COMBINED SCIENCE

Paper 0653/01
Multiple Choice

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

General comments on whole paper

At 46%, the mean on this paper is way below what would be expected. Candidates who hope to achieve good grades need to be better prepared.

Comments on individual questions (Biology)

General comments

Candidates tended to find the Biology questions more difficult than in past years, but no question strayed beyond the knowledge required by the syllabus. All but one of the questions exhibited a satisfactory degree of discrimination and the one that failed did so only marginally and remained acceptable since it was the easiest question in the section.

Comments on individual questions

Question 2

It was clear that less able candidates were not comfortable in the knowledge that diffusion occurs from a h to a low concentration, with a third of them selecting the option which was the exact reverse of this fact. This may indicate a failure accurately to read the question.

Question 3

There is a misconception that lowering the temperature of an enzyme will denature it, and this led to over a quarter of the candidates opting for **A**. The question was straight-forward in that it asked for no more than a recognition of the fact that it is boiling that has this effect on enzymes.

Question 4

This was the easiest of the biology questions, though there was more than a hint of the erroneous belief that water enters plants through their stomata.

Question 5

Food tests are a basic part of the Biology section of the syllabus, but the responses to this question would suggest that the majority were unsure of the expected results – particularly of the biuret test for protein, where almost three-quarters thought that pale blue represents a positive result.

Question 6

The syllabus refers to 'goblet cells .. in the trachea and bronchi'. It was therefore disappointing that only 30% appeared to be aware of that fact, with over a quarter of candidates believing that they are located in the intercostals muscles, and even some able candidates suggesting the pleural membranes.

Question 7

Nearly a quarter of the candidates were unclear which chambers of the heart are atria and which are ventricles.

Question 8

With less than a fifth of the candidates selecting the correct answer, it would appear that this question was not particularly successful. Certainly it revealed several misconceptions. Amongst the grey areas were whether the coloured solution would be carried in the xylem or the phloem, which of the tissues in the diagram was the xylem and believing that the whole of the vein would carry dissolved substances absorbed by the stem. Almost a quarter, in apparent total confusion, opted for the intercellular spaces becoming stained. Certainly some able candidates confused xylem and phloem, but despite all the problems, the few who were successful were those who did well, overall, in the test.

Question 12

This information was about the carbon cycle, but the question asked for knowledge of when *oxygen* would be released. Candidates needed to think through carefully when answering the question. Almost a half of the candidates are to be praised for working out the problem successfully, though it is very difficult to follow the reasoning that led almost a quarter to believe that oxygen is released when carbon compounds in plants become carbon compounds in dead organisms.

Comments on individual questions (Chemistry)

The Chemistry questions in this paper performed quite well being of approximately equal difficulty for Biology and Physics.

Only **Question 17** proved to be significantly straightforward with a large proportion of candidates choosing the correct option. The following questions proved to be difficult for candidates.

Question 23

Here weaker candidates tended to opt for option B rather than the correct option C. This was due to candidates not reading the question thoroughly and simply linking the colour blue with copper compounds in test-tube 1.

There was a slight tendency for the stronger candidates to choose option D, not realising that the magnesium would consume all the acid.

Question 24

Here weaker candidates tended to choose option B, realising that a combustion reaction occurred but not that it was also a redox reaction. The question discriminated well.

Question 27

This question also discriminated well with only the stronger candidates choosing the correct option, B. Weaker candidates were equally spilt between options C and D. The confusion between monomers and polymers caused these errors. Candidates based their reaction on the second line of the stem instead of relating back to the fact that compound X was used to make the plastics.

Comments on specific questions (Physics only)

In general, candidates did not find the Physics items on this paper particularly easy. None of the item facilities was above the 70% level, which is unusual for candidates sitting this paper. On the other hand, questions where the facility showed that candidates found the topic particularly difficult were 30, 36 and 39. The following comments on selected questions may be of help to teachers.

Question 28 showed up a candidate weakness, which can be summarised by the warning “Read the question carefully”. Nearly half answered this item correctly, but almost as many chose D, which would only have been the correct answer if the question had asked for the elapsed time measured by stopwatch Y. Slack thinking affected answers to question 30, because less than a quarter of candidates answered correctly, whereas nearly two-thirds got the densities reversed. A surprising lack of understanding of spring extensions showed itself in question 31, and how 21% could think that the extension is found by adding the two spring lengths is a real mystery. In question 33 candidates cannot have been thinking clearly because 58% of them thought that the ball, despite losing energy during the bounce, still managed to rise back to the starting position *or higher*. It would be interesting to see what logic led to this conclusion.

In question 34, there was a surprisingly large number who seemed to think that heating the rod would shrink it so that it would go in the hole. Question 36 was identified above as an item the candidates found “hard”. Actually, question 36 showed up a lack of understanding. Only a quarter answered correctly, with a majority of the rest thinking that the ray went on to pass through the other principal focus. Question 38 was answered correctly by half the candidates, with the remainder tending to go for the two common misconceptions that (i) the electricity gets progressively weaker the further it goes from the supply, and (ii) lamps in parallel must be dimmer. The transmission of electricity using high/low voltage was not well understood (question 39), with the statistics suggesting widespread guessing.

