COMBINED SCIENCE

Paper 0653/01
Multiple Choice

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

General comments on whole paper

At 58%, the mean on this paper is at a respectable level. Candidates for this paper appear to have been well prepared.

Comments on individual questions (Biology)

Question 1

This question tested the simple knowledge that the cell wall is made of cellulose. It has to be a little surprising that over half the candidates appeared to be unaware of that fact.

Question 5

There is always confusion over just when a plant is photosynthesising and when it is respiring, as evidenced here by over a third of the candidates appearing to believe that the black cover would prevent respiration.

Question 6

There was a similar pattern here to that shown in question 1. Apparent guessing suggests that candidates were not familiar with the knowledge that the coronary artery directly supplies the heart.

Question 7

Candidates were guilty of not using the diagram to help them. The final act in the flow diagram was intended to indicate the addition of iodine solution with a dropping pipette, thus it was disappointing that over a half of them opted for iodine as substance 4.

Question 8

Again, a case of not carefully reading the question. Candidates appeared to misunderstand that an increased reaction time is the result of an increase, not a decrease, in the time taken for impulse conduction. Failure to work this out led to over a half of them opting for the exact reverse of what actually happens, rendering this by some way the most difficult of the biology questions.

Question 12

Food webs and food chains are traditionally well understood, as was the case with this question, making it the easiest in the biology section of the paper.

Comments on individual questions (Chemistry)

Question 14

It is a little surprising that nearly a third of the lower-scoring candidates chose response D rather than the key (C). This may possibly suggest insufficiently careful reading of the question in that the salt is clearly described as being 'aqueous'.

Question 15 was found decidedly hard by the lower-scoring candidates of whom two fifths chose response C. Indeed, for these candidates, the key (B) was the least popular choice. Questions similar to this one have appeared in previous papers. Nevertheless, the topic is quite explicit in the syllabus and, in principle, these formulae should be a matter of direct recall.

Question 16

As many as half of the lower-scoring candidates chose response A rather than the key (C): they seem merely to have considered the total number of particles in the nuclei rather than the number of protons.

Question 18

By contrast, simple lack of knowledge would explain why over half of the lower-scoring candidates chose response B rather than the key (A).

Question 20 was found to be rather easy with a consequential low discrimination across the ability range.

Question 22 proved to be unsatisfactory in that candidates across the ability range seem to have guessed between the responses. This is a little surprising in that the question relates to common test reagents. Barium nitrate is used to test for aqueous sulfate ions and would not, therefore, give a white precipitate with zinc chloride. The other two would do so, hence key C.

Question 24

In this question, the lower-scoring candidates guessed between the responses and the discrimination factor was excellent.

Question 27

Response C was the most popular choice (41%) amongst the lower-scoring candidates and even a third of the higher-scoring candidates offered this response as the answer, the key being A.

The question did refer to "long chain molecules" so the choice of 'small' in column 1 is surprising, perhaps just unthinking.

Comments on individual questions (Physics)

In general, the Physics questions on this paper were well answered. The questions which candidates found easy (facility ≥ 70%) were 28, 29, 30, 31, 34 and 39. Questions where the facility showed that candidates found the topic difficult were 33 and 35. The following comments on selected questions may be of help to teachers.

Although candidates generally found no problem with item 29, 15% of them did not read the question carefully enough and simply chose C, the highest point on the graph. Nearly half the candidates answered 32 correctly, with virtually all the rest either forgetting to subtract the mass of the measuring cylinder or doing the division the wrong way up. Question 33 really did cause candidates difficulty, with half thinking the answer was B (i.e. greatest KE at the top) and the rest being equally undecided about the other options. Question 35 should not have caused problems, even without the aid of the diagram, but there were as many candidates who thought that ultra-violet caused the heating effect as there were those who answered correctly. There was a lot who chose B or D, as well.

It was pleasing to see that over half the candidates answered question 36 correctly, as it is unusual to have an item on this paper that involves two lenses. The most common problem was in recognising which distance was the focal length of lens Y. Item 37 posed no problem to half the candidates, but it should be noted that 42% of candidates chose the options which claimed the voltmeter would read 12 V when S_2 was open. A quarter of candidates thought that device X in question 38 was a resistor. However, a resistor does not do what was described in the stem, and in any case a resistor is not represented by a square. Better candidates generally answered correctly. In question 40, many candidates thought that gamma-rays carry a charge.

COMBINED SCIENCE

Paper 0653/02
Core Theory

General comments

As usual for this limited grade paper, the candidature generally found the content to be challenging. There was a wide range of marks seen. The three science disciplines generally provided challenge in equal measure, although it appeared that the Chemistry sections of the syllabus had not been learned quite as effectively as the others. As usual, calculations in Physics were done quite well and candidates coped successfully with data interpretation. Candidates are still writing in a very confused manner about environmental issues and the dual use of the term *radiation* in the contexts of nuclear processes and electromagnetic radiation caused difficulties for many candidates. There was no evidence that candidates generally had difficulty in completing the paper in the available time.

