the correct answer. A few candidates may not have given themselves enough time to sort out the problem.

Question 12

Well over a half of the candidates did not appreciate that that identical twins would have identical genes, and thus genes could not be responsible for the weight difference. However, the question did particularly well at differentiating between candidates of varying abilities.

Comments on individual questions (Chemistry)

Question 14

Many of the lower-scoring candidates appear to have been guessing: indeed, the key (D) was the least popular choice for such candidates. It seems very difficult to persuade candidates that copper is an unreactve metal.

Question 16

This Question was intended to test straightforward recall of a topic explicit in the syllabus. It is disappointing, therefore, that over 50% of the lower-scoring candidates chose response **A**.

Question 17

May be an example of insufficiently careful reading of the Question by the lower-scoring candidates. Responses **A** and **C** were roughly equal in popularity and together attracted nearly 70% of these candidates. The Question referred to the complete combustion of methane and in such circumstances hydrogen is not a product.

Question 18

Response **B** was the most popular choice of the lower-scoring candidates - but relatively high m.p. is a characteristic of transition metals.

Question 19

Another Question that was found particularly demanding by the lower-scoring candidates, some 40% of whom chose response **B**. This suggests that they merely saw O_2 in the lead 'formula' and O_2 in the carbon dioxide without considering the stoichiometry in the equation.

Question 20

As in **Question 19**, response **B** was the most popular choice with the lower-scoring candidates. They ought to have 'eliminated' hydrogen because it is monovalent and only combines with one other atom, not two as shown in the third diagram.

Question 22

In this Question, the lower-scoring candidates strongly favoured response **A** with the key (**D**) being their least favourite choice. This implies some confusion about oxidation and reduction in extracting a metal from its oxide.

Question 25

Although intended as a test of recall of topics explicit in the syllabus, response **B** was unduly popular across the ability range.

Question 26

A third of the lower-scoring candidates chose the key (**C**) but other such candidates appear merely to have guessed between the other three responses.

Comments on individual questions (Physics)

There were just two questions which large numbers of candidates answered correctly (facility greater than 70%). These were **Questions 34** and **38**. Questions which had a particularly low facility (i.e. a low proportion of candidates answering correctly) were **Questions 30**, **36** and **40**. Very few of the remaining Physics questions had a facility above 50%. The following comments about individual questions might prove to be instructive.

In **Question 28**, all that was required was to multiply the area by the depth of water. Nearly half clearly thought that the question was asking about the total volume of the tubes. The majority of candidates did not read **Question 30** carefully, and assumed that it was about mass and weight, instead of force and weight. Consequently, all but 18% chose options which included both N and kg. This is a silly way to lose marks. Over one-third answered **D** for **Question 31**, which was the density of water, not meths. Questions like that in **Question 33** have been asked so many times on Physics papers that it is hard to believe that anybody could answer incorrectly. In this instance, less than half answered correctly, with almost as many mistakenly thinking that the person had kinetic energy when she was standing at the top of the stairs.

In **Question 35**, a large proportion chose **B**, a statement relating to conduction.

It should not be difficult to work out which pair of values of *I* and *R* in **Question 36** multiply to give 3.0 V; only 32% could manage this. In **Question 37**, lots of candidates seem to have confused the properties of components in parallel and components in series. It was pleasing to see such a large proportion of candidates answering a question about electrical safety correctly (**Question 38**). On the other hand, it was disappointing to see evidence of wide-scale guessing in **Question 40**. Absorption of radiation by paper is usually well understood.

COMBINED SCIENCE

Paper 0653/02

Core Theory

General comments

As usual for this limited grade paper, the candidates generally found the content to be challenging. Some high marks were seen, suggesting that these candidates may have done well in the Extended Paper 3. In this paper overall, the three sciences seemed to provide challenge in equal measure although there was some evidence that while candidates were generally prepared to attempt biology questions, failure to attempt questions is more common in the physical sciences. Many candidates tended to lose marks through poor examination technique. A common problem was that weaker candidates tended to answer questions without reference to any science. There was some evidence that weaker candidates found it difficult to complete the paper in the allotted time.

Comments on specific questions

Question 1

(a) The majority of candidates correctly identified **C**.

(b) This question was generally well answered by candidates across the ability range, with many scoring full marks. Candidates needed to make sure that their labelling line for the partially permeable membrane clearly indicated the cell membrane and not the cell wall.

(c) The majority of candidates had learned how to test for starch, and most scored at least two marks for knowing the use of iodine and the resulting colour change. Several other points covering practical details of the test could have secured the third mark. A significant number of candidates described destarching prior to the starch test. This was not penalised.

(d) This question discriminated very well. The most common mistake was to suggest that the plant shown would reproduce asexually. In general there was evidence that plant structure had been learned well by the majority of candidates.