COMBINED SCIENCE

Paper 0653/02

Core Theory

General comments

The entry for the November sitting of this component continues to be about double that of the June entry with 732 candidates submitting scripts. Only a very small number produced excellent scripts suggesting that they would have gained a higher grade than C if entered for Paper 3. Rather a large proportion of the entry scored very low marks and often left many questions unanswered or produced answers which suggested that they were unfamiliar with both the syllabus content and examination technique. Even better candidates spent unnecessary time giving lengthy answers where a short phrase would have secured the same number of marks. There was evidence that some candidates did not have the use of a calculator. There was no evidence that candidates had difficulty in completing the paper in the available time.

Comments on specific questions

Question 1

(a) (i) This had not been learned well by candidates. The idea that arrows in food webs represent energy flow was rarely stated. Candidates usually opted for an answer such as *they show what eats what*.

(ii) This was usually answered correctly. Candidates across the ability range showed that they could identify producers and consumers in the food web.

(iii) The required answer was *all of them*. This response was hardly ever given with candidates usually opting for one or two of the organisms shown in the question. The most common choice was *hawks*. Strong candidates, that correctly responded to part **(a)**, tended not to score this mark.

(b) (i) Some excellent answers were seen, showing that candidates had a good understanding of digestion. Most candidates scored at least one mark. It was important for candidates to be clear about the need for digestion. Answers needed to refer to *absorption*. Responses which discussed the slightly vaguer idea of *extraction of nutrients* did not score the second mark. However, if candidates amplified this by adding *into the blood* then the mark was given. Another answer which was commonly seen, but which did not score, was the idea that digestion is needed *so that food can go into the alimentary canal*.

(ii) Candidates generally scored at least one mark here with good descriptions of mechanical digestion. It was important, however, that discussion of chemical processes specifically mentioned enzymes or a named enzyme.

(c) Several marking points were available in this question, and candidates tended to show that they understood in general terms what this question was about. When discussing the entry of carbon dioxide to the plant, candidates had to state, or strongly imply, that the gas entered *from the air*. Better candidates referred to *stomata* although this was not essential. A sensible inclusion of the term *photosynthesis* also gained a mark. Candidates often gave confused versions of the overall chemical process involved in photosynthesis, but they could gain a mark if they made it clear that carbon dioxide and water became combined. Reference to the site of photosynthesis in the chloroplast was another marking point, but very rarely seen in answers.

Question 2

(a) (i) Very many candidates committed a rubric infringement and drew either a single arrow or arrows. Many others drew arrows very carelessly with seemingly little attention to making look vertical. Although many correctly labelled the ball's weight only a very small minority identi upthrust. The most common reason for losing a mark was poor labelling.

(ii) The majority of candidates understood the concept of balanced forces. In order to gain this mark they had to state that the forces were balanced because the ball was not moving. Even if they had drawn no arrows at all in part **(i)**, or had drawn them incorrectly, candidates very often scored the mark for part **(ii)**. Generally this was answered well.

(b) The required answer was 0.3. Only a minority of candidates gave this answer.

(c) (i) To gain the two marks available, candidates needed to discuss the fact that waves possess kinetic energy and that this is converted to electrical using a generator. Some intricate descriptions of devices were seen but candidates hardly ever mentioned kinetic energy. There was a tendency for candidates to combine concepts drawn from wave, tidal and hydroelectric sources in their answers. Fair numbers of candidates gained a mark for a sensible reference to a generator but hardly any scored two marks.

(ii) Candidates could usually state the name of a renewable energy source. Common answers which were not allowed included *light, the sun, the Earth* and *nuclear*.

(d) A wide range of suggestions were seen. The most common incorrect answers were still reasonable attempts e.g. incorrect parts of the electromagnetic spectrum. However, many candidates correctly referred to ultra violet.

(e) This question produced a very wide range of incorrect responses. Provided rays actually passed through the lens, bore a reasonable relationship to the incident rays, were not shown casting a shadow and a reasonable attempt had been made to draw them straight, then one mark was scored. The second mark was for bringing them to a focus between the lines of the incident rays. Some candidates failed to score the second mark because they drew converging rays but did not bring the lines to a focus.

Question 3

(a) (i) Only *petroleum* or *crude oil* was accepted. A surprisingly wide range of incorrect responses were suggested by large numbers of candidates. The more reasonable suggestions which were not accepted included *petrol, fossil fuel* and *dead plants.*

(ii) Very few candidates could answer this question. Any reasonable suggestion which was closely related to boiling point, intermolecular forces or molecular size was accepted, but despite this very few marks were awarded.

(iii) This question is frequently asked and yet the knowledge required to answer it had not been learned very well by the majority of candidates. Many scored one mark for *carbon dioxide* but only a minority obtained both marks. *Hydrogen oxide* is not accepted as an alternative for water. Many candidates suggested *carbon monoxide* which could not be accepted.

(iv) Questions concerning climate change and pollution issues are often asked but the basic concepts had not been learned very well by most candidates. Candidates in some Centres showed very little knowledge of the suspected role of carbon dioxide in global warming. No mark was available for discussing the consequences of global warming. It was common for candidates to confuse concepts involved with global warming and ozone depletion.

(b) (i) This question proved difficult for many candidates who were unsuccessful in interpreting the bar chart to identify gas **R** as *nitrogen* and gas **S** as *oxygen*. Those who named these gases in the reverse order scored a maximum of one mark, but large numbers of candidates revealed that they had not understood what this question was about.

