# IGCSE COMBINED SCIENCE

**Paper 0653/01**

**Multiple Choice**

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

## General comments

The mean score on this paper was just 60%, which is less than would be hoped for in this paper. However, the mean score for the Physics items was more like 71%, which is much closer to the expected figure. As always, the items were those which had been previously used in papers of equivalent standard, so when it comes to the Physics part of the syllabus, the candidates would appear to have been well prepared.

## Comments on individual questions

### Biology questions

Apart from three questions, candidates coped quite well on the Biology section of the paper. All other questions provided a realistic challenge for candidates.

### Question 1

For candidates offering a science rather than a pure biology paper, it might have been expected that they would be comfortable with the concept of heat increasing the rate of molecular movement. That a significant proportion of the better candidates appeared to think that it would not, might suggest that the problem was in the phrasing of the question. The inclusion of a negative may well have led to confusion.

### Question 2

This question was intended to test only the knowledge that enzymes are protein molecules that produce a violet-mauve colour with biuret solution. It is possible that candidates were misled by reference specifically to catalase, or it might be that they were simply not sufficiently conversant with their food tests. Whatever the reason, this question was almost certainly answered by guesswork, with roughly equal numbers opting for each possibility.

### Question 6

With just over two-thirds of candidates making the correct choice, this would appear to be a satisfactory question, but of those, there were rather fewer of the better candidates than might have been hoped for. There can be no obvious reason why there should have been the belief amongst a quarter of the candidates that a blockage in the pulmonary vein would lead to a heart attack. Perhaps if the blood vessels had been named rather than shown on a diagram, there would have been less of a problem.

### Chemistry questions

Overall, the Chemistry questions seem to have proved to be, in general, more demanding than the Biology and Physics.

The comments below focus on the performance of the lower-scoring candidates.

### Question 16

This proved to be a hard question with low discrimination. Response **B** was the most popular but it is possible that many candidates simply guessed. Apparatus P does not work because both liquids have a boiling point higher than that of water.

Apparatus Q does not work because there is no fractionating column – so response **C** has to be the key.

### Question 18

Although on the hard side, this question discriminated extremely well. Amongst the lower-scoring candidates, responses **B** and **C** were nearly equally popular (about 25%, each). However, **B** is a noble gas and **C** is an alkali metal.

### Question 19

Also promoted guessing amongst the lower-scoring candidates. This is rather disappointing in what is essentially a straightforward question. An alkaline solution and a yellow flame test ought to point to **D** as the key.

### Question 20

Tempted over half of the lower-scoring candidates to choose response **D**. This is surprising since alloy formation is associated with metals so that response **A** might have been thought to be the obvious key.

**Question 21**

Also indicates some lack of basic knowledge in that the lower-scoring candidates tended to favour response **A** rather than **C**, the key.

**Question 22**

Caught many candidates out – across the ability range, although there is evidence that the lower-scoring candidates merely guessed. The term 'salt' can be applied to sodium hydrogensulphate even if only half of the hydrogen in sulphuric acid has been replaced by a metal.

**Question 23**

Also promoted guessing amongst the lower-scoring candidates. Although perhaps an unfamiliar reaction, it is nevertheless disappointing that the breakdown of glucose into carbon and water was not recognised as a decomposition vis-à-vis the other choices.

**Question 24**

Was also a disappointment in that the key, **A**, was nearly the least popular choice of the lower-scoring candidates.

**Question 26**

Why did over half of the lower-scoring candidates consider that plastics are obtained from a renewable resource?

**Question 27**

Amongst the lower-scoring candidates the key, **C**, was the least popular choice. Taken in conjunction with **Question 26**, this seems to point to some weakness with regard to the organic sections of the syllabus.

**Physics questions**

There were several items which large numbers of candidates answered correctly (facility greater than 70%). These were items 28, 29, 31, 36, 37, 38 and 39. There were only two items, which seemed to give candidates some real problems, numbers 34 and 35, but even in these two, roughly half the candidates answered correctly.

Because of the general competence on the Physics section, there are only a few useful comments to be made.

**Question 32**, the vast majority of candidates realised that the work done on the light block would be less but nearly 40% did not realise that the same was true for the power. In written papers, candidates sometimes show that they think that as the labourer is more tired when he lifts the second block, he will have to exert more power.

**Question 33** worked well, but a quarter of candidates answered **A**, presumably because the air gap does prevent some heat loss (but not by radiation).

**Question 34** – whenever refraction questions are set at this level, large numbers of candidates show their ignorance. Ray optics really does need careful study.

**Question 35**, Some candidates linked ability to hear the sound with loudness and therefore amplitude. They failed to spot that it would be too small an amplitude which would prevent the sound from being heard, not too large. In **C**, that sound waves are transverse is true, but irrelevant, despite nearly a quarter of candidates choosing this option.

**Question 36** had over 70% facility, which is good, but the statistics show that 22% of candidates think that current is measured in V.

**Question 40** was one of the few with disappointing statistics, which show that whilst most (but not all) were clear that alpha-particles would not get through the aluminium, they were not no sure about the other three radiations.