Comments on specific questions

Question 1

(a) This question was generally answered well across the ability range with very few candidates failing to score. The most common mistake was the failure to recognise element **C** as the alkali metal in period 3. By far the most common response instead of **C** was element **H**. Most candidates recognised **F C** and **G** as elements with similar properties.

(b) (i) Candidates tended to know an acceptable definition of oxidation. It was important that candidates made it very clear that a chemical reaction with oxygen occurred or that oxygen was joining with the oxidised substance. It is not sufficient to state merely that an oxide is formed or that substances are burning or that the substance mixes with oxygen. A number of candidates suggested that oxidation meant that oxygen was being produced in a reaction.

(ii) Many candidates scored from at least half of the available marks in this question. It is unwise for candidates to give a long list of possible colours and expect the Examiner to pick the nearest correct one. The colour and reason were marked separately both cases. Hence incorrect colours but correct reasons could score some marks.

(iii) This question was not very well answered. Candidates need to be warned that the simple response *chemical* is stated in the question and so is not going to score any marks. Some candidates suggested *exothermic* or *endothermic*, but these are not accepted as types of chemical reaction.

Question 2

(a) This straightforward labelling exercise very rarely produced full marks. There was no particularly noticeable pattern of incorrect responses.

(b) (i) Diffusion was the only accepted answer. Respiration and osmosis were the most common incorrect responses.

(ii) The question about emphysema was very poorly answered by most candidates from most Centres. Candidates tended to write at length, often repeating information given in the question. The key issue of reduced surface area within alveoli was rarely mentioned. There were many references to tar blocking the passage of oxygen.

(c) (i) In order to score this mark, candidates needed to state that red cells contain no nucleus or that they have a characteristic shape very different from white cells. However, if going for the shape answer they needed to give details which described or implied the bi-concave nature of the red cells' shape. The mark tended to be lost through lack of this level of detail.

(ii) A minority of candidates correctly identified haemoglobin as the cause of the colour in red cells. Common incorrect answers were revealing, e.g. many candidates simply stated that the red colour was caused by the presence of blood, oxygen or iron.

(d) Candidates' knowledge of the importance of oxygen to the process of respiration and energy provision in cells is very often tested in this paper. Despite this, the question was generally poorly answered with very many low level responses such as *so the cell can work properly* or *so that the cell can survive*.

Question 3

(a) (i) The usual alternatives to kinetic such as motion or movement were allowed. References to *force* were not uncommon and several candidates reversed the answers to **(i)** and **(ii)**.

(ii) Candidates needed to use the word *potential* in their answers. A common response which does not score a mark is *gravity* which is a force.

(b) (i) Candidates performed well on this question and most scored full marks. The most common misconception seen in answers from weaker candidates is that the rising part of the graph shows something rising into the air. Another common error is that the horizontal part of the graph represents the golf cart at rest.

(ii) Most candidates showed that they could read from the graph. Answers in the range 2.3 – 2.5 m/s were accepted.

(c) In general candidates performed very well on this question and the majority had little difficulty applying the correct formula to arrive at the answer 2 m/s. It is important that candidates do write down the formula using correct words or recognised symbols. If the formula is presented using physical units then the formula mark is not awarded. Similarly, a correct answer without the formula will lose credit. Marks are not awarded if the candidate simply writes the triangular aide memoir which links this (or any other) set of variables.

(d) (i) This question was well answered. Most candidates gave the correct response **60 N**.

(ii) This question was not quite as accessible as **part (c)**, but better candidates successfully worked through to the answer **30 J**. Many candidates did not attempt this question and of those who missed out on marks, a common problem was that they gave the correct physical quantities but in an incorrect version of the formula.

Question 4

(a) (i) Both of the words *fractional distillation* were required, although the alternative word *fractionation* was accepted. About half of the candidates were able to answer this correctly.

(ii) This was not very well-known although better candidates did discuss boiling point (range) as required. Any strongly implied references to boiling point or intermolecular forces were accepted.

(b) (i) The available marks were awarded for correct reactants and products. The majority correctly identified oxygen as the other reactant, but few were able to provide the products. It was clear that candidates had difficulty applying the usually well-known complete combustion equation to the slightly less familiar hydrocarbon, kerosene. Large numbers of candidates suggested kerosene oxide as a product.

(ii) Most candidates gave an acceptable way of telling that the reaction was exothermic. Any response implying that heat was being transferred to the surroundings was accepted.

(c) In general, candidates are usually well able to draw atomic diagrams and many scored full marks. Sometimes a mark was lost because candidates failed to make any attempt to indicate or label the nucleus as the question requested.