(ii) One mark was for referring to *unreactivity*. It was not enough simply to say that *argo* Many candidates suggested that the low proportion of argon in the air meant it would be that it could have no effect. A second mark was for further information relating to the u nature of argon, such as a reference to *filled electron shells*. A reasonable number of cand gained one mark, but two were rarely awarded.

Question 4

(a) (i) Large numbers of candidates successfully stated the required formula, showed clear working and gave the correct answer which was 6.94 m/s. Inappropriate numbers of significant figures were not penalised. Ideally the candidates should have written down the formula **speed = distance / time**, but a mark was awarded if they gave just the right hand side of this equation. Suitable symbols were accepted as alternatives for the words. The mark for the answer was awarded provided it was the correct answer and the working shown was consistent. Success in this question was not related to success in the rest of the paper. Many candidates who had not learned much of the other subject matter still managed to produce perfect answers to this question.

(ii) The majority of candidates did not score the marks for this question. Calculations involving acceleration were far less familiar than the type of calculation in part **(i)**. One mark was available for stating the formula **acceleration = change in speed / time** although as in part **(i)** the mark was awarded just for the right hand side and/or the use of appropriate symbols. Several candidates did not gain the mark because their use of symbols did not show the *change* in speed. The second mark was for consistent working and the answer 1.67 m/s^2. Inappropriate numbers of significant figures were not penalised.

(b) The majority of candidates were not able to describe the energy changes involved in this question. Common mistakes were to discuss forces and make references to gravity rather than gravitational potential energy. Many candidates started their descriptions from the beginning of the run-up to the high jump which was not included in the question. Many candidates gave single words connected by arrows, which was an acceptable way of tackling the question, but one which tended not to score all of the available marks. The expected answer should have described the change from kinetic to (gravitational) potential energy as the athlete initially rises; then the change from (gravitational) potential to kinetic as the athlete moves downwards; then the change from kinetic to other forms such as heat and sound on landing. Candidates tended to over-complicate the situation and introduced incorrect changes which could not be ignored.

Question 5

(a) (i) Many candidates correctly identified *insulin*. There were no particularly common incorrect answers although *bile* was sometimes suggested.

(ii) Many candidates correctly identified the *pancreas*. There were no particularly common incorrect answers.

(iii) In order to gain the marks the candidates needed to state that insulin promoted the conversion of glucose to glycogen in the liver. Most candidates were not familiar with this process. It was common for candidates to suggest that insulin in some way kills glucose or reacts with it.

(b) (i) Most candidates gave lengthy discussions about the association of fatty foods with obesity and other health issues without ever mentioning rice and lentils. One mark was awarded for stating that fat contains a large amount of *energy*, and the second mark was for a reference to either that rice and lentils contain *less* energy (per unit mass) than fats or that rice and lentils provide carbohydrate. Unfortunately, many discussions which included correct biology or health issues could not score any marks since they did not answer the question.

(ii) Questions concerning coronary disease are frequently asked and it is essential for candidates to refer to heart *muscle* in their answers rather than simply the heart. Lengthy answers describing, for example, restricted blood flow to the heart did not score marks. Similarly some better candidates had realised that restriction of oxygen or oxygenated blood was an issue but again failed to state clearly that it is lack of oxygen to heart muscle which leads to attack. Ideally candidates needed to discuss restricted flow of oxygenated blood to heart muscle, causing failure of heart muscle respiration and consequent failure of the working of the heart muscle. A mark was available for a general reference to respiration but this was hardly ever mentioned.

Question 6

(a) (i) Many weaker candidates were obviously unfamiliar with the concept of subatomic parti candidates generally scored this mark. Occasionally terms such as *elements* were substitut *electron* and several times *newton* or *nucleus* was given instead of neutron.

(ii) The question specifically asked for a discussion of atomic structure and therefore answers such as, *24 is the relative atomic mass,* were not credited. The atomic number is always taken to refer specifically to protons and so reference to electrons was not credited. This question was not answered as well as had been expected.

(b) (i) In order to score the single available mark, answers to this question needed to be without any error. Inclusion of balancing numbers or subscripts was very common, causing loss of the mark. About half of the candidates were able to write the fully correct word equation.

(ii) Candidates entered for Paper 2 are not required to be able to discuss ion formation by electron transfer. Despite this, some candidates were able to do so and gained credit. All that was required was for candidates to identify *magnesium oxide* and state that this was ionic because a *metal had bonded to a non-metal*. In general, this aspect of Chemistry had not been learned very well, and very few candidates scored both marks.

(c) (i) Large numbers of candidates simply re-worded the question and so did not score. Better candidates realised that they had to state a generalisation i.e. *that metals react with acids to give a gas*. The second mark was for naming *hydrogen*. The majority of candidates suggested tube **B** and thought that the gas would be oxygen. In general this question was not answered well.

(ii) Most candidates suggested that $\mathbf{H_2}$ represented a *compound*, even though they went on to give otherwise sound definitions of both elements and compounds. The available mark was given only for the explanation. A commonly seen answer which cannot be credited is that, *it is an element because it contains only one atom* rather than *one type of atom*. In many cases it was evident that candidates thought that only compounds can exist as molecules.

(iii) The only answers accepted were *magnesium sulphate* and (excess dilute) *sulphuric acid*. About a third of candidates gained this mark.

Question 7

Very many candidates were clearly unfamiliar with all aspects of radioactive decay and could not attempt any part of this question.