# COMBINED SCIENCE

**Paper 0653/02**

**Paper 2 Core**

## General comments

The entry for this component was almost 280 candidates. There were a comparatively large number of very weak candidates who seemed to find the majority of the questions to be inaccessible. Calculations in the Physics questions were comparatively well answered but candidates did not fair so well in most of the Chemistry.

## Comments on specific questions

### Question 1

**(a)** Most candidates scored one mark. Two lines linked the solid to descriptors and missing one of these was the most common reason why two marks were not awarded

**(b)(i)+(ii)** Better candidates realised that this question was about liquid expansion. The question refers to warming of the liquid and references to boiling or evaporation did not receive marks. Candidates were required to discuss the increase in liquid level, and then describe the effects of warming on particle speed and separation.

**(iii)** This required candidates to refer to the absorption of heat by the black paint. A common error was to suggest that the black colour attracts heat energy.

### Question 2

**(a)** Most candidates scored one mark for identifying the uterus. A very small number could identify the amnion and most mistook the cervix for the vagina.

**(b)** This question is often asked and candidates are getting better at learning that mother's and fetus's blood systems are separate. This question was comparatively well answered and many candidates scored all three marks, which were available for reference to diffusion of oxygen from the mother's blood through the placenta. One salvage mark was available for any reference that the oxygen originated from the mother.

**(c)** Candidates generally assumed that the ill effects of smoking on the smoker would transfer directly to the fetus, and most marks lost on this question were the result of this misconception. The required answer needed to refer to the reduction in oxygen transferred to the fetus and consequent effects on fetal growth.

### Question 3

**(a)(i)** Most candidates scored one mark for correctly identifying the period numbers but very few had learned the trend in physical properties on descending Group VII.

**(ii)** In view of the poor success rate of part **(i)**, it was inevitable that many did not gain this mark either.

**(b)(i)** Less than half the candidates gained this mark.

**(ii)** It was not enough for candidates to suggest answers such as *there are two bromines for one magnesium*. Some reference to particles, or amounts was also needed.

**(c)(i)+(ii)** This was comparatively well answered and a majority of candidates suggested chlorine as expected. Ozone (and hence oxygen) is also an acceptable answer. In part **(ii)** it was important to describe the consequence of failure to add chlorine as well as explaining that chlorine sterilised the water. Answers such as *we could not drink the water* were judged inadequate without qualifying statements about risk of disease. A minority of candidates thought that the question referred to the chemical composition of water molecules, and so suggested answers such as *hydrogen*, which is *needed to make water*.

**Question 4**

**(a)(i)** Any reasonable attempt to state Geiger Muller tube, Geiger counter, G-M tube or spark counter gained the mark.

**(ii)** Vague references to the use of protective clothing were not credited unless they specifically referred to the use of lead linings. A mark was also available for references to minimising exposure times.

**(b)(i)** Very few candidates gave the required answer that ionising radiation causes atoms or molecules to become ionised. Some candidates described the characteristics of one or more types of radiation and other described their penetrating powers.

**(ii)** A large number of answers were possible here but candidates needed to avoid vague comments about burns or illness. References to cancers or mutations and damage to cells or DNA were the levels of detail required.

**(c)** This was fairly well answered and most candidates scored at least one mark, with many gaining all three. Acceptable answers to the first statement included heat/thermal, to the second, gas/vapour/steam and to the third, turbine.

**(d)(i)** This question is very often asked and many candidates are still not learning that the reason for stepping up the voltage is to reduce the current and so minimise energy losses on transmission. This question was not well answered. The most common misconception remains the idea that because the electricity has such a long way to go it needs high voltage to make sure it gets all the way.

**(ii)** The majority of candidates had learned how to do Ohm's Law calculations and arrived at the correct answer of **22 ohms**. It is important in these questions to obey the rubric and write a recognisable formula with sensible symbols. No marks are given for the triangular mnemonic. Only one mark is awarded for the correct answer alone.

**Question 5**

**(a)** Most candidates scored some marks for this question. Although none of the descriptors strictly described the chloroplast the code letter **A** was allowed as an answer.

**(b)(i)** This was marked strictly and candidates had to specify root hair cell, there being no accepted alternatives, including root cell. Consequently a minority of candidates gained the mark.

**(ii)** The accepted answer was large surface area but only a minority of candidates gave this answer.

**(iii)** Many candidates had learned the equation and the award of both marks for this question was quite common. Candidates should be reminded that requests for **word** equations mean that word equations and not symbolic equations must be given. They should also be warned to avoid "abbreviating" common substances such as carbon dioxide to $CO_2$ .

**(iv)** Any sensible reference to loss by evaporation was credited. and most candidates scored this mark.

**Question 6**

**(a)** A large number of candidates scored no marks on this question, which was unexpected.

**(b)(i)** About half the candidates scored a mark for correctly referring to heat or light. A common incorrect answer was chemical energy.

**(ii)** The products of complete combustion had not been learned by many candidates. A common incorrect suggestion was butane oxide.

**(c)** Most candidates correctly identified the polymer and went on to give an acceptable reason for their choice. It was decided to accept answers which showed that the candidate understood what a polymer molecule is like, and many could do this.