Question 5

(a) Candidates generally scored very well on this data recognition question. A simple response that the emissions had decreased during the period shown on the chart gained some credit. Full marks could be scored by referring to the rapid and significant decrease from 2000 to 2001 followed by a less significant decrease in subsequent years. Even if candidates wrote things such as emissions had "settled down" in subsequent years a mark was awarded.

(b) The two marks here were for reference to the need to burn fuels (fossil fuels) in a power station, i.e. remote from the factory itself. Only better candidates showed that they had understood the context of this question.

(c) The candidates did not score the marks for the simple answer 'burn less fuel'. There were a number of sensible suggestions candidates could make. Hence answers such as 'encourage employees to make fewer car journeys' or 'install alternative energy sources such as solar panels or wind turbines' were credited. Answers which would have required the company to scale back its operations were not accepted.

(d) This question is very often asked because it is believed to be an important issue. However, many candidates still show great confusion over the causes and effects of atmospheric pollution. Most candidates gained some credit for a simple reference to global warming. The predicted consequences of global warming could also have secured some credit. A discussion of the greenhouse effect being the cause of global warming was another way of securing full marks.

(e) This is also a frequently asked question and candidates continue to do well on it. There were many correct references to the need to maintain high species diversity and that the destruction of habitat may lead to extinctions. Some candidates may have been distracted by the previous question and discussed the value of the rainforest as a system to "soak up" harmful carbon dioxide "so that we can breathe". References to the as yet untapped potential of new natural substances also scored marks.

Question 6

(a) (i) The expected response was *electromagnetic* but this answer was rarely seen. *Transverse* was accepted as an alternative.

(ii) Candidates' only possible answer to this question was *reflection*. Many used related terms such as *bounce back* or *echo* and there were many who wrote *refraction*.

(b) (i) This was well answered by about half of the candidates who showed very good skills in drawing circuit diagrams. Candidates needed to read the question carefully, and many drew two pairs of lamps in parallel, possibly distracted by the visual arrangement of car lights. Credit was available for a fully correct set of circuit diagram symbols even if the circuit arrangement was incorrect. Several candidates lost a mark for a careless drawing of the switch which looked both open and closed simultaneously. Candidates are advised to draw the switch in the open position to avoid any doubt about whether or not they have included it in the diagram.

(ii) It was clear that many candidates had learned the reasoning involved in this answer but often failed to provide enough detail. The simple statement 'because it is a parallel circuit' does not add enough information to be credited. The requirement was for the strong implication that current is still able to pass through the remaining filaments. Candidates found a great variety of ways of expressing this idea and about half of the candidates gained credit. Interestingly, some candidates who had failed to draw a parallel circuit in the previous question were able to give an acceptable answer to this part.

(c) Candidates generally answered this question very successfully. Some simply wrote down the correct answer, **22 cm**, and so did not score the mark for showing working. Candidates need to be advised that the present policy in this paper is to withhold marks when requested working is missing, even when the numerical answer is correct. The most common incorrect final answer was 19 cm which arose when candidates correctly calculated the extension produced by the three additional nuts but forgot that the spring was already at 13 cm due to the first nut. Surprisingly another incorrect answer was 21 cm suggested by candidates from several Centres. These candidates provided perfectly correct working, but then made an arithmetical error.

Question 7

(a) The full mark range was seen for this question. Candidates in general had learned this very well and the majority scored full or nearly full marks.

(b) Most candidates discussed relevant aspects of photosynthesis and scored full marks. It is important that candidates refer to *light* rather than more general energy descriptors such as *the sun's rays*. A minority of better candidates did not read the question carefully enough and wasted much time on some near perfect descriptions of detecting starch using the iodine test.

(c) (i) *Asexual* was the only accepted response, and most candidates recognised that this was what was required.

(ii) The meaning of *clone* was very well-known by the majority of candidates. Most gave references to the clone being identical to the parent organism. Many went further and stated that the clone would be genetically identical. Weaker descriptors such as *similar* did not score a mark.

Question 8

(a) This question discriminated very well. The majority of candidates lost only one mark, but there was no obvious pattern to the ways in which marks were lost.

(b) (i) Only a minority of candidates were able to answer this, which was a little surprising. The damage caused to cells by ionising radiation is often tested in this paper and the wording of the question had been intended to key candidates into sterilisation. A very wide variety of answers were seen, all of which were correct descriptions of aspects of radiation, but most of which were not relevant to the process of destroying cells, particularly those of harmful microorganisms.

(ii) By far the most common incorrect response was the use of X-rays. About half of the candidates were rewarded for discussing cancer treatment, thickness measurement or looking for leaks in pipes. Use in weaponry or electricity generation were not accepted since these strictly exploit fission or fusion rather than simple radioactive sources.

(c) (i) It was clear that many candidates had an idea of what is meant by background radiation but had difficulty in expressing the concept. Hence, answers such as 'radiation left over after the experiment is finished' or 'radiation which is nothing to do with the experiment' were frequently seen. Provided candidates conveyed the idea that background radiation arises from sources which are always present in the environment, they gained the mark. Many candidates did not attempt this question or **parts (ii)** and **(iii)** which followed.