(a) The only creditworthy response seen to this question was *Geiger Muller detector*, or any reasonable attempt at this answer. The mark was rarely scored.

(b) The most common answer which gained credit was to cite the link with *cancer*. Candidates could also have described the *ionising nature* of alpha particles or discussed the *damage caused to cells or DNA*. Candidates needed to avoid generalised answers such as *it damages the body* or *it kills people*. Very many candidates incorrectly suggested that alpha particles easily penetrate skin. In fact a mark could have been gained by stating that alpha is most damaging when breathed in or ingested.

(c) There are a great many acceptable answers to this question. Despite the wording of the question, many candidates still went for *power generation*. The most common incorrect answer was to describe the *medical* uses of X-rays. The use of radioactive isotopes in weaponry was not accepted.

Question 8

Candidates generally found this an easy question in which to score marks.

(a) A very large majority of candidates scored full marks in this question, showing they had learned this aspect of the course very well indeed. Even when a candidate scored hardly any of the other marks on the paper it was common to gain four marks on this question.

(b) This question was also very well answered and candidates across the full mark rang[illegible] mark. The most common incorrect answer showed *circumcision* rather that[illegible] Candidates needed to take care not to place their cross where the urethra crossed the spe[illegible]

(c) (i) This question, although not quite so well answered as parts **(a)** and **(b)**, still produced very m[illegible] correct answers. Candidates needed to be very careful with their labelling lines, especially if optin[illegible] to show cytoplasm. However, most were careful and the majority of candidates scored both marks, with labels to nucleus, cell membrane or cytoplasm. A common mistake was to substitute the term *cell wall* for *membrane*. Weaker candidates missed the instruction about structures found in all animal cells and labelled *head* and *tail*.

(ii) Most candidates scored at least one mark with a correct reference to the tail enabling *movement*. A second mark could be gained by describing *streamlined* shape facilitating easy movement, *enzymes* in the head to digest a way into the ovum, *low mass* so less energy expended in movement or that this cell contains *half the normal number of chromosomes*.

Question 9

(a) (i) The most common mistakes were to suggest either the name *hydrogen* or element **B**.

(ii) This question tended to produce more correct answers than **(i)**. The most common incorrect responses were **B** and **C**.

(b) (i) Even if candidates were not familiar with the thermal decomposition of calcium carbonate they could deduce from the connection with limewater that the required answer was *carbon dioxide*. It was evident however, that many candidates were unfamiliar with either of these aspects of Chemistry. Suggestions such as *calcium dioxide* were not uncommon and very many candidates suggested *limewater.*

(ii) Very few candidates gave *thermal decomposition*. Although the reaction is endothermic this is never accepted in questions asking for reaction type. A few candidates suggested *combustion* but a majority did not attempt to answer this question.

(iii) This was potentially a difficult question requiring candidates to apply knowledge to solve a problem. Many candidates gave logically sound answers and gained credit. They needed to say a great deal more than the simplistic *repeat the experiment and see if it's the same*. Many candidates went down the route of re-heating or adding acid to the solid residue. They did, however, need to be very clear that their suggested action should be applied to the residue. Most of the better candidates scored two or three marks.

Question 10

Candidates generally found this an easy question in which to score marks.

(a) (i) The majority of candidates were able to interpret the circuit diagram and score at least one mark for getting two of the three lamps correct. Large numbers scored both marks.

(ii) The majority of candidates scored this mark.

(b) The majority of candidates scored one mark for identifying the need for the 4 Ω and 6 Ω resistors. The second mark was for specifying that they must be connected in series.

COMBINED SCIENCE

Paper 0653/03
Extended Theory

General comments

There were some excellent performances on this Paper, with numerous candidates showing very good understanding of almost all of the topics tested. At the other extreme, a large number of candidates scored well below one fifth of the available marks; many of these appeared to know nothing of any of the material in the supplement, nor have any clear understanding of the core topics. It is likely that this group of candidates would have been more successful if they had been entered for Paper 2.

Some candidates wasted space and time by effectively rewriting the question before they began their answer. For example, they might begin their answer to **1(b)** by writing: 'A glucose molecule in an insect could become part of a glucose molecule in a plant leaf by...'. This is poor examination technique.

Candidates should be reminded that the number of marks allocated to a question gives them guidance about the number of facts, or the level of detail required. If there are two marks available, then a one-word answer can clearly not gain both of them.

Comments on specific questions

Question 1

(a) (i) At IGCSE Level, it is not enough to state the arrows in a food chain represent 'is eaten by'. It is stated in the syllabus that candidates should know that the arrows represent energy flow and this was the expected answer.

(ii) Where candidates had picked up on the idea of energy flow through a food chain, they usually gained both marks. However, many did not, and there were numerous answers along the lines of there not being any animals big enough to eat carnivores.

(b) The great majority of candidates remained fixed on food chains, and did not realise that this question related to the carbon cycle. It was rare to see the simple statement that respiration by the insect releases carbon dioxide into the air, which is then absorbed by the plant and used in photosynthesis. Most answers described the death and decomposition of the insect – which could have been appropriate – but then went completely astray by suggesting that the plant would take up glucose from the soil through its roots. A few irrelevantly described pollination, or suggested that glucose could be transferred from the insect to the plant when the insect fed on the plant's leaves.