**(d)(i)** This question prompted a variety of answers. The most common mistakes were made by candidates who either suggested the atomic number or atomic mass of sulphur. Few formulae need to be recalled in this syllabus and candidates should be advised to learn those, which are specified.

**(ii)** Most candidates gained a mark for reference to acid rain, but very few outlined how sulphur forms sulphur dioxide (oxide was accepted) when burnt. Further marks could be gained for some detail of the consequences of acid rain or the effects of sulphur dioxide on humans. The single acid rain mark was the most common award for this question.

**Question 7**

**(a)** Large numbers of candidates correctly referred to the retention of soil by root systems but very few could give a second reason why plants reduce erosion. It was hoped that candidates had learned about the protection of soil from direct impact of rain. The protection from wind was not credited since the question makes it clear that frequent rain would preclude the drying out of soil and so wind erosion would not be a problem.

**(b)** A minority of candidates recognised that species diversity would be low. References to *only a few animals eat sugar cane* did not score since candidates must always make it clear that species diversity refers to numbers of different species. Candidates could gain a mark by saying that only sugar cane is growing and a minority did score this mark.

**(c)(i)** In order to score these marks candidates needed to discuss the process of diffusion through the wall of the alimentary canal. Marks could also be gained by referring to the precise location i.e. in the small intestine or through villi. The most common way marks were lost was to discuss the meaning of the term digestion, which was often done well but regrettably was not the required answer.

**(ii)** This had been learned well by about half the candidates, and many correctly discussed the production of insulin in the pancreas. A mark was also available for reference to the role of the liver in glucose reduction. Many candidates suggested that vigorous exercise or the consumption of large amounts of water would reduce glucose levels.

**(iii)** The majority of candidates recognised the link between energy production and glucose and so most scored one mark. Only a very small number referred to respiration which scored the second mark.

**Question 8**

**(a)(i)** Candidates can expect this question in one form or another in most Chemistry examinations, and they should be encouraged to learn an acceptable answer. Very few could express their answers clearly enough to score the only available mark. A safe answer is that elements contain only one type of atom whereas compounds contain more than one type of atom joined together. The idea that a compound is a mixture of elements does not score the mark. The other safe answer is to discuss the inability of an element to be broken into simpler substances.

**(ii)** Only the better candidates clearly stated that iron oxide is reduced by losing oxygen. Careless answers such as *iron is reduced because it has lost the oxide* scored only one mark. The concepts of oxidation and reduction in terms of gain or loss of oxygen had not been learned very well by most candidates.

**(b)(i)** This mark was rarely awarded. Aluminium seemed to be a common incorrect answer.

**(ii)** Most candidates scored a mark here for references to the need for water and oxygen (air accepted). Additional detail referring to chemical reactions between iron and oxygen or water being prevented because the zinc prevents contact secured the other available marks. Correct discussions relating to sacrificial protection were unexpected on this paper but credited if they appeared.

**(c)** Better candidates recognised that iron sulphate and zinc sulphate would be formed, but the majority of candidates could not answer this question. There was no particular pattern to the incorrect responses.

**Question 9**

**(a)** These questions were successfully answered by most candidates. It was important to describe the different sections on the graph in terms of speed. Thus the responses *increases* instead of *acceleration* or *gets faster* did not score. The award of three marks was common showing that candidates had learned the interpretation of these graphs very well.

**(b)** It was also very common to award both marks for this question, candidates again showing great proficiency in this type of calculation. It is important in these questions to obey the rubric and write a recognisable formula with sensible symbols. No marks are given for the triangular mnemonic. Only one mark is awarded for the correct answer alone. The required answer was **150 m**.

# COMBINED SCIENCE

**Paper 0653/03**
**Extended**

## General comments

There were some excellent performances on this Paper. However, a significant number of candidates appeared to have been inappropriately entered, and there were many who scored marks in single figures. Candidates who have no knowledge of the content in the Supplement of the syllabus have to wade through much unfamiliar material on the question paper in search of questions that they can answer, and it is very likely that they will do better on **Paper 2** rather than **Paper 3**.

In general, marks were spread fairly evenly through the Paper. **Question 2** was often answered very well, but also often answered very badly. Many of the weaker candidates had difficulty with the early parts of **Question 4**, but were able to deal with **Part (b)(ii)**. Some struggled with all parts of **Question 6**, and it was not uncommon for candidates to score 0 on this; others answered it well. Almost all, however, dealt very confidently with the calculations in **Question 9**.

## Comments on specific questions

### Question 1

**(a)** Most candidates gained at least 2 marks here. The most common errors were to link the 'expands the most when heated' box with a solid, or not to link that box to anything.

**(b)** This was less well done. Many candidates struggled to link particles and pressure. Those who used the term 'collisions' generally scored at least one mark, but not all explained the increase in pressure as due to increased *frequency* of collisions with the wall of the cylinder. Some described what the particles were doing, but did not state what effect this would have on the pressure. Some used very poor and inappropriate language, for example describing the particles as 'trying to escape'.

### Question 2

The range of answers on this question was very wide. Many gave excellent answers, whilst others had no idea what was meant by a 'genetic diagram'.