Question 2

(a)(i) The question asked candidates to show what happened only to cooled air, and so they should only have drawn arrows to show cooled air descending from the freezing compartment of the refrigerator. If a candidate drew the full convection cycle they were penalised unless they labelled which part of the cycle represented cooled air. Many candidates drew arrows outside the refrigerator.

(ii) Even when a convection cycle had been drawn in part **(i)** many candidates failed to write the correct answer in part **(ii)**. Many other incorrect terms in addition to conduction were suggested.

(iii) Generally candidates were not able to express the idea that cooled air would have a higher density and would therefore descend inside the refrigerator. The idea that cooled air would be heavy without reference to density was not credited.

(b) Candidates tended to score both marks for this question, and there was much evidence that this type of calculation was familiar to the majority right across the ability range. Candidates are getting much better at giving proper formulae. In this type of question the formula must contain an equals sign and be expressed using either correct words or symbols. Very few candidates lost the formula mark this year by giving the triangular mnemonic. The required answer was 6000 (Ω)

(c) This proved one of the most difficult questions on the paper for most candidates, and the award of full marks was therefore extremely rare. Lengthy paragraphs were seen which scored no marks because candidates gave little relevant science in their answer. Only a small minority correctly described the function of the aluminium foil as a reflector of radiant heat, but very many grouped it together with the expanded polystyrene as a good insulator. Many candidates discussed the structure of the walls preventing heat from escaping from inside the refrigerator rather than preventing heat from entering. Virtually no candidates discussed the expanded polystyrene preventing heat passing into the refrigerator by reduction of either conduction or convection.

Question 3

(a) Although a majority of candidates gave the correct answer, a surprising number gave a variety of incorrect suggestions. This type of question is relatively common and it is hoped that in future years greater numbers of candidates will learn what is shown in a chemical formula.

(b)(i) Most candidates had learned the role of catalysts although weaker candidates tended to leave this question unanswered.

(ii) About half of the candidates correctly identified manganese as a transition metal.

(c)(i) Many candidates correctly suggested covalent, hopefully having picked up the clue in the question stem.

(ii) In this question candidates generally did quite well and drew a correct displayed formula showing the double bond. Some stronger candidates gave correct dot and cross diagrams which were credited despite this technically being a rubric infringement.

(iii) A pleasing number of candidates were able to balance the equation. Some candidates showed no familiarity at all with the concept of balancing equations and wrote chemical symbols or other ideas in the two spaces indicated.

Question 4

(a) The required answer was respiration and the most common incorrect suggestions were transpiration and pollution. Candidates tended not to score this mark.

(b) A common misconception revealed by some of the responses to this question was that living organisms take in oxygen and give out carbon dioxide but when dead they only give out carbon dioxide. Candidates were required to describe of the role of decomposers and to explain that carbon dioxide was the result of their respiration.

(c) There were many possible marking points which would give candidates the available two marks. Most candidates had learned that fossil fuels originate from living organisms and could describe essential processes and conditions which lead to fossil fuel formation.

(d)(i) The required answer here was the burning of fossil fuels or other named fuels which produce carbon dioxide. Deforestation was not accepted, and neither were unqualified references to *driving cars* or *pollution from factories*.

(ii) It was clear that the majority of candidates recognised how the graph could be used to show that factors other than human activity could cause increases in carbon dioxide levels. However, they found it difficult to express their ideas. They needed to imply that high levels of carbon dioxide existed at a time before there was much, if any, human activity.

(iii) Candidates were expected to discuss global warming and at least one specific negative consequence. References to the greenhouse effect were only credited if it was clearly stated that this vital natural phenomenon might go out of control. Large numbers of candidates confused global warming with ozone depletion and a significant number of mainly weaker candidates suggested that increased carbon dioxide would eventually lead to suffocation of humans.

Question 5

(a)(i) Candidates generally scored marks on this question although it was less common to see a correct identification of force $\mathbf{F_2}$, for which the answers air resistance or friction were expected. It was noticeable that large numbers of weaker candidates simply suggested the terms push and pull.

(ii) Even if candidates did not identify one or other of the forces in part **(i)**, they very often correctly stated in part **(ii)** that $\mathbf{F_1}$ must be greater than $\mathbf{F_2}$. The most common mistake was to suggest that the forces were balanced.

(b) The majority of candidates scored both marks for this calculation. Candidates are getting much better at giving proper formulae. In this type of question the formula must contain an equals sign and be expressed using either correct words or symbols. Very few candidates lost the formula mark this year by giving the triangular mnemonic. The answer required was 5000 (km/h).

(c)(i) and **(ii)**
These questions were answered correctly by a large number of candidates. The most common mistake was, as might be expected, the confusion of mass and weight between both parts of the question. Some candidates lost marks by attempting to illustrate the difference between weight on the Earth and the moon by quoting masses in kilograms.

(d) The only sensible answers to this question were solar energy or sunlight. An enormous number of impossible answers which would have been correct if on the Earth suggested that many candidates had jumped to a hasty decision about what the question was asking.