Question 2

(a) Most candidates understood that black surfaces absorb radiation better than white ones, and it was pleasing to be able to award both marks to a high proportion of answers. However, terminology often let down an otherwise good answer. For example, some candidates stated that black surfaces 'attract' more radiation than white.

(b) This was often answered correctly. Weaker candidates often drew the rays diverging rather than converging, or even reflecting back off the lens.

(c) The majority of candidates struggled with this. Very few appreciated that waves move *up and down*, and many seemed to confuse this with tidal or even hydroelectric power generation.

(d) This was generally well answered, often at great length. Weaker candidates frequent displacement method but stated that this directly measured density, rather than volu inverted the formula.

Question 3

(a) Most candidates were able to get at least one mark here, generally for the electron arrangement. Numerous candidates did not show or state the number of protons and neutrons.

(b) (i) This was answered well by many candidates, but many more showed considerable confusion. Weaker candidates often did not appreciate that magnesium *ions* travel to the cathode, and were very unlikely to state that two electrons are transferred from the cathode to each of these ions. Several wrote about both magnesium ions and chloride ions, without specifying which involved the cathode.

(ii) Answers describing a technique for working out a formula (such as 'swap and drop') are not suitable as 'explanations' in an examination question. Only the better candidates were able to explain this in terms of the balancing of charge of the magnesium and chloride ions.

(c) (i) Better candidates tended to answer this well, with simple statements that magnesium atoms lose electrons during the reaction. However, many did not know this definition of oxidation, and wrongly wrote about combination with oxygen.

(ii) This proved difficult, but the best candidates wrote good answers showing a clear understanding of the relationship between hydrogen ion concentration and pH. However, many answers were completely confused, often trying to explain pH changes in terms of positive and negative ions.

Question 4

(a) (i) These two structures were generally correctly identified, although part **A** was often misnamed as the sperm duct. This is one occasion where spelling is important, and if the word 'urethra' had been misspelt in such a way that it could be confused with 'ureter', then the mark was not awarded.

(ii) Candidates were not asked to name **C** or **D**, but many wasted time by attempting to do so. Most knew the function of **D**, although a surprisingly large number stated that it 'stores' sperm rather than actually makes them. The function of **C** was less well known, with frequent garbled statements that it carries 'all the waste liquids' from the body, or even 'waste material from the stomach'. The word 'urine' was expected.

(iii) This was almost always answered correctly.

(b) This question tested a difficult concept, but many of the better candidates rose successfully to the challenge. These often included the idea of environmental change in their answers, and the ways in which variability can mean that at least some organisms will be able to survive such changes. Weaker candidates often wrote about how useful it is to be able to tell each other apart.

Question 5

(a) (i) The majority of answers correctly mentioned crude oil and fractional distillation.

(ii) This was generally correctly calculated.

(b) (i) A surprising number of candidates did not appear to know that oxygen is the gas that reacts with diesel fuel in engines. Moreover, many who did were then unable to identify gas **S** as oxygen. Gas **R** was frequently chosen, because they thought that oxygen is the most abundant gas in air.

(ii) Only a small proportion of answers correctly identified the black substance as carbon. Most thought that it was carbon monoxide, or even in a few cases carbon dioxide. Incomplete combustion was quite often mentioned, even when the substance was not correctly identified.

(iii) This was much more often answered correctly than **(ii)**, with most candidates ment… monoxide. The term 'suffocation' was often used and this is not appropriate here – in g… a term best avoided in examination answers. In this case, it was sufficient to say that th… toxic or poisonous.

Question 6

(a) Those who understood the concept of half life generally gained both marks here, although several omitted the unit or misread the *x*-axis scale. Quite a few calculated the fifty per cent drop in activity as though it had begun at 22 000 counts per second, rather than 20 000.

(b) This is a case where candidates really need to learn a definition, as they often falter when trying to describe the concept in their own words. There was much confusion between numbers of protons and neutrons. Some confused isotopes with ions.

(c) This was often very well answered. Most knew that alpha radiation cannot penetrate skin, although some candidates were led astray by this idea and wrote at length, and incorrectly, about how the radiation therefore gets stuck in the skin and cannot get out. Better candidates stated clearly that it causes problems only if the source gets inside the body, and then went on to say how damage is caused.

Question 7

(a) This is another definition that candidates would be advised to learn by heart. Relatively few were able to state that it is the maintenance of a constant internal environment.

(b) (i) Most could name insulin (although some appeared also to have been taught about glucagon, which confused them).

(ii) Better candidates mentioned the liver and the conversion of glucose to glycogen. Those who had been taught about glucagon often confused it with glycogen and lost a mark here.

(c) This discriminated well, with those candidates who understood osmosis generally getting both marks. Many, however, tried to describe glucose moving by osmosis. Some simply wrote a definition of osmosis, which gained no marks unless it was applied to this particular situation. Many did not make clear whether 'high concentration' meant a high concentration of glucose (which is the assumed meaning), or of water.

(d) (i) This was very poorly answered. Most candidates appear to have completely unscientific ideas about these health issues. It was very rare to see the idea that fats contain more energy per gram than carbohydrates (as found in lentils and rice) and therefore that a high fat diet makes it more likely that the energy taken in will be greater than the energy used by the body. Many stated that fats contain a lot of carbohydrate. The idea that fats are 'difficult to digest and therefore have to be stored in the body' frequently appeared, indicating a complete lack of understanding of digestion and how food is processed in the body.