**(a)** This proved surprisingly difficult. Few candidates were able to explain either what an 'allele' is, or the meaning of the term 'recessive'. The simplest definition of an allele is a particular variety of a gene.

**(b)(i)** This question tested understanding of the meaning of the term 'genotype', but many candidates gave the phenotype instead. A few invented their own symbols for alleles.

**(ii)** Where candidates knew how to draw a genetic diagram, this was usually done entirely successfully. To gain all three marks, the answer needed to indicate the genotypes of the parents, the gametes and offspring. Weaker candidates sometimes tried to draw a pedigree.

**(c)** This was often well answered. Many answers explained that amino acids come from proteins, and therefore that Rohani should take care not to eat protein-containing foods such as fish or meat.

**Question 3**

**(a)** It was rare to see a correct answer to this question. Most simply guessed, and there was no pattern in their answers.

**(b)(i)** Many candidates completed the bonding diagram to show $CCl_4$ rather than methane. They could still get one mark if the diagram was correct.

**(ii)** The long and complex working around this equation showed that some candidates spent a very long time in working out their answer. In general, answers were correct, but this was not always the case. The most frequent error was to place a 2 in front of $Cl_2$ rather than a 4.

**(iii)** Many candidates correctly suggested that fluorine would react most vigorously, but their explanation went no further than saying that this is because it is the most reactive. The expected answer was that it is at the top of the group in the periodic table**;** reactivity decreases as you go down the group. A few candidates correctly explained the reason for this trend. A very common incorrect answer was bromine.

**(c)(i)** There were numerous answers, even from good candidates, which gave a general description of the meaning of the term 'isotope' rather than answering the question, which was about *these* isotopes. Candidates needed to say that the second isotope has two more neutrons than the first.

**(ii)** This was generally correctly answered, although a few candidates used the atomic numbers rather than relative atomic masses in their calculation.

**Question 4**

**(a)(i)** Once again, candidates had great difficulty in explaining the meaning of this technical term. A wide range of answers was accepted, but nevertheless it was common to give no marks for this part of the question.

**(ii)** This was better answered, with most answers mentioning the longer half-life of sodium -24.

**(iii)** A good number of candidates were able to do this calculation correctly, with working visible that enabled the Examiner to see how they had arrived at their answer. Some only calculated the mass after two half lives, but they could still gain one mark for this. A few left out the unit in their answer.

**(b)(i)** The expected answer was that high voltage means low current, which in turn reduces the loss of energy in the wires, as many candidates correctly explained.

**(ii)** This was generally done well, even by candidates who had scored 0 in the earlier parts of the question. Some did not know the unit for resistance.

**Question 5**

**(a)** While many candidates answered this entirely correctly, others went completely astray. The commonest errors were to suggest that the cell wall controls what enters or leaves the cell, and that the cell surface membrane is fully permeable.

**(b)(i)** This was well answered, even by weaker candidates. However, there was sometimes confusion about concentration gradients (does water move from *its* high 'concentration', or the solute's?).

**(ii)** Most candidates knew that iodine would be used to test for starch, but they then stopped thinking clearly and gave the expected colour as blue-black - even when they had explained in their answer to (i) that starch molecules were too big to get through the membrane.

**(c)** Few candidates really answered this question as it was asked. Many described *how* the water moves into the plant, or what happens to it *after* it has reached the xylem vessels. All that was required was a reference to root hairs and to the water moving through the cells of the root (some knew the term 'cortex') and into the xylem vessels.

**Question 6**

**(a)** This was surprisingly badly answered. Some candidates did correctly name carbon dioxide, carbon monoxide or water, but there were many wild guesses, such as butane oxide or methane dioxide. Candidates should also be reminded that, when a question asks for a name, then a name is expected in the answer, not a formula.

**(b)(i)** This should have been answered correctly by every candidate, as the formula for methane had been given in **Question 3(b)** and many candidates had correctly drawn a bonding diagram for it. However, mistakes were frequent, with D the most common incorrect answer.

**(ii)** Some candidates correctly identified this large molecule as a polymer, and explained how many monomers must have joined together into a long chain to form it.

**(c)(i)** Few candidates answered this question confidently, but many correctly guessed that heating might be involved - though many seemed to be describing fractional distillation rather than cracking. Some also mentioned the use of a catalyst.

**(ii)** Many answers correctly stated that the hydrocarbon has only single carbon-carbon bonds; if there were any double bonds, then the bromine would have been decolourised.

**Question 7**

**(a)** Many candidates were able to give a partial answer to **(a)**, but it was rare to award two marks. The most common correct answer involved reference to the roots holding the soil. Some candidates also explained that the leaves would stop raindrops falling directly onto the soil.

**(b)** This was usually well answered, although some described seed or fruit dispersal.

**(c)(i)** Very few candidates were able to go directly into a relevant answer to this question. Almost all began by attempting to describe digestion, and immediately got into difficulties by describing glucose being ‘broken down’ to ‘sugar’ or ‘starch’ by amylase. Such descriptions often used up all the available answer lines, so the relevant part of the answer was squeezed into the space below.

**(ii)** This was often answered very well, and many candidates clearly understand the role of insulin in the control of blood glucose level.