Question 6

(a) In their answers candidates had to show clearly that they understood that the heat energy was the result of the reaction. The simple statement that the reaction is exothermic secured the mark. It was not sufficient for candidates to offer statements such as *because of the flames*. Generally, only the better candidates could express the concept clearly enough.

(b)(i) Candidates had to explain that the formula showed a 2:1 ratio of potassium to oxygen particles. A degree of flexibility was allowed in terms of the vocabulary candidates used to explain the concept. Many technically correct statements that the formula shows potassium has joined with oxygen were seen, but with only one mark available these were not credited.

(ii) Many candidates correctly answered this question in terms of numbers of protons and electrons, but some introduced neutrons, and weaker candidates suggested that atoms contained equal numbers of positive and negative ions. There was much evidence that the concepts of positive and negative electrical charge were well known and that equal measures produce electrical neutrality.

(c) This part of the syllabus was reasonably well known by many candidates who consequently scored both marks. The two parts of the answer were marked separately and no error carried forward was allowed.

(d)(i) The general response to this question was very poor. There are very few chemical formulae in this syllabus which candidates are expected to recall, and it is hoped that candidates would have been advised to learn them.

(ii) The response to this question was not as good as had been expected. Even if candidates failed to identify hydrogen as the gas produced, they could still gain up to two marks for a correct description of the test for the gas they had named.

Question 7

(a)(i) This was answered correctly by almost all of the candidates.

(ii) The pattern which candidates needed to describe was the simple one that the higher the incidence of HIV/AIDS the higher the incidence of TB. Several candidates from across the ability range suggested answers based on socio-economic factors which are always going to be a most unlikely source of marks. In questions like this one, marks are gained solely by describing patterns shown in the data. The question was generally well answered.

(iii) This proved to be a very challenging question for all but the strongest candidates. In order to score both marks, candidates needed to describe the weakening of the immune system which then meant that the TB bacterium could not be destroyed. The second mark required reference to the TB bacterium rather than just TB.

(b) This was also a challenging question with only a small minority gaining both marks. Candidates needed to describe how TB would greatly reduce the amount of oxygen taken in to the body and that this would then adversely affect respiration. Many candidates wrote lengthy answers describing how TB would reduce the ability to breathe.

(c)(i) In general, candidates were very knowledgeable about STDs and the majority scored both marks. A common way that candidates lost a mark was to offer the term STD as an answer.

(ii) It is greatly encouraging to be able to report that the vast majority of candidates knew that the use of condoms is the effective way of reducing the spread of these diseases. Other acceptable answers included references to abstinence from intercourse, remaining faithful to one partner and the use of antibiotics. A general reference to the use of contraceptive methods does not gain the mark.

Question 8

(a) In general this was not well answered and only a minority of candidates scored full marks. The ray diagram had to be carefully drawn and many candidates lost marks simply because of carelessness. Some candidates attempted to draw several rays which greatly confused their answer. There needed to be a ray from the tooth to the mirror and then a second ray, touching the first on the mirror, to the eye. The angle of reflection needed to be sensible and finally the rays needed to carry directional arrows. There were a great many incorrect versions of the diagram some of which showed rays which were nowhere near either the tooth or the eye.

(b)(i) The frequency limits of human hearing were very poorly known, and many candidates failed to gain any marks.

(ii) Similarly, most candidates could not express the meaning of frequency of a sound wave. Some did state that frequency was the number of waves in a given unit of time, but the use of the Hz symbol in part **(i)** implied that the answer should restrict the unit of time to one second.

(iii) Generally candidates could identify two forms of energy and most scored the mark. A common way to lose this mark was to suggest an energy source rather than a form of energy. Consequently terms such as *wind, wave, tidal* were not credited.

(c)(i) Many candidates knew that the problem with the circuit lay with the battery, but they needed to be more careful about the way they expressed their answer. It was not sufficient to say simply that *the battery was the wrong way round.* They had to make it clear that <u>one</u> of the cells was facing the wrong way. Stronger candidates successfully did this. Many candidates from across the ability range were distracted by the open switch and/or its position and others suggested that the circuit would not work because it did not contain either an ammeter or voltmeter or both.

(ii) Even if they had not secured the mark from **(i)** many candidates were able to redraw a corrected version of the circuit. It was accepted if candidates simply left out the second cell.

Question 9

(a)(i) and **(ii)**

These marks were scored by the majority of candidates and there was no particular pattern to incorrect responses.

(b) Candidates usually scored one to two marks on this question, referring correctly to the greater strength of the alloy, its resistance to corrosion (rusting was not accepted) and its low density. It was less common for marks to be awarded for sensible reasons why these properties are particularly useful in materials used for aircraft construction. Vague references such as *it helps the plane fly better* were not credited. Acceptable answers included references to fuel economy and resistance to stresses in flight, although some candidates discussed resistance to the great pressure from the atmosphere at high altitude which unfortunately could not be credited.