(ii) This, too, was poorly answered. Most candidates appear to have no correct understanding of any links between heart disease and diet. There was much general comment about fat 'clogging up the veins and arteries' or collecting around the heart and making it 'difficult for it to pump'. Better candidates mentioned that cholesterol may accumulate inside arteries, and often went on to mention the coronary artery and its role in providing oxygen to the heart muscle so that it can continue to contract.

Question 8

(a) This was generally answered correctly.

(b) (i) Many candidates were unable to do this, and it appeared that they were entirely unfamiliar with this reaction. The most common errors included the appearance of oxygen on the left hand side of the equation, or of calcium (not calcium oxide) on the right. Several answers introduced new elements on the right hand side of the equation, for example by including water in the products even though there were no hydrogen atoms on the left.

(ii) This question proved more accessible than **(i)**, with many more correct responses.

(iii) Better candidates generally answered this well, usually suggesting adding acid to the s looking for further gas being given off. Some suggested continuing to heat it. Wrong an often included the addition of indicators to the solid.

(iv) This was not well known, with relatively few candidates appreciating that this is done to reduce the acidity of the soil. Many wrongly suggested that calcium carbonate breaks down to provide carbon dioxide, or that it is a fertiliser.

Question 9

(a) (i) Most picked out a 6 Ω and 4 Ω resistor, but many did not stipulate that these should be connected in series.

(ii) Those who knew how to calculate the total of two resistors in parallel generally got all three marks. However, many left this answer space blank.

(b) (i) Many answers gained at least one mark, but there was some confusion with motors.

(ii) Numerous candidates left this blank, but most did attempt to draw some kind of sine wave roughly centred on the horizontal line. Very few, however, calculated that there should be five cycles.

(c) This was often well answered, but a surprising number thought that tension would be produced by the wires *expanding*, rather than when they contract in cold conditions. Several tried to answer in terms of electricity transmission.

COMBINED SCIENCE

Paper 0653/05

Practical Test

General Comments

In general, performances were disappointing overall and not as good as last year. Certainly there were some difficulties in the preparation of material for **Question 1** and several Supervisors decided to make changes to **Question 2** that were unnecessary. This may have accounted for the decline in standard achieved. Supervisors should ensure they enclose a set of their answers as this can have an adverse effect on the marking of the candidates' work. There was no evidence of a shortage of time.

Specific Comments.

Question 1

Clearly the samples of seedlings grown locally did not always produce the expected results but there were some very poor answers. Surprisingly few candidates were able to score the first mark. The obvious answer was temperature but the majority simply answered, 'water'. Amount of water was an acceptable answer. Many of the drawings were poor, often in ink, and many failed to show the difference in appearance between the seedlings. The instruction 'one' was written in bold yet many tried to draw the complete set. The measurements of height were not at all consistent, even within a Centre. It was not necessary for candidates to know about phototropism in part **(b)**, but it was assumed that they could make a reasoned response to their observations. In the event it was poorly answered.

Question 2

It should be emphasised that making a change to a question is not acceptable and usually works against the candidates. Marking can be adjusted to meet a particular difficulty within a question but it is much more difficult to do within a Centre. Some Supervisors tried to assist their candidates but this must be discouraged. The mass of the hanger is taken care of in part **(a)** and it is not necessary to know its mass. The spring also has mass but the total mass of spring and hanger form the spring constant. However, as no mark was awarded for accuracy of the final result, these particular difficulties had no effect on the final outcome.

A good example of failing to follow instructions occurred in part **(a).** Some candidates had the position of the mass with 200 g at a greater value than that with no mass, despite zero being labelled at the base of the ruler. Many candidates were unable to work in millimetres and the extension in part **(a)** was often in centimetres, thereby losing the mark.

A few candidates were unable to evaluate T and T^2 despite the instructions. Graphs were not very good with the main criticism concerning scale. As much of the grid as possible should be used. The majority assume that all lines pass through zero and therefore lost a mark by making it do so. Many had no idea of how to calculate a gradient, often just counting the number of squares. Finally, the mark in **(g)** was awarded to those who could correctly substitute and evaluate. No mark was awarded for accuracy.

Question 3

The use of the word precipitate was limited. Each year it is pointed out that milky, cloudy etc. are unacceptable. In **(a) (ii)** oxygen was often deduced instead of hydrogen. A good number deduced the presence of sulphate but few deduced that **B** was an acid. Part **(b)** was easy and many scored the three marks. The necessary test is given in the notes, although many recorded a brown colour rather than a precipitate, thereby losing a mark. Once again candidates did not read the question. It asks for 'an experiment', not two. Although not penalised, it was an unnecessary addition.

COMBINED SCIENCE AND COORDINATED SCIENCES

Paper 0653/06
Alternative to Practical

General comments

The paper has been designed in the usual way, incorporating elements from the Assessment Criteria for Practicals printed on pages 37 and 38 of the 0653 syllabus (pages 68 and 69 of the 0654 syllabus) and notes on following pages. These invite the candidate to display knowledge of laboratory procedures and tests, read and record results and then draw conclusions. As usual, answers given by candidates from some Centres reveal that they have done little or no experimental work. This may be because of lack of appropriate facilities or because of time-table restrictions. The Examiners wish to emphasise once more that adequate experience at the laboratory bench is essential for success in this paper. This conclusion is reinforced by comments on individual questions below.