**(iii)** This was a difficult question, but better candidates were often able to make a very fair attempt at it, frequently using references to insulin and the control of blood glucose level. Many, however, seemed entirely unfamiliar with the term, and invented meanings that had nothing to do with homeostasis or any other function of the body.

**Question 8**

**(a)(i)** Some candidates misunderstood this question, and tried to explain the difference between iron and iron oxide, rather than between an element and a compound. The simplest explanation is that an element contains only one type of atom, whilst a compound contains different types of atoms bonded together.

**(ii)** Better candidates had no difficulty in working out the charge on the $Fe^{3+}$ ion, but they could not always explain their reasoning.

**(b)** Although some candidates did recognise that zinc is used in galvanising, this was relatively rare to see. However, many answers did explain that the coating prevents oxygen and water coming into contact with the steel. Some correctly described how sacrificial protection works.

**(c)(i)** Surprisingly few candidates were able to give a correct answer to this question. Common errors included $H_2$, $H_2O$ and OH.

**(ii)** Most answers correctly suggested that the bubbling would stop.

**(iii)** This question required some careful thought, and it was good to see many correct answers. Candidates who recognised that a displacement reaction would take place generally got at least two marks. However, it was rare to see a correct statement about what would be *observed* as the reaction took place. Many referred to bubbles again, even when they gave an entirely correct word or symbol equation for the reaction, where it was clear that no gas was evolved.

**Question 9**

**(a)** Both parts of this were generally answered correctly. A few candidates, however, thought that the athlete was running at a steady speed between A and B, and had stopped between B and C.

**(b)** Most candidates recognised that they needed to calculate the area under the graph, and were often able to do this correctly. Several misread the question, and calculated the whole distance travelled, not just the distance travelled over the first 20 seconds. Some came up with rather improbable answers, such as 175 km, but did not seem to recognise that this was unlikely to be correct.

**(c)** This was generally answered correctly.

**(d)(i)** Most knew the formula f = ma, and were able to calculate a correct answer. However, not all gave a correct unit.

**(ii)** The formula power = work/time was even better known, and most candidates again calculated a correct answer. Once again, not everyone gave a correct unit.

**(e)** This was often well answered. Some very good answers included careful diagrams showing how a vertical line drawn from the centre of mass would lie inside or outside the base as the trophies were tipped over. However, so long as the ideas of a low centre of mass and a wide base were contained in the answer, full marks could be given. A few suggested that ‘trophy X’ would be the most stable. They could still get two marks if they appeared to be describing trophy Q.

# COMBINED SCIENCE

**Paper 0653/04**

**Coursework**

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

Seven Centres submitted coursework for the June examination. Most have provided coursework in previous years and have acted on advice given. In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates' work was comparable with previous years with candidates covering the whole mark range. The organisation by most Centres was much improved.

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

In all Centres the assessment criteria were well understood and applied for most practicals. In a few cases the task was not sufficiently demanding to warrant the use of the full mark range. No Centre tried to assess both skills C1 and C4 in the same investigation.

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

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

**(d)** Good practice.

Some Centres make very useful comments about individual candidate's performance on a summary sheet. Most Centres provide a comprehensive package of information provided to candidates usually in the form of worksheets together with appropriate marking criteria.

# COMBINED SCIENCE

**Paper 0653/05**

**Practical**

## General comments

A number of Supervisors commented upon the difficulty in obtaining good quality material for **Question 1**. These difficulties have been noted and will be taken into account. Whilst the majority of Supervisors complete their own copy in entirety, some do not. It is essential that the Supervisor does the experiments under similar conditions to the candidates and encloses the results with the scripts. The Examiners take a great deal of trouble to ensure that candidates are not unjustly penalised and a full set of results for comparison purposes are vital. It is equally important that the Supervisor instructions are followed, e.g. in **Question 1** a note was included concerning the preparation of the pepsin and amylase solutions. Results in some cases suggested that this note had not been followed.

There was some indication that the time allocated was insufficient. This is of course the same for all candidates. The mark scheme produced a good spread of marks and all marks were used.

## Comments on specific questions

### Question 1

Without doubt this was the most difficult question. The instructions were lengthy and had to be followed very carefully to obtain good results. Many appeared to have little understanding of what this question was testing and any wrong observation made the answering of part **(b)** difficult. The key to this experiment was found in the statement for each of the two tests, namely pepsin and amylase. The observations made in part **(a)** were frequently incorrect. Often the result of poor or careless work but made more difficult if a similar exercise had never previously been encountered. Part **(a)(ii)** needed special care but the starch/iodine test should have been very familiar even if never carried out in this particular manner. Part **(b)** was dependent upon the observations although few were able to make the appropriate connections and as a result, this part was poorly answered. A common mistake in part **(ii)** was to give the number of a tube rather than the name of the enzyme. Another common answer was 'protein' or 'starch'. Few appreciated that it was the low pH in **(iii)** that did not allow the starch to be broken down. The statement that starch was not broken down did not score a mark.