(ii) This part was often answered within **part (i)** and so these two questions were marked together. This question was not answered very well and only a minority of candidates gave acceptable responses, which include *cosmic rays, from the sun, from space, from the ground, from rocks, which is always around us in the environment*. Of the candidates who attempted this question a sizeable number suggested *microwave*.

(iii) Only a small minority of better candidates related this question back to the main stem and realised that the background count needed to be subtracted from the detector reading to give the result **1160 cpm**.

Question 9

(a) (i) There was much information within the question stem and candidates needed only to supply one of the product substances in order to complete the equation. Only a small minority of candidates gave a fully correct equation. Many committed rubric infringements by using words not given in the list and many thought that words such as *heat* or *gases* could be included in a word equation. Many included the same substances on both sides of the equation.

(ii) This was intended to be a simple question but it proved rather inaccessible for most candidates. Many did not add anything to the question stem and gave answers such as *because metallic copper is formed*. Some better candidates suggested, most reasonably, that the burning hydrogen provided the evidence because hydrogen needs oxygen to burn which it must have obtained from the copper oxide which must, therefore, have left the copper on its own. It had been hoped that candidates would simply describe the colour change in the solid in the tube. They could also have described a test such as electrical conductivity on the resulting solid product.

(b) (i) Generally this was answered correctly. There was no particular pattern to the incorrect responses. Regrettably this is one instance when spelling errors cannot always be ignored and so suggestions such as copper sulphide or sulphite had to be penalised.

(ii) This had been intended to be a straightforward question about the application of filtration but was very poorly answered across the ability range. Candidates needed to explain that because copper does not react with dilute sulphuric acid then it would remain as the residue while the soluble copper sulphate (or whatever they had named in the previous question) passed through the paper. It is possible that many candidates, particularly at the upper end of the ability range, read more into this question than there was.

(c) (i) This was not well answered and only a minority of candidates were able to give the correct response.

(ii) Candidates could gain some credit by any reasonable reference to attraction arising from particles carrying opposite charges. A further mark was available for the additional detail that copper particles would be positive and oxide would be negative. Very few candidates scored full marks.

(d) Although this question really demanded observations, candidates were allowed simply to state the names of the substances which would appear at the electrodes. They could not, however, suggest processes which could never be observed. Therefore, answers such as ‘negative ions go to the positive electrode’, while technically correct, is the answer to a different question. A common mistake even from better candidates was to reverse the answers. A sizeable minority of candidates wrote about the observations which would be seen during the purification of copper rather than what would be seen using the electrolyte in the question.

COMBINED SCIENCE

Paper 0653/03
Extended Theory

General comments

The majority of candidates were able to make creditable attempts at all questions, with some very good overall performances. Some, however, did not appear to have covered much of the material in the Supplement sections of the syllabus. There were no apparent difficulties in understanding what was required in any of the questions, and almost no candidates showed any evidence of running short of time.

Comments on specific questions

Question 1

(a) This was generally well answered. The most common error was to confuse chlorophyll and chloroplast.

(b) (i) This question tested the understanding that starch is a polymer of glucose. The expected response was at least two more rectangles linked in line with the one already given. Many candidates did this well, but others drew various imaginative structures, such as two circles attached to the rectangle.

(ii) Relatively few candidates appeared to be aware that phloem vessels are likely to be destroyed when the outer parts of a plant stem are damaged, despite this being a specific learning outcome in the syllabus. Better candidates were able to explain that sugars are transported in phloem and that roots are entirely dependent on sugars transported from leaves, as they cannot synthesise their own.

(c) (i) This was usually answered correctly; either asexual reproduction or vegetative reproduction was accepted.

(ii) The relative advantages and disadvantages of sexual and asexual reproduction are not easy concepts, and few candidates gave good answers here. Many suggested that asexual reproduction produces more offspring, or happens more quickly, which is not generally true and was not credited. The strongest answers referred to the fact that asexual reproduction results in the production of genetically identical offspring. If the parent plant is well adapted to its environment, then the offspring will be equally well adapted, and therefore likely to survive. Some answers got part way along this route, but then stated that 'the offspring will inherit the good characteristics of the parent', which implies that they will *not* inherit the bad ones.

(d) Various relevant functions were suggested by candidates, the most common being transpiration and respiration. Other acceptable answers related to the storage of food reserves as starch or storing water if the plant lives in a dry environment.

Question 2

(a) A pleasing number of responses were entirely correct. The most common error was to link beta radiation to the 'has no mass' box.

(b) This was generally well answered, although there was some confusion between atomic mass and atomic number.

(c) The expected answer was that gamma radiation is ionising, or that it destroys cells. Many candidates answered appropriately, but some gave particular properties of gamma radiation that would not be helpful in this application, such as the fact that it has no electrical charge.