Comments on specific questions

Question 1

This question is based on the corresponding question in **Paper 5**, the Practical test. Seeds were germinated under three different sets of conditions. Candidates were required to study photographs of the germinated seedlings and record their results.

(a) (i) A table was required to display the shape and vertical height of the seedlings in boxes **A**, **B** and **C** shown in Fig. 1.2. The majority of candidates were able to draw a table but many tables lacked proper headings.

(ii) Candidates needed to study the shapes of the three sets of seedlings and write their descriptions in the table. Many candidates wrote a great deal, with varied ways of describing the seedlings. Examiners could not find a better word than 'shape' to tell candidates what was needed. Box **A** seedlings were tall and mainly straight. Seedlings in box **B** were also straight but not as tall. In box **C** they were short and bent over. Descriptions of this type were credited with marks.
There was space in Fig. 1.2, so some candidates wrote their descriptions here as well as in the table that they had drawn in **(i)**.

(iii) and (iv) Candidates needed to choose a seedling from Box **A**, label it in Fig. 1.2 and indicate its height measured from the base of the photograph and the measurement written in the table. This procedure was repeated for one seedling from Box **B** and one from Box **C**.
Errors here included failure to label the measured seedling; the base of the photograph not used as the base-line; omission of the units of measurement; and the recording of the height in the wrong place. Inevitably marks were lost because of these errors.

(b) Most candidates deduced that the seedlings in boxes **B** and **C** were different because the seedlings in box **C** had grown towards the light entering from the side of the box.

Many candidates found this question easy to answer despite its complexity.

Question 2

This question was based on the corresponding physics question in the Practical examin involved finding the time for an oscillation of a spring loaded with increasing masses.

(a) (i) It was a simple matter to read the stopclock dials as 15s and 17s. Sometimes the second time wa stated as 15.2 s.

(ii) Division by 20 to find **T**, the time for one oscillation was usually done correctly.

(iii) $\mathbf{T^2}$ had to be determined. This was difficult for many candidates.

(b) Plotting the graph of $\mathbf{T^2}$ against the mass of the load was a simple task for almost all candidates, as the axes were already labelled. However, candidates who had not managed to work out the two missing values of $\mathbf{T^2}$ now read these off the graph. Examiners had been careful to ensure that this procedure did **not** lead to the correct values. Some candidates failed to draw a straight line as instructed, so lost a mark. Others made their line pass through the point (0,0) contrary to the given statement that it would not do so.

(c) The gradient of the straight line had to be determined. This was much more difficult. The first mark was obtained by drawing a triangle on the line, the dimensions of which would lead to the calculation of the gradient; or by indicating on the graph how values of x- and y- had been derived. The second mark was for using these values to find the gradient. Common errors included finding x/y instead of y/x; counting squares to find the values of x and y instead of using the real values; and incorrectly calculating the value of (say) 0.48/300.

(d) The use of the given formula led to a value of g, the acceleration due to gravity, of around 9.5 ms^{-2}. Errors carried forward were allowed, so some fantastic values were seen and allowed to stand for the mark.

(e) Lastly, candidates were asked to explain why the straight-line plot of $\mathbf{T^2}$ against the load did not pass through the point (0,0). Acceptable answers showed that the spring and weight holder had their own mass, therefore at mass 0 oscillation would still occur. However, candidates with a mathematical understanding wrote that $\mathbf{T^2}$ was not directly proportional to the mass. This answer was also accepted.

The better candidates scored well on this question, though the maximum mark was not often awarded.

Question 3

This question explored the candidate's understanding of a precipitation reaction to make the insoluble salt magnesium carbonate and the soluble salt potassium chloride. The equation for the reaction, with state symbols, was given in the introduction.

(a) The correct meanings of the state symbols (aq) and (s) were usually given, but ‘aquatic’ and ‘aquarius’, sulfur, sodium and solution were also suggested.

(b) To react with 50 cm^3 of magnesium chloride solution, is less, more or the same volume of a more concentrated potassium carbonate solution needed? Most candidates correctly answered "less than 50 cm^3".

(c) This was a basic practical question; how to fold a filter paper so that it fits into a filter funnel. Candidates who had never carried out this task could not explain it satisfactorily. Many candidates suggested making a radial cut or just pushing the circle of paper into the funnel. The Examiners looked for two folds to make a 90^0 segment, then opening it out to form a cone.

(d) The diagram showed the precipitate, magnesium carbonate, being collected in the filter funnel. Candidates were required to describe what to do next to obtain pure magnesium carbonate. There were many incorrect answers here, instead of the simple ‘pour water through the funnel containing the precipitate.’

(e) In this question Examiners looked for a simple visual test such as 'If there is a precip... a few drops of potassium carbonate are added, not enough was added at first.'

(f) The Examiners were clear that the sample must be pure, therefore partial evaporation follow... cooling is necessary. Crystals will form but impurities will remain dissolved. 'Evaporate to dryne... gained only one mark.

The answers to this question were, on the whole, very disappointing and showed a lack of practice in the skills tested.

Question 4

This involves an experiment to find the reaction time of a person catching a 50 cm ruler that is dropped without warning. The experiment may usefully be copied by a science class and the data in Fig. 4.4 used to find reaction times.

(a) (i) Diagrams showing the level of the thumb as the ruler is caught were given in Fig. 4.3. Candidates read the distance the ruler had dropped. This was usually correctly done.