### Question 2

A significant number did not attempt to measure the plasticine accurately although this was not penalised in this instance. Stating the units in centimetres does not mean the answer is in whole numbers. The Fig. 2.1 did make it clear that measurement 2 was going to be the largest. A good number made either measurement 1 or 3 the largest. Inevitably some candidates did not heed the instruction to weigh to the nearest gram. Any attempt to weigh more accurately was penalised. The mark in **(c)** was essentially for a correct calculation of mass divided by volume although a result greater than 3 suggested poor measurements and did not score. Part **(d)** was generally well done as was part **(e)**. The value of $d_1$ should have been 10 cm less than the balance point although not all candidates agreed. Equally there were those who produced an impossible figure for $d_2$. If the balance point was say 50.0 cm it is difficult to see how $d_2$ could be greater than 50 cm. Some unusual metre rules! The majority correctly used the equation in **(e)(iv)** and were able to calculate density.

**Question 3**

Answers to this question were in the main very good.  A number were careless in recording the mass of X, a very easy mark wasted.  A volume of gas between 40 and 60 $cm^3$ was acceptable and many scored both marks.  Part **(b)** was almost always correct so long as the name of the gas was used and not its formula. The colour in (c) had to be in the blue region and the pH needed to be about 10.  A common answer in **(d)(i)** was ‘hydrogen’.  Presumably some tested this acid solution in **(ii)** as the pH was often recorded as being 1.

# COMBINED SCIENCE
# CO-ORDINATED SCIENCES

**Papers 0653/06**

**Alternative to Practical**

## General comments

As usual, this paper contains questions that encourage the candidates to imagine themselves at the laboratory work-bench, actually doing the investigations on which the questions are based. Parts of each question demand a knowledge of laboratory procedures appropriate to the syllabus. Other sections require the candidate to record their observations and to display or manipulate the data. Conclusions must be drawn from the information. Finally, the candidate may have to suggest extensions to the investigation or to use their knowledge to explain certain aspects of the experiments.

Some candidates did not read the descriptions of the experiments carefully enough and so were unable to answer the more tricky and subtle questions. Those without sufficient laboratory experience were caught out, as usual, by questions that required a certain degree of skill and experimental aptitude. However, there was a smaller proportion of weak candidates than usual. The majority of Centres are to be congratulated on their success in preparing their candidates for this paper. Many excellent candidates showed real insight and ability in their answers. Correct answers were given to every question but no one candidate scored 100%.

## Comments on specific questions

### Question 1

The question described the procedure for testing two digestive enzymes, amylase and pepsin, to discover whether their activities are affected by different pH levels. The pepsin was added to a cloudy protein solution with and without hydrochloric acid, and the amylase was similarly added to starch solution. Finally, all the mixtures, together with the unmixed protein and starch solutions were kept at 40° C for five minutes: the candidates were told that the acidified pepsin-protein mixture had become clear. The un-acidified amylase-starch mixture had undergone digestion; shown by the use of iodine solution.

**(a) (i)** Most candidates correctly listed the contents of the six test-tubes.

**(ii)** The observations of the protein tubes, recorded as cloudy or clear, gained two marks. A large number of candidates tried to give more information about the reactions that could not be observed.

**(iii)** The recording of the observations following the addition of iodine to the starch tubes gained another two marks. Candidates found this to be harder than part **(i)**, as they needed to recall that starch gives a blue-black colour with iodine.

**(b) (i)** The question “Which enzyme worked better in conditions of low pH?” was often incorrectly answered, because “low pH” was thought to mean “a low concentration of acid” whereas the opposite is true; so “amylase” was the wrong answer.

**(ii)** This followed part **(i)**, asking for an explanation for the lack of activity of amylase in the tube containing hydrochloric acid. Unfortunately the candidates answering “amylase” on part **(i)** sometimes explained that “amylase only works well in conditions of low pH”, so losing this mark as well.

**(iii)** The reason was asked for the inclusion in the experiment of tubes containing only starch or protein. A minority of candidates used the word “control” in their answer. “To see whether starch or protein will digest in solution at 40°C without the enzymes” was accepted, but there were many poorly phrased answers, and the response "to compare with the other mixtures" was not given a mark.

**(c)** Finally, a test for protein in solution was sought from the candidates. The name of the test was not necessary if the candidate suggested the addition of copper sulphate and sodium hydroxide. “Benedict’s” solution was NOT accepted, even though it would work in practice, giving the same purple (mauve, violet) colour that gained the second mark.

A commendable proportion of candidates gained all or most of the marks for this question.

**Question 2**

This question, together with **Questions 1** and **3**, is based on the corresponding practical examination. The candidates in the practical examination had to find the density of plasticine by two different methods. In the first method, a cube of plasticine having each side about 2 centimetres was made by hand. It was measured using a ruler and then weighed on a balance. In the second method, the volume of the cube was found by displacement of water in a measuring cylinder and the mass was found using a balanced metre rule and a known mass. Most errors in this question were because the candidates did not imagine themselves actually carrying out the experiment. The importance of this ability was mentioned in the introduction.

**(a) (i)** Most candidates managed to find the length of one side of an illustrated cube in millimetres, convert this to centimetres and then find the cube of the number to give the volume. The cube in the diagram had rounded corners, illustrating the difficulty of making a perfect cube. Although the correct method of calculating the volume was given, some candidates substituted different numbers in the equation.