(d) Both **(i)** and **(ii)** were well answered. Most candidates correctly worked out the half-life, and then showed clear working in arriving at their answer to **(ii)**.

(e) (i) This, too, was generally answered correctly.

(ii) Although more than half of the responses to this question were correct, a large number of candidates did not recognise that the background radiation must be subtracted from the reading in order to find the count rate of the source. Of these, most simply gave the incorrect answer 1200, but a few added the background radiation to this number.

Question 3

(a) (i) A wide range of answers was accepted, of which the most frequently seen were petrol and diesel.

(ii) Many answers correctly stated that it is the different boiling points of the compounds in petroleum that enable them to be separated by fractional distillation. Several, however, wrongly stated that it was the temperature at which they evaporate, or their melting points. Others gave structural differences, such as the length of the carbon chains, which, although not incorrect, does not quite go far enough to provide a good answer to this question.

(b) This was poorly answered, with only a small proportion of candidates giving the correct response of $20O_2$. Some suggested O_{40}. Many, however, were not able to count the number of oxygen atoms in the products of the reaction, and so did not realise that there needed to be 40 oxygen atoms on the left hand side of the equation.

(c) This was well answered on the whole, with a pleasing proportion of candidates recognising that the diagram showed the sharing of electrons between oxygen and carbon atoms, representing a double covalent bond. Weaker answers, however, often stated that the oxygen and carbon were sharing 'atoms', or that ionic bonding was represented.

Question 4

(a) Almost all answers correctly stated that the emissions decreased over the time period. Better answers elaborated on this, for example by stating that the steepest fall was between 2002 and 2003, or that the emissions stayed the same between 2004 and 2005.

(b) A range of answers was accepted here, such as a move away from burning fossil fuels to using renewable sources of energy, the use of low-sulphur fuels, or the 'scrubbing' of waste gases to remove sulphur dioxide. Weaker candidates often made no sensible suggestions.

(c) Candidates who made the link between these emissions and acid rain were generally well on their way to full marks for this section. Many, however, wrote inappropriately about other environmental issues, such as global warming or the ozone layer.

Question 5

(a) Although almost all candidates recognised that section **A** – **B** on the graph represents acceleration, very few stated that it is *uniform* acceleration. A few calculated the correct value. Almost all correctly stated that **B** – **C** represents travel at constant speed, although a few wrongly thought that the cart was not moving.

(b) The majority of candidates correctly attempted to calculate the area beneath the graph, arriving at the right answer with the right unit. Some, however, incorrectly used the formula *distance* = *speed* × *time*. Some gave a wrong unit of m/s or m^2.

Question 6

(a) (i) This was generally well answered. The most common incorrect answer gave oxygen on the right hand side, rather than water. Other errors included the use of the word 'air' instead of 'oxygen' and a complete reversal of the equation, with copper oxide and hydrogen as products rather than reactants. A few attempted to write an equation using formulae, which was credited so long as they were all entirely correct.

(ii) This proved difficult. Some candidates did appreciate that copper would appear, and described an appropriate colour that they would expect to see. Most, however, simply described something that they could see in Fig. 6.1, usually the excess hydrogen being burnt, or mentioned the appearance of water in the reaction tube. A number stated that the flame would start to look green.

(b) (i) Many struggled with this, although once again there were some entirely sound answers describing the balance between the numbers of protons and electrons in an oxygen atom and in an oxide ion.

(ii) This was even more difficult, with relatively few entirely correct responses. Many did not appear to use the formula CuO, instead trying to count up the number of electrons on a copper atom and therefore to predict the number of electrons in its outer shell, which they invariably got wrong.

(c) (i) This was generally answered correctly, although some wrongly gave a formula rather than the name as requested.

(ii) Most recognised that this was something to do with relative reactivity, and the better candidates stated simply that zinc is more reactive than copper. The statement that 'zinc is more reactive' was not credited.

(iii) Those who knew that oxidation involves the loss of electrons generally gave the correct response here, recognising that zinc is oxidised. However, most did not and there were many incorrect answers, the most common of which was copper.

Question 7

(a) This was surprisingly poorly answered, with only a small proportion of candidates getting all four labels correct. Most knew the trachea, but fewer knew where a bronchus could be found. Many confused the ribs with the intercostal muscles, or the pleural membranes with the pleural fluid.

(b) The key points to be made here were the reduction of surface area in the lungs, and the resulting difficulty in the diffusion of oxygen from the alveolar air spaces into the blood. Many answers did no more than repeat the information given in the question, which gained no credit.

(c) This question brought to light much misunderstanding about what a red blood cell is and what it does. Several answers said that it 'contains blood'. Surprisingly few answers mentioned haemoglobin. Many thought that red blood cells transport glucose. Of those who did correctly mention the shape providing a large surface area, many incorrectly thought that this allows the cell to *carry* more oxygen, rather than allowing speedy diffusion of oxygen into and out of the cell.