(c)(i) About half the candidates were able to answer this question. Many stated that iron had been reduced and then went on to identify correctly that in fact it was iron oxide which had lost oxygen. Depending on the actual wording, some of these candidates were credited with both marks. Just about every other possible combination of suggestions about what had been reduced and why were seen from candidates who had not learned this part of the syllabus well.

(ii) Most candidates scored one or two marks on this question. Common suggestions which did not score marks included that steel is *harder, cheaper, more easily bent* (which was considered too vague), *has a higher melting point*.

(d) About half the candidates scored this mark although many did not attempt to answer. The most common incorrect answer was to write the full symbol for a chlorine atom showing atomic and mass numbers.

COMBINED SCIENCE

Paper 0653/03
Extended Theory

General comments

The majority of candidates performed at the standard to which this extension paper was aimed. However, there was a significant minority for whom this level of demand was inappropriate. Some candidates occasionally had difficulty in interpreting questions or expressing their answers, but in general the use of English was good. Poor handwriting, however, did cause some problems for examiners.

Candidates are advised that, if they wish to change an answer, it is best to cross out the original one and write a new one, rather than trying to overwrite the original. This is particularly important for diagrams, where it is not always easy to interpret what the candidate wishes to be marked, and what has been crossed out.

It is important that candidates realise that, where a formula is asked for, this needs to be complete. For example, "V = IR" would be credited, while just "IR" would not. They also need to remember that units are always required with a numerical answer.

Comments on specific questions

Question 1

(a) This was usually answered correctly, although a surprising number of candidates gave the answer five.

(b) Approximately half of all answers to this question were correct. The most frequent error was to show two oxygen atoms and one hydrogen. Where a candidate realised that there were two shared pairs of electrons, the rest generally fell correctly into place. Several candidates left the examiner with an answer that was almost impossible to read, because of much crossing out.

(c)(i) Most answers correctly gave experiment **C** as having the highest reaction rate, but correct explanations did not always follow. The expected answer was that this was the experiment in which the same volume of oxygen was collected in the shortest time.

(ii) Most candidates got at least one mark here, for mentioning temperature or surface area of the manganese dioxide. However, they did not always go on to link this appropriately to a change in rate – for example, by saying that an increase in temperature would result in an increase in rate. Even fewer then explained this in terms of frequency or strength of collisions between particles. Some wrongly used the term 'heat' instead of 'temperature'.

Question 2

(a)(i) Not all candidates fully realised that they had been asked to show what happened to the *cooled* air, and drew a circulating convection current. This was accepted as long as the cold air was correctly labelled.

(ii) This was usually answered well, although some answers suggested that individual *particles* became more dense when they were cooled.

(b)(i) This was often answered correctly, but many candidates divided by 60 only once, arriving at an answer of 6000 joules instead of 100.

(ii) The concept of power appears not to be well understood. Better candidates simply brought forward their answer from **(b)(i)** (which was accepted even if **(b)(i)** had been incorrect), but several attempted long and complex calculations. A few thought that the question was asking for the source of power, and stated 'electricity'.

(c)(i) This was mostly answered well, although some candidates did not write a full or correct formula relating resistance to voltage and current.

(ii) Many candidates struggled with this. They did not all know a formula for adding parallel resistances, and even those who did often could not add the fractions. Even when all else was correct, they often forgot that what they had calculated was 1/R, not R. Many simply added the two values.

Question 3

(a) Most answers were correct.

(b) Almost all labelled **Q** correctly, but fewer were able to label **P** and even fewer **R**. In many cases, it was not absolutely clear where the label line was intended to indicate. This was especially important with **P**, where examiners were not always certain whether the line was meant to end within the cell wall or at the cell surface membrane.

(c) This part of the syllabus appeared to be unfamiliar to a significant minority of candidates. Many incorrectly suggested that boiling is done to 'kill the cells' or to extract chlorophyll.

(d)(i) Most identified the flower as being insect pollinated, but not all were able to give a suitable explanation. The most common correct answers were that the flower has large petals, or that the anther or stigma is enclosed within the petals.

(ii) This question brought to light some confusion amongst some candidates about the differences between asexual and sexual reproduction. However, a pleasing number recognised that this is an example of sexual reproduction, because gametes and fertilisation are involved – even though there is only one parent.

(iii) Only the better candidates mentioned that the new plants would be genetically identical, or that there would be no variation between them and the parent plant, or between each other. Many incorrectly suggested that it would be faster (which is often not true).

Question 4

(a) This was generally well answered, usually with the statement that the reaction is exothermic. References to the flame were not enough unless there was also a mention of heat production.

(b) This question discriminated well. Most candidates got at least one mark, but it was rare to give full marks. Some answers confused covalent and ionic bonding. However, the loss of an electron from potassium and the acceptance of two by oxygen was often well described. Relatively few candidates, however, mentioned the attraction between the negative and positive ions, which is a crucial feature of ionic bonding. Several candidates wrote very lengthy answers that went well beyond the space allocated. They should be strongly advised to try to keep their answer within the answer lines; if they must write elsewhere, then it is very important to indicate clearly where the rest of their answer can be found.