**(ii)** The mass was found using the diagram of the balance window, as usual. The subdivisions of the scale were 0.2 g each, some candidates read them as 0.1 g; thus, 25.1 g was correct but 25.2 was not.

**(iii)** Too many candidates multiplied the mass and volume to find the density, but most used the correct method here, and errors in parts **(i)** and **(ii)** were carried forward.

**(b) (i)** There were some candidates who did not realise that part **(b)** was concerned with an entirely different way to calculate the density of the plasticine. Thus, they tried to use data from part **(a)**. The measuring cylinder showed the total volume of water and plasticine as 110 $cm^3$, after 100 $cm^3$ was the initial volume of water. It should have been simple enough!

**(ii)** Now a diagram showed a symmetrical 100 cm beam with a 50 g mass at the 30 cm mark on a metre rule, balanced by the plasticine at the 90 cm mark. The first task was to find the distance of the two masses from the pivot. Some candidates measured the diagram on the page instead of calculating! Fortunately the artist had drawn it to scale, so the two distances on the diagram were in the ratio of the actual distances.

**(iii)** The equation for calculating the mass of plasticine was given, so it was just a matter of substituting the distances from the pivot, calculating 20 x 50 g and then dividing by 40. Alas, some candidates found the answer as 2.5 g because they calculated 20 x 50 as 100.

**(iv)** The density of plasticine was found using these values of the mass and volume. The same mistake was made here as in **(a)(iii)**.

**(c)** Candidates were invited to suggest which measurement of volume was the more accurate. There were two possible answers. The shape of the hand-made cube and the measurement of its dimensions was sure to be inaccurate. Also, the scale of the measuring cylinder showed only 10 $cm^3$ increments, so it was impossible to measure the volume to the nearest $cm^3$. Either of these observations could gain the two marks. However, many candidates failed to make sensible suggestions. A large proportion of errors arose because the question was not understood, so mass measurements were discussed. Others wrote that it was difficult to measure the cube with a ruler. This gained no marks. Comments about human error in measuring were not relevant, since this could be involved in either of the methods of finding the volume.

Most of the better candidates were able to gain 9 or 10 marks for this question.

**Question 3**

The decomposition of a carbonate, substance **X**, to give a measured volume of carbon dioxide, forms the basis of this question.

**(a)** **(i)** and **(ii)** The procedure for heating the carbonate and collecting the evolved gas, in a measuring cylinder over water, is outlined. The candidate had to suggest what happens if the delivery tube is not removed after heating, from below the surface of the water in the trough. This question was found to be the hardest part of the examination. Many candidates suggested that the gas in the measuring cylinder returned to the test-tube in which substance X was heated. A very few correctly said that water entered the test-tube, but were usually unable to give the reason for this, that the gas in the test-tube cooled down and contracted so that air pressure forced water into the tube to take its place. This kind of investigation, in which a gas is collected over water from a heated source, clearly does not form part of the laboratory experience of most candidates; this is a great pity.

**(b)** Surprisingly, many candidates could not read the volume of gas in the inverted measuring cylinder.

**(c) (i)** The question said "Explain how the candidates can use limewater to test the gas that is in the measuring cylinder". This should have been clear enough, but most candidates did not absorb the literal meaning of the question. The gas is in the cylinder over water. How do you do the experiment? The Examiners looked for suggestions that the measuring cylinder must be covered and lifted out of the water, limewater is poured in and then the cylinder is shaken, or the gas in the cylinder is sampled and passed into limewater. Answers such as "Bubble the gas through limewater" or "add limewater to the water in the trough" gained no marks. Such answers show that candidates had not imagined themselves to be actually doing the experiment, a requirement noted in the introduction to this report.

**(ii)** Most candidates could state that the gas was carbon dioxide.

**(d)** **(i)** and **(ii)** Substance **X**, and the residue from heating it, are tested with Universal Indicator. The pH of the solutions is said to be 8 and 10 respectively. Candidates were not expected to know the accurate colours of the indicator at these pH levels. However, a change of colour from greenish-blue to blue-purple was looked for. For example, the colours blue and purple were accepted as the correct answers.

**(e)** Candidates were asked to suggest an alternative method for collecting the gas carbon dioxide that does not use water, such as the use of a graduated syringe. Many could not do this, suggesting that candidates had never seen this happen. A few enterprising candidates suggested that carbon dioxide could be collected over oil, and credit was given for this answer. Some diagrams showed apparatus that would have exploded when heated.

**Question 3** was the least satisfactorily answered of all the questions in the examination. The Examiners have commented in previous years on the poor performance of some candidates in questions based on chemistry. There is still room for improvement in this respect.

**Question 4**

This question is based on an experiment to investigate the process of transpiration in leaves. Success in answering the question is built on a proper understanding of the procedure. Four sets of leaves are compared, three of which are treated with grease on one or both surfaces. The leaves are weighed before and after a 48-hour period.

**(a)** Almost all candidates were able to find the change in the masses of the leaves before and after the 48 hours drying period.