(d) Surprisingly few candidates mentioned respiration. Of those who did, even fewer stated that this provides energy for use by body cells. The statement that it '*makes* energy' is incorrect.

Question 8

(a) (i) Most answers correctly gave the formula *work* = *force* $\times$ distance, but relatively few converted the distance to metres in their calculation. Candidates should be reminded that when asked to give a formula such as this they should not write one that is made up of units, for example 'joules = newtons $\times$ metres'.

(ii) This formula was less well-known, so many candidates were not able to answer this question at all. Of those who did, several did not know the correct unit to give with their answer.

(b) (i) Either 'transverse' or 'electromagnetic' was accepted here.

(ii) The expected answer was 'reflection', but relatively few got this right.

(c) As always, the calculation of the combined resistance of resistances in parallel proved difficult for many. Those who knew a correct formula were generally on safe ground, although many forgot to turn their answer 'upside down' to give the final value.

(d) This was well answered. Candidates took various routes to get to their answers, any of which were acceptable so long as their train of thought could be followed.

Question 9

(a) Almost all candidates correctly gave **F**, **C** and **G** for the first set of answers. Many also answered the second part correctly, but many wrongly chose **H**.

(b) (i) This was not well done. Many candidates did not appear to refer back to the information they had been given earlier in the question, and did not recognise that oxygen is formed in the reaction and will be lost from the flask.

(ii) Answers needed to state that the higher the mass of manganese dioxide, the faster the rate of decomposition.

(iii) This required an appreciation of the data in Table 9.1 showing that the mass of manganese dioxide did not change during the reactions, and therefore that it is acting as a catalyst. Once this was recognised, full marks were generally gained. However, a significant number of candidates were not able to analyse the data given in the table, and either gave no answer at all, or suggested that manganese dioxide is being broken down in the reaction.

(iv) Most candidates answered this well. They knew that particles would have more kinetic energy at higher temperatures, and were able to relate this to a greater frequency of collisions and therefore a faster rate of reaction.

(c) Apart from candidates who used atomic numbers in their calculations rather than relatively atomic masses, most were able to perform this calculation correctly.

COMBINED SCIENCE

Paper 0653/04
Coursework

(a) Nature of tasks set by Centres.

Only 2 Centres submitted coursework for the June examination. This includes one which has provided coursework in previous years and one new Centre. In both Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates work was comparable with previous years with candidates covering the whole mark range. Both Centres were well organised.

(b) Teacher's application of assessment criteria.

The new Centre tried to assess both skills all skills including skills C1 and C4 in the same investigation.

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

Tick lists remain popular particularly with skill C1. Many Centres do not annotate their scripts in sufficient detail. Most Centres make useful comments to justify marks awarded. The use of the annotation on candidates' scripts has been encouraged.

(d) Good practice.

COMBINED SCIENCE

Paper 0653/05

Practical Test

General comments

Degree of difficulty of this paper was similar to previous years and this was confirmed by the performance of candidates. All three questions were answered reasonably well and no question proved especially difficult. Some Supervisors appeared to have been rather lax in providing a suitable specimen for **Question 1**, unless candidates made their own decision to draw just one leaf. It may also be the case that some are not preparing the solutions in **Question 3** as described in the instructions. Deviation from the specified concentrations may produce results different from those intended. A few Supervisors failed to adequately complete a set of results. It should be stressed that the Supervisor's results are extremely useful, and failure to send them may disadvantage the candidates.

Comments on specific questions

Question 1

As already suggested above, some candidates simply drew one leaf rather than a minimum of two together with the stem. Many drawings did not show any wilting of the leaves. Again the instructions made it clear that the leaves had to show signs of wilting. The most common answer to **(a)(ii)** was 'lack of water'. Full marks were awarded to those who commented on the loss of water by transpiration or evaporation, and that this water could not be replaced. Many candidates failed to score the mark in **part (iii)** either because they failed to shade in the stem or because they did not draw a stem. **Part (iv)** was poorly answered. Very few described the woody nature of the stem due to lignin and how this provides support for the plant, even when water is scarce. A surprising number did not know what a transverse section is. Drawings of the whole piece of celery were not credited. Of those who did draw a transverse section, many correctly named the xylem. There were several acceptable answers to **(c)**, including humidity, light intensity, wind speed etc. Those who simply gave the one word 'light' did not score.

Question 2

The majority of candidates were able to successfully carry out the experiment and produce a full set of readings. Some careless errors included giving the measurements in centimetres and having the ruler upside down. Both of these errors lost marks. A few failed to record a value for h_0 although, in many cases, extension values were recorded. Some were careless in drawing the graph, plotting masses rather than forces. Although most drew a straight line passing through the origin, very few actually marked (0,0) as a point. The table made it quite clear that this was a valid point. The majority were able to correctly read from the graph the extension produced by a force of 0.40N. Whilst most responded 'yes' to the question in **part (d)** answers appeared to rely upon knowledge, rather than appreciating the significance of the straight line.