(c)(i) This, too, discriminated well. Most recognised that the equation is not balanced, but were often not able to explain why. Answers often stated that 'there are not the same number of atoms in the reactants and the products', without making clear that it is the numbers of *each type* of atom that must be the same. Many apparently forgot to provide the correctly balanced equation.

(ii) Most answers were clear and correct, although there was some confusion with the test for hydrogen.

(iii) This proved difficult, and only a minority gave a correct response.

Question 5

(a)(i) The forces were usually named correctly, although some got them the wrong way round and some gave 'drag' instead of air resistance or friction.

(ii) Most candidates recognised that this force will increase.

(iii) This was usually well answered, although some suggested that as the forces became equal and opposite the tank would stop moving.

(b) Almost all candidates answered this correctly. Some made things unnecessarily difficult for themselves by trying to convert kilometres per hour to metres per second.

(c)(i) Although this was generally correct, a surprising number of candidates thought that mass would be less on the Moon.

(ii) Many wrote 'it is less' or 'it is more', without making clear whether 'it' referred to weight on the Moon or on Earth. In general, the word 'it' needs to be used with great caution in examination answers.

Question 6

(a) Quite a few candidates gave the answer 'white blood cells' to **(i)** and could then only think of 'red blood cells' to answer **(ii)**. However, there were many correct answers to both parts.

(b)(i) Not all candidates appreciated that a high incidence of HIV/AIDS occurs in the same areas as a high incidence of TB. Some tried to link the percentage of one of the diseases to the geographical position of a part of the world, or to whether countries were developed or developing.

(ii) There were some good answers to this. However, many wrote about the white blood cells not being able to 'attack the TB', rather than the bacterium that causes it. Some thought that TB is caused by a virus, apparently missing the information in the first line of the question.

(c) Again, there were some good answers, but also many that fell short. Weaker candidates often gave vague descriptions of 'the body' learning how to deal with TB. Some seemed to think that the vaccination would directly kill any TB bacteria in the body.

Question 7

(a) Most answers to **(i)** and **(ii)** were correct.

(b) Very few candidates appeared to understand the concept of displacement reactions. The word 'bromide' was often used instead of 'bromine'. Many thought that sodium chloride gave the orange colour.

(c)(i) Candidates who described reduction in terms of loss of oxygen generally had no difficulty here, but those who tried to use the concept of oxidation number, or even the gain or loss of electrons, were more likely to get into trouble.

(ii) Surprisingly, very few candidates were able to calculate the relative formula mass.

Question 8

(a)(i) Most answered this well, but there were also many incorrect responses. The most common error was to show the light rays travelling *from* the eye. Some did not show the ray reflecting from the mirror.

(ii) This was generally answered well, and full marks were often given. However, some got the formula upside down, stating that you would divide volume by mass. Others gave detailed descriptions of measuring volume by displacement but then said that the value obtained was the density of the object.

(b) This question proved more difficult than expected. Answers to **(i)** often suffered from lack of clarity, for example just stating that the 'battery is wrong' or that 'the battery is not connected properly'. Diagrams for **(ii)** sometimes showed only one cell.

Question 9

(a) Most candidates correctly identified the process as respiration.

(b) Most answers correctly mentioned decomposition, and some gained a second mark by explaining that the decomposers respire, or by mentioning an example of a decomposer, such as bacteria or fungi.

(c) This was generally well answered.

(d)(i) The most frequent correct suggestion was that sulphur was removed from fuels.

(ii) There were some good answers to this, with better candidates suggesting that not all cars were fitted with catalysts (perhaps because there were still many older cars on the road, or because not everyone could afford a catalytic converter), and that the catalytic converters do not convert absolutely all of the nitrogen oxides to nitrogen. Some did not read the question carefully and suggested that there might be nitrogen oxides emitted from other sources, such as factories or trucks.

(iii) This was surprisingly poorly answered. Many candidates did not mention acid rain, and even those who did seemed to have little idea about its effects on living organisms. Far too many candidates wrote about the ozone layer or global warming.

COMBINED SCIENCE

Paper 0653/04

Coursework

General comments

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

Only one Centre submitted coursework for the November examination.

The tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates work was comparable with previous years.

(b) *Teacher's application of assessment criteria*.

The assessment criteria were understood and applied well for all of their activities.

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

The scripts had some annotation at the point where the mark was awarded.

(d) *Good practice*.

Very useful comments about individual candidate's performance were made on the summary sheet.

COMBINED SCIENCE

Paper 0653/05

Practical Test

General comments

The paper proved slightly easier than last year and many candidates scored well. Most supervisors once again played their part and made helpful comments where individual difficulties were concerned. However, it must be stated that it is vital that the instructions are read very carefully to avoid penalising candidates. It is too late to discover after the examination that one or more of the reagents did not work. Equally to forget to inform the candidates of the value of the resistance of the wire in **Question 2** did make for some difficulty. One Centre recorded a value for the resistance of 10^{-6} of an ohm!