(ii) Candidates needed to determine the averages of two sets of readings. Most candidates had no problem with this task.

(iii) The data in Fig. 4.4 was used to convert the distance dropped into the reaction times for three different persons.

(b) There were many very poor answers to this question, such as those from candidates who wrote that it travels via the veins. Examiners needed the specific answer 'via the motor neurone' (or efferent nerve).

(c) This question was easy for most candidates who correctly identified person **B** and went on to say that **B** had the highest reaction time and therefore would be most likely to be involved in an accident. However, the word 'least' was misunderstood by some, so they identified the most safe driver who would be **C** or **D**. If this occurred, an explanation of why **C** or **D** would be the safest driver was credited for the second and third mark.

Many candidates scored high marks for this question.

Question 5

The expansion of liquids is used in 'liquid-in-glass' thermometers. This question is based on an experiment to compare the expansion of water, methanol and ethanol. Test-tubes fitted with capillary expansion tubes were shown in a water bath and then actual size diagrams of the expansion tubes were illustrated.

(a) (i) The candidate needed to use a ruler graduated in mm to find the distance between 'initial' and 'final' levels of the three liquids, to the nearest millimetre. Many candidates ignored the units given in the results table and recorded distances in centimetres. This meant they lost one of the three marks. Other candidates ignored the 'initial level' mark and measured from the lower end of the tube. Yet others seemed not to understand the term 'millimetre' and gave 120, or even 1200, as the first answer instead of 12.

(ii) All three tubes were placed in the same water bath to ensure that all had the same temperature rise. Candidates who wrote vaguely of 'the same conditions' were not awarded the mark.

(iii) The water bath was stirred during heating. There were suggestions that this 'prevented the water from boiling', or 'increased the heating effect', instead of merely to ensure the same temperature throughout the bath.

(b) One of the candidates doing the experiment obtained an unexpected result. His tube
How would this change the result? There were many theories about the water not be
expand past the air, or the air dissolving in the water. The air would expand more than th
causing increased pressure and forcing water up the expansion tube giving an inflated result
better candidates wrote about this effect.

(c) (i) This question was about whether the glass of the test-tubes expands less than, the same as or more than the liquids. This could be answered by reference to the actual results of the experiment during which it was obvious that the liquids had expended more than the glass; or by stating that the particles of glass were held together by greater forces than the molecules of liquids. A surprising number of candidates wrote that glass expands more than the liquids, showing ignorance of the kinetic theory and inability to reason from the experimental results.

(ii) Lastly, another question referring to the results. Weaker candidates almost without exception wrote that forces between ethanol molecules were greater, showing that the idea of intermolecular forces within liquids was not understood.

The scores for this question mirrored quite closely the mark awarded for the paper as a whole. Candidates should be prepared for this type of question, which explores, in a novel way, ideas that should be familiar to them.

Question 6

The chemistry question in **Paper 5**, the practical test, is the basis for this question. Candidates were given solid **A** and solutions **B** and **C**. They carried out tests, wrote their observation and drew conclusions about these un-named substances. In this paper, the tests, results and conclusions were presented in three columns. Certain information is missing, the spaces being indicated by dotted lines. Other areas where nothing is to be written were shaded.

(a) A series of tests on the solution of solid **A**, which is sodium hydrogen sulfate, are listed.

(i) To the solution of solid **A**, aqueous barium chloride and dilute hydrochloric acid are added, the standard test for a sulfate in solution. Only the best candidates gave the correct answers that the precipitate formed is white, showing that a sulfate is present.

(ii) Examiners did not accept the answer ‘a gas is given off’ since this is stated in the question. What is seen is bubbling or effervescence and the dissolving of the magnesium. The gas given off is tested with a lighted spill. Such answers as ‘the lighted spill went out with a 'pop'' were credited; however, candidates must understand the important idea that that the gas ignites.

(iii) Sodium carbonate is added to the solution of solid **A**. The gas given off is tested with a lighted spill and with lime-water. This time, it is what happens to the spill that is important; the flame dies. The effect of the gas on lime-water was the observation that was most often correctly described in this question.

(b) Solution **B** is iron(III) chloride.

(i) Better candidates correctly described the brown precipitate.

(ii) The conclusion is that chloride ions are present; what is the test and what is seen? Aqueous silver (or lead) nitrate gives a white precipitate.

(c) Solution **C** is a reducing agent that could be sodium sulfite, though candidates did not need to know this.

(i) Hydrochloric acid and solution **C** are added to solution **B** and warmed. Then ex… hydroxide is added to the mixture The iron(III) ions in **B** are changed to iron(II) … precipitate produced is green or grey-green.

A large proportion of candidates, including whole Centres, scored less than 3 marks for … question. Not only was the knowledge of these standard tests for ions in solution very poor, it was apparent that many candidates were unable to follow the relationship between a test, the observation and the resulting conclusion. Although the form of this question as part of the Alternative-to-Practical paper is quite usual, it was clear that many teachers have not given their candidates practice in answering such questions, let alone the necessary experience of seeing the tests at the laboratory bench.

The "Notes for use in Qualitative Analysis" printed on page 42 of the 0653 syllabus for 2010 (page 73 of the 0654 syllabus), should be carefully studied by all candidates, not just by those who have opportunity to carry out practical experiments. The description of the Alternative-to-Practical examination printed on page 41 (page 72 of the 0654 syllabus) should be familiar to all teachers of candidates for this paper.