Question 3

Answers to **parts (a)**, **(b)** and **(c)** were mostly satisfactory, although there were groups of candidates who failed to obtain a precipitate or milky appearance when carbon dioxide was passed through the lime water (solution **C**). Whether this was poor technique on the part of the candidates or whether the limewater was not checked prior to the examination was not obvious. The vigorous effervescence when magnesium was placed in solution **B** in **test (a)(ii)** should have immediately identified solution **B** as the acid. When **B** reacted with solution **A** in **test (c)(i)**, once more the effervescence identified **A** as the carbonate. Even when the appropriate observations were made, few were able to piece together the evidence. **Test (c)(ii)** should have produced a white precipitate although of no real value in identifying the solutions. **Part (d)** was poorly answered, except for appreciating the reaction between carbon dioxide and limewater. As suggested above there were two key reactions that should have enabled correct identification.

COMBINED SCIENCES

Paper 0653/06
Alternative to Practical

General comments

The examination is designed to test candidates' knowledge and experience in practical Chemistry, and roughly follows the section in the syllabus entitled "Criteria for Assessment of Experimental Skills and Abilities". Inevitably, each question will also contain relevant material from the Biology, Chemistry or Physics sections of the syllabus and sometimes a mixture of one or more of these. The Examiners are always at pains to emphasise that this paper is an alternative to assessment either by coursework or by Paper 5, the Practical Test. Paper 6 is not an alternative to spending time in the laboratory. Unfortunately, there will always be candidates whose schoolwork has contained little or no experimental experience. They are at a serious disadvantage, as the details of this report show.

Comments on specific questions

Question 1

This question is based on an investigation of the transpiration stream in a piece of celery standing in water and dye, shown in the first diagram. After a suitable time, a transverse section of the celery, shown in the second diagram, reveals the movement of the dye in the stem.

(a) (i) Most candidates were able to name xylem as the vessel through which the dye travels.

(ii) This was often poorly answered. Candidates mis-read the instructions and tried to sketch the celery section after a piece of celery had dried out, rather than as flaccid leaves after the first diagram. Marks were available for explaining that the celery had lost water by transpiration and so had become wilted or had lost turgor pressure.

(b) (i) The Examiners preferred the answer "wind" or "humidity" rather than "light" as a factor influencing transpiration rate, but any one of these three answers was credited.

(ii) It was the intention of the question that a method of comparing transpiration rates at different temperatures should involve dye absorption by celery, as in Fig.1.1. However, candidates could earn some marks for a description of a potometer experiment. Some candidates omitted the dye, then suggested that that the amount of water left in the beaker should be measured. This might work if the surface of the water was covered with oil. Some thoughtful answers were noted but many answers were poor.

Unacceptable answers to **Question 1** showed that candidates did not read the question carefully enough or had no experience of this type of investigation.

Question 2

This question tested knowledge of transverse waves, including ideas about wavelength, speed and frequency.

(a)(i)-(iv) The hardest part of this section was the calculation of the frequency in waves per second (hertz) which turned out to be a number less than 1. Candidates giving the answer 9 (waves per minute) gained some credit.

(v) This tested the idea that particles of matter under the influence of a transverse wave move at right-angles to the direction of the wave. Most candidates did not answer this correctly.

(b) (i) The same point was tested here, where a ribbon tied on a rope moves vertically as the wave moves horizontally along the rope. Candidates were more successful with this, but many arrows were drawn showing the arrow moving horizontally or at an angle.

(ii) To achieve the marks in this part, a candidate had to understand that the energy of waves is increased by changing the amplitude or the frequency. Too often answers referred to the teacher "using more force" or "waving his hand faster". Unless there was some further explanation it was hard to credit such vague answers.

Despite the problems mentioned, most candidates scored well in this question.

Question 3

To answer this question, candidates needed knowledge of elements in the third Period of the Periodic Table, their symbols and simple properties.

(a) A common error was to confuse phosphorus with potassium (P with K), sodium (kept under oil) with phosphorus (kept under water), sulphur and silicon (S and Si). Often, chlorine was identified as a colourless gas. Three correct arrows, linking symbols with the stated physical properties, was a rare occurrence, and many answers were obviously chosen at random.

(b) This caught out a substantial number of candidates who had obviously never connected up common laboratory instruments such as ammeters and voltmeters in a circuit. The mark scheme specifically penalised a mistake in polarity or in connecting the voltmeter in series, but there was worrying ignorance of the idea that wires must be connected to the terminals. Often, wires were drawn passing through (or over) the cases of the instruments. A circuit that would work, using the battery, lamp and sample, was credited, but the other two components had to be connected in some way that would not impede the current.