Comments on specific questions

Question 1

Although not difficult to draw, many candidates made very small drawings of the raisins. Many were little more than small circles in the centre of the box provided. Many candidates were far from clear about osmosis and described the movement of the sugar solution into raisin **A**.

The results of the tests in part **(b)** varied greatly. A minority did not record the colour as instructed, but wrote 'no reaction'. The colours varied greatly suggesting some unfamiliarity with the reagents. It is difficult to see how any of the solutions could be colourless yet a good number thought so. The majority were able to correctly deduce sample **F** and **G** for the last part, even though the colours recorded previously did not actually fit. Despite this, many candidates scored well.

Question 2

This question was well answered and high marks were generally achieved. Surprisingly, a small number of candidates produced strange values for **S**, bearing no relation to that provided by the supervisor. The table was usually completed correctly although, again, a small number could not calculate the resistance correctly. A minority clearly had the ruler the wrong way round. It may be helpful to point out that individual values of current readings were not marked. A mark was awarded for the trend in readings provided they were sensible. Values in excess of two amperes were not awarded the mark.

Graphs were not particularly good, with too many failing to draw a smooth curve. A small number were careless with their scales. Most made the line pass through zero although it is doubtful that many appreciated this as a point. Full marks were awarded to a good number of candidates and showed that careful following of instructions is well rewarded.

Question 3

Part **(a)** was mostly answered correctly although a mark was lost for describing solutions **Y** and **Z** as bases. A mark was frequently lost in part **(b)** for failing to make it clear that the experiment was actually performed. Too many said "if a white precipitate is formed, etc". Some simply described the acid as 'chloride'. A careless mistake. Many answered part **(c)** poorly, due to a failure to distinguish between clear and/or transparent and colourless. The pink solution itself was clear and the statement that it went clear after the addition of **Y** or **Z** is simply poor chemistry. It is very important that candidates do know the difference between clear and colourless. A solution of copper sulphate is clear but certainly not colourless. Failure to notice any bubbles in **(c)(ii)** meant that it was impossible to appreciate the presence of a carbonate. As a consequence many candidates were unable to correctly name the solution **Z**.

COMBINED SCIENCE AND CO-ORDINATED SCIENCES

Papers 0653/06
Alternative to Practical

General comments

The Alternative to Practical paper aims to test candidates' skills in laboratory procedure. A thirteen-point description of the questions can be found on the relevant page of the syllabus. The paper set in November 2007 covers most of the points. To adequately test the whole range of abilities, each of the six questions in the paper contained easy items and also harder ones. As described below, some of the questions included subtly difficult parts that were comprehended and answered only by the most able candidates. Some Centres are to be highly commended for the very good scores awarded to their candidates. The time allocated for the paper seems to have been adequate for the vast majority.

Comments on specific questions

Question 1

This question concerned the passage of water into raisins (dried grapes). The concentration of sugar in a raisin is much higher than in the dilute sugar solution in which it is left overnight, therefore water passes into the raisin by osmosis. Candidates had to record the appearance and mass change of the raisin and then answer questions about the processes by which water passed into it.

(a)(i) It seems that many candidates had not seen a raisin in its uncooked state, so when asked to "describe what has happened to the shape" of a soaked raisin, it did not occur to them that it had simply swollen or increased in size, despite the adjacent diagram of an unsoaked raisin. Others failed to answer the question and described osmosis, when all that was needed was a simple statement about its change of size.

(ii) The balance scales for the masses of the soaked and unsoaked raisins were shown. It was a simple matter to record the masses, but some weak candidates failed to place the decimal point in their answers.

(iii) Subtractions to find the changes in mass were usually correct.

(iv) Now came the much harder question, to explain the change in mass of the soaked raisin "by referring to the concentrations (water potentials) of the raisin cells and the solution in which it was immersed".

The first type of error was to suggest that it was the sugar that had entered the raisin cells. This meant that no marks were gained in this section. Many other candidates confused the concentration of the sugar with the concentration of water. In this case, they could gain all the available marks by saying that water entered the raisin by moving from a high concentration (of water) to a lower concentration, by osmosis. The better candidates pointed out that a low sugar concentration in the solution meant that it had a high "water potential" so that water passed down a concentration gradient into the raisin where the water potential was low.

(v) The unsoaked raisin lost a little mass overnight, so it had lost water by evaporation.

(b) Candidates had to suggest the procedure for finding out which of two sugar solutions is the more concentrated, using a modification of the experiment already described. A few answers described procedures involving the change of length of potato sticks rather than the change of mass of raisins, so these gained no marks. Other candidates assumed that "concentration" referred to water rather than to sugar. Where this happened, as long as the answer was clear, marks were gained. Far too often, candidates said that the raisin gaining more mass indicates that the solution in which it is placed is more, rather than less, concentrated. It was not clear whether they were referring to sugar or water concentration. Teachers need to remind students that the "water potential" of a solution and its "solute concentration" are inversely proportional. It is better not to refer to the "concentration of water" when dealing with this topic.