**(b) (i)** Most candidates were successful in calculating the average loss in mass of each set of leaves. The final set lost an average of 0.03 g: a few candidates did not calculate to this accuracy and lost a mark. A number of candidates divided by 2 to find the average of three amounts, showing a mathematical weakness.

**(ii)** It was easy to see that greased leaves lost far less mass on average than ungreased ones, an answer given by most candidates.

**(iii)** The question "Which surface, upper or lower, allowed the greater amount of water loss?" proved more difficult. Some confused candidates thought that the question referred to the surface that had been greased. Their incorrect answer could not be supported by the data, so they lost two marks.

**(iv)** The lower surface of the leaves allowed more loss in mass. Candidates were expected to refer to the greater concentration of stomata on the lower surface, but if they adequately described the waxy layer on the upper surface of some leaves, a mark was awarded.

There were many completely correct answers to this question.

**Question 5**

In the experiment on which this question is based, 10 $cm^3$ portions of water at 80°C were added to 50 g of ice and the resulting temperature of the mixture was measured each time. No temperature rise was noted until the $6^{th}$ and subsequent additions. Three thermometer scales were shown so that the candidates could read and record the last three temperatures.

**(a)** The thermometer readings were expected to be recorded to the nearest 0.1°C, appropriate to the details of the thermometer scales. Alas, many candidates failed to record 20.0°C for the third reading and so lost a mark.

**(b)** The candidates had to plot volume added against the temperature of the mixture. A graph grid was supplied with the x- and y-axes marked and labelled. The y-axis began at -10°C, a fact that misled some candidates, since they plotted the 0°C reading on the lowest line of the graph. Only one mark was deducted for this error, but the candidates inevitably penalised themselves further in part **(c)(ii)**. The correct graph had the shape of two straight lines intersecting at 51 $cm^3$ and 0°C, the point at which all the ice had melted and the temperature of the mixture began to rise.

**(c) (i)** Candidates had now to explain why the temperature did not rise until six portions of hot water had been added. A distractor to the correct answer was provided by the equivalence of the masses of ice and hot water! The answer "because 50 g of hot water had to be added to 50 g of ice" was not accepted. Other candidates said that the ice did not begin to melt until this point, or that it took a long time to melt. The answer that there was still some ice present in the mixture until a certain volume of hot water had been added, or that all the heat energy added had been used in melting the ice while the temperature did not rise, was acceptable.

**(ii)** Candidates who had correctly plotted and drawn the graph, were able to deduce the volume of hot water needed, about 51 $cm^3$.

**(d)** An equation was given for the calculation of the amount of heat energy needed to melt the ice. Candidates had merely to substitute the temperature of the hot water and the volume deduced in **(c)(ii)** and then complete the calculation. The most common error here was in giving the wrong temperature of the hot water, information that was right at the beginning of the question. Correct calculation was credited, for one mark, even if substitution of one value was incorrect.

Some candidates gained full marks on this question, but overall the answers were slightly disappointing.

**Question 6**

The solubility of oxygen in water is of vital importance to the planet and all its inhabitants. An experiment to discover the composition of dissolved air is described in this question. Water from a mountain stream is boiled and the boiled-out air is collected. Then its composition is investigated by using up the oxygen in rusting iron.

**(a)** The graduated tube in which the volume of boiled-out air is to be found is placed over the end of the delivery tube; what must it contain? Experience of collecting any gas over water gives the clue, but a significant number of candidates did not answer "water".

**(b)** "What happens to the steam produced when the water boils?" An innocent enough question, but the majority of candidates seemed to fall into the trap and say that it was collected in the graduated tube. Some candidates said that the steam evaporated and became a gas, and there were even a few who said that it became hydrogen!

**(c)** The section of the graduated tube showing the water level was illustrated here. Alas, some candidates did not realise that the whole of the tube was not shown, so they did not record the actual reading but tried to calculate the volume by subtraction. Also, the subdivisions of the scale were 0.2 $cm^3$ so others recorded 12.2 when it was actually 12.3.

**(d)** After iron filings had been allowed to rust in the air within the tube, its volume had decreased. The scale was again shown. An error in finding the volume, similar to that in part **(c)**, was made by some candidates.

**(e) (i)** The volume of oxygen removed could be found by subtraction. Errors were "carried forward" when this was marked.

**(ii)** The percentage of oxygen in the boiled-out air could now be found. Some candidates, having answered correctly to this point, failed to find the right formula for this calculation. The data leads to a composition of about 35% oxygen by volume in the boiled-out sample. Errors were carried forward when marking.

**(f) (i)** Given the normal composition of air, candidates were asked to suggest which is more soluble in water, oxygen or nitrogen. The greater proportion of oxygen in boiled-out air should have led them to the conclusion that oxygen is rather more soluble.

**(ii)** Asked why the solubility of oxygen in water is important to aquatic plants and animals, candidates showed some ignorance about processes in which oxygen is used up. Many candidates said that oxygen is used in photosynthesis. Any reference to respiration gained the mark. Such comments as "they will die without oxygen" gained no credit.

This question was effective in demonstrating the insight of the better candidates and the lack of laboratory experience of others.