(c)(i)-(v) Knowledge of the chemistry of one of the elements had to be used to explain the colour of the flame on combustion, the name and physical state of the product, and its effect on litmus. Only the best candidates could answer this and then go on to suggest a credible safety precaution.

A completely correct answer to this question was rare, although the separate parts all attracted right answers.

Question 4

This question is based on knowledge and experience of the Biology section of the syllabus. Inevitably, candidates focused on the characteristics of yeast as an organism rather than on the chemical reaction, catalysed by enzymes, that was being studied. A more comprehensive outlook on science enabled candidates to score higher marks.

(a) (i) A minority of candidates failed to draw a smooth curve through the points they had plotted. Most scored full marks.

(ii) This question was rarely fully answered. Most candidates recognised that there was an increase in activity of the yeast as the temperature rose from 30 °C to 45 °C; however, this was not well explained. Some candidates thought that the temperature rise was caused by the increased activity, (and therefore increased energy output), of the yeast, not realising that the temperature was controlled by the student doing the experiment. Very few candidates said that increased activity was caused by the increased kinetic energy of the molecules of sugar in the solution at higher temperature. The Examiners realised that almost all candidates, asked to explain higher reaction rates in a purely inorganic context, would explain them in terms of higher kinetic energy of the particles. There are, therefore, implications for the teaching approach when studying this kind of reaction in a biological context.

The second part of the question was answered better by many candidates, who linked the decrease in evolution of carbon dioxide with the denaturing of the enzyme.

(b) A wide range of drawing skills was noted. The answers given full credit either showed a graduated gas syringe or illustrated the collection of the gas over water in a graduated vessel. There were many diagrams of bubbles being collected in a beaker or in a closed test-tube.

(c) Some candidates gave a satisfactory account of an experiment in which equal masses of yeast were added to equal volumes and concentrations of glucose and sucrose, at the same temperature. Many merely wrote "Do the experiment again but with sucrose this time". Such a response gained no marks.

Question 5

This question was based on the corresponding Paper 5 question in which candidates for the practical test had to find the extension of a spring using a range of masses, then plot an extension/load graph.

(a) Conversion of mass to force in newtons was a simple matter for almost all candidates.

(b) Similarly, reading the scale of the ruler and so measuring the height of the pointer was easily done.

(c) A few candidates failed to calculate the extension of the spring for the three loads. A very few candidates read off the extensions from the graph after they had plotted the maximum extension. This involved an error outside the tolerance applied by the Examiners, so a mark was lost.

(d) The Examiners were pleased by the good standard of graph plotting demonstrated by most candidates.

(e) The extension caused by a force of 0.8 newtons had to be found using the graph. Some correct figures were written, but the result had to be visible as a line or point on the graph, as the question demanded. Other candidates failed to find the point on the *x*-axis corresponding to 0.8 newtons. The most common error here was giving the value at a load of 0.9 newtons, due to mis-reading of the scale.

(f) The last part of the question asked candidates to predict the shape of the graph if the spring were to be "over-stretched" (beyond the elastic limit). Most candidates made the graph bend in the wrong direction.

The Examiners congratulate many Centres for the high standard of answers to this question.

Qu**estion 6**

This Chemistry question is based on the corresponding question in Paper 5. Three solutions, **A**, **B** and **C**, are named as calcium hydroxide, sodium carbonate and dilute sulphuric acid. During the answers to the question, candidates had to correctly identify the solutions.

(a) (i) It should have been easy to identify the gas given off when magnesium is added to one of the named substances, but the majority of the candidates named the gas as carbon dioxide and from then on their answers were often muddled and incorrect.

(ii) As a result of an incorrect answer to **(a)(i)**, the solution that reacted with magnesium was often named as sodium carbonate.

(b) (i) Addition of sulphuric acid to copper sulphate was a "negative result" test, so there should be no precipitate or "no change". If, however, the answer given to **(a)(ii)** was "sodium carbonate", there would be a blue precipitate for which an "error carried forward" mark was available.

(ii) The name "copper carbonate" for the blue precipitate stated to occur with sodium carbonate solution was rare.

(c) (i) The names of two substances that react to give carbon dioxide were needed here. Surprisingly, this easy question was answered by few candidates.

(ii) Carbon dioxide was passed into solution **C**. There was no change when it was passed into solution **A** and **B**, so what would be seen with solution **C**? About half of the candidates could answer "a white precipitate" or "goes white".

(d) (i) The candidates were told that the litmus showed that solution **A** was alkaline, and asked the colour of the litmus. What colour is the litmus? Many candidates gave the correct answer.

(ii) Solution **B** was added to the litmus mixed with 2 cm^3 of solution **A**. The litmus changed colour when 3 cm^3 of **B** had been added. Candidates were asked which of **A** or **B** was more concentrated. Many candidates did not appreciate that a neutralisation reaction was occurring, and merely said that "litmus changed colour quicker (or faster) with solution **A**." The Examiners required an appreciation that **B** was reacting with **A**.