There was a very wide variation of marks awarded for answers to this question. High marks indicated that students had undertaken a thorough study of osmosis.

Question 2

This question was based on the corresponding question in Paper 5, the Practical paper. Practical candidates had to carry out simple experiments on three solutions. Two of them, solutions **Y** and **Z** were alkaline and one, solution **X**, was acid. Also, the colours of indicator **P** were given in acid and in alkali. Finally they had to show the presence of hydroxide ions in one alkaline solution and carbonate ions in the other.

(a) Given the colours of an indicator in the three solutions, the candidates had to state whether they were alkaline or acid. Candidates who got this wrong had not read the first paragraph where the responses of indicator **P** had been given.

(b) (i), **(ii)** and **(iii)**
This was a slightly different way of asking how to show the presence of sulphate ions in solution. Having stated that a soluble barium salt must be added, giving a white precipitate, the name of an acid containing sulphate ions had to be given. Only the better candidates scored well here.

(c) In this part of the question, candidates had to imagine that the acid, solution **X**, was being added drop by drop to a mixture of indicator **P** and the alkaline solution, **Y**.

(i) The examiners were looking for a clear statement that alkali **Y** was still in excess so that the end-point of the reaction, and the change of colour of **P**, had not been reached. There were many vague answers, including, too often, that "no reaction takes place until enough acid has been added".

(ii) What was the colour change occurring when enough of solution **X** had been added? For many candidates this part of the question was too far away from part **(a)**, so many implausible answers were given.

(iii) Those who had followed the logic of the question were able to state that the reaction was neutralisation.

(d) **Fig. 2.2** gave details of tests **1** and **2** carried out on solutions **Y** and **Z**. From the results, candidates were asked to deduce the names of the solutions. Test **1** showed that solution **Y** could have been sodium hydroxide or aqueous ammonia. Test **2** showed that there was a soluble carbonate present, which could be sodium carbonate. Most candidates suggested that a carbonate was present but failed to name a cation which was necessary for the mark.

Answers to **Question 2** were often very disappointing and showed that many candidates had a poor knowledge and understanding of simple tests for acids and alkalis.

Question 3

This question was based on the physics part of the Practical examination, in which candidates had to record the current flowing along, and calculate the potential drop across lengths of resistance wire. Then they plotted a graph of the potential drop against the length of wire.

(a)(i) Three ammeter readings were shown. The second decimal place of each reading had to be found by interpolation. The second reading was more difficult than the first; many candidates suggested 0.51 A when it was clearly at least 0.52 or 0.53. The third reading was similar.

(ii) The formula for calculating the resistances of the 25 and 60 cm lengths of wire was given. A mark could be gained by correct calculation of one of these resistances.

(iii) Three values of **V**, the potential drop, were calculated from the resistances in ohms and the current in amps. Two marks were allowed for any two correct answers, not one mark as shown on the question paper. Errors were carried forward in marking.

(b) A graph of the potential drop was plotted against the length of the wire. The clear instruction to plot the length of the wire on the horizontal axis was ignored by some candidates who lost a mark. The axes had to be correctly labelled, including at least one of the units (volts or centimetres). There were errors in using consistent increments in the scales. At least four of the five points, correctly plotted, were necessary for the second mark. Then a smooth curve, passing through the origin, had to be drawn for the third mark.

There were many completely correct answers for this demanding part of the question. Whole groups of weaker candidates could not draw a graph, showing failure to cover the necessary mathematics.

(c) Finally, candidates were asked to deduce the shape of the graph when a larger voltage was applied to the circuit. The question asked “explain how you decided this” but no answer lines were provided for the answer, although space was available, so a maximum of one mark was awarded for a line drawn and labelled, above the line drawn in **(b)**. This compensated for the change of marks in part **(a)(iii)**

Question 4

This question was based on the experiment undertaken by candidates for the Practical examination, Paper 5. They had to carry out tests on solutions containing respectively a reducing sugar, albumen, sodium chloride and a yellow dye, as though they were urine samples. The object of the exercise was to correctly identify the “patients” who supplied the urine and their illnesses.

The question required a knowledge of the relevant food tests and tests for ions in solution. Candidates also needed to carefully read and understand the question. Very many weaker candidates did not score any marks at all because of shortcomings in one or both of these essentials.

(a) Candidates had to complete a table to show the colours of the mixtures after the samples had been tested with Benedict’s reagent or by the biuret test. If the colours blue and red (or orange) appeared in the first row of the table, a point was scored; if the colours were in the correct places, the second mark was given. Similar marks were given for the colours blue and lilac (purple) in the second row.

The question demonstrated a lack of experience of food tests.

(b)(i) and **(ii)** The test for aqueous chloride is the addition of silver nitrate. This was more often correctly given, and a white precipitate indicated as the result.

(c) The presence of a fake sample in the set was a control, to ensure that the tests were fair. Another suggestion given was that the volumes of the samples tested was always the same.

Overall, the answers to **Question 4** were most disappointing and show that practical experience in this important aspect of the biology section of the syllabus is often lacking. However, whole sets of candidates answered the question well.

Question 5

This question is based on a familiar experiment, the production of carbon dioxide from pieces of marble and hydrochloric acid. However, there were some subtle twists to the procedure that caught out many candidates. The experiment was carried out at measured temperatures and the time taken to collect a test-tube full of gas noted.

(a)(i) A diagram of the apparatus was shown. The names of two essential pieces of apparatus, the thermometer and the source of heat, missing from the diagram, had to be provided. Most candidates managed to suggest at least one of them, although the name of the scientist Bunsen was often misspelt.

(ii) In the diagram shown, gas was being collected in a test-tube over a trough of liquid. This liquid was not named as water (it could have been a saturated solution of carbon dioxide) so the better candidates who knew that carbon dioxide is somewhat soluble in water may have been confused. The question asks "What must the collection tube be filled with, before the experiment begins?" The answer could have been "the liquid in the trough". This answer was almost never provided. The Examiners were looking for a realisation that the tube must contain a liquid before gas can be trapped in it, so the answer "water" (although in practice one would not collect carbon dioxide over water) was awarded the mark. This was the answer given by most good candidates. Those who had no practical experience of collecting gas over water gave a variety of incorrect answers, including "a vacuum" or the name of a gas such as air, oxygen or nitrogen.

(iii) Far too many gave "hydrogen" as the answer here.

(b) Two digital clocks were shown, displaying two missing times for the evolution of a test-tube of gas. The times had to be recorded as seconds. A few candidates could not translate 02:05 into seconds.

(c) One change to the method, to give a more accurate result, was asked for. Measurement of the volume of acid and the mass of marble, or the use of a gas syringe to collect the gas, were the most frequent correct answers. At least one candidate suggested collecting the gas over oil. (See **(a)(ii)** above). "Repeat the experiment and find the average times" also earned a mark.

(d) The time taken to fill a tube of gas decreased as the temperature of the acid was raised, and this misled some candidates into thinking that the reaction rate slowed down. Candidates had to show that the time decrease meant a faster rate of reaction. Some candidates stated that "the time taken was faster" at high temperatures, an answer which makes no sense.

(e) Finally, an explanation of **(d)** in terms of the higher kinetic energy, increased speed of movement or greater collision frequency of the reacting particles was asked for. Some candidates stated that the reacting particles "vibrated more" at higher temperatures. This answer was rejected.

A completely correct answer to **Question 5** was rarely seen, but there was a good proportion of thoughtful answers to the subtleties of the question.

Question 6

The experiment on which this question is based concerns the thermal conductivity of metals. Candidates were told this in the first sentence, but many lost track of the logic of the question. One end of a metal bar was heated and a dent was made in it. After cooling, a glass bead was placed in the dent and held there by wax dripped from a candle. The other end of the bar was then heated in a Bunsen flame and the time taken for the wax to melt and the bead to fall off was recorded.

(a) Two digital timers were shown for candidates to read and record the missing times. The same errors occurred here as in **Question 5 (b)**.

(b) (i) Candidates had to suggest the property of the bar that enabled a dent to be made in the heated metal. At this point many candidates confused the two stages of heating of the bar and then completely forgot the concept of thermal conductivity.

(ii) Asked which metal was hardest to dent, candidates correctly chose steel. Unfortunately for the candidates, this metal was also the metal taking the longest time to conduct heat to melt the wax. This led many candidates to try to find a reason for choosing steel from the data in the table, which was unconnected with the real reason why steel is the hardest metal; it is an alloy, whereas all the rest are pure metals.

(c) Candles are common enough for candidates to realise that wax is a hydrocarbon and from a petroleum fraction. However, animal fat and beeswax were also accepted as sources.

(d) This question asked for a reason why magnesium should not be used for this experiment. Vague answers such as “magnesium is a dangerous substance” or “It is too reactive” were not accepted. The examiners looked for a clear indication that heated magnesium reacts with oxygen and burns vigorously, or a statement that its melting point is too low.

(e) One way to make the experiment a fairer test was asked for. The use of equal-sized pieces of metal, or of a more controlled form of heating, were accepted as answers. “Repeat the experiment and find the average times” was also given the mark.

(f) The last question asked for a reason, based on the properties of metal and glass, why the experiment did not work with a glass bar. Candidates who had forgotten the purpose of the experiment gave answers that made no sense.

Candidates who had studied the phenomenon of conduction of heat, and whose knowledge included facts about the properties of metals, gave good answers to this question. Many other candidates gave poor answers.