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FOREWORD

This booklet contains reports written by Examiners on the work of candidates in certain papers. **Its contents are primarily for the information of the subject teachers concerned**.

COMBINED SCIENCE

Paper 0653/01

Multiple Choice

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

General comments

None of the questions proved especially easy, though all but one was answered successfully by ove the candidates and all very effectively discriminated between candidates of differing abilities.

The mean mark was 23.0. The standard deviation (7.7) was the highest in recent years and the reliability coefficient was correspondingly also high. Nevertheless, the statistics of some of the Chemistry questions were surprising or disappointing.

However, candidates generally performed very well on all but four of the Physics items on the paper, for which they are to be commended.

Comments on specific questions

Question 4

The only significant obstacle to negotiate here was to note and allow for the fact that the loss in mass was for a two-hour, rather than a one-hour, period. The importance of reading a question carefully can never be too greatly stressed, advice which could have been heeded to advantage by over a quarter of the candidates.

Question 6

It was a little mystifying that over a quarter of the candidates linked alveoli with cilia and goblet cells which suggested misunderstandings not only over the structure of alveoli, but also of bronchi.

Question 10

There may have been problems in the interpretation of the diagram of the female reproductive system or with knowledge of the siting of an IUD. In the event, equal numbers opted for the uterus and the vagina. Reassuringly, those opting for the uterus displayed far greater competence in the paper as a whole.

Question 12

A fundamental misunderstanding was exposed here, with almost a quarter of candidates failing to appreciate the importance of the environment in causing variation within a species.

Question 15

The idea of multiple bonds within molecules – and specifically of the molecules in this question – is explicit in the syllabus but nearly 40% of the lower-scoring candidates chose **B**.

Question 16

The lower-scoring candidates preferred either response **B** or **C** rather than the key (**A**). Melting point and solubility may give some evidence of ionic bonds in a solid but behaviour as an electrolyte is much more definitive.

Question 17

Response **B** was more popular than the key (**C** = potassium) with the lower-scoring candidates but the flame colour of potassium is explicit in the syllabus.

Question 18

There is evidence of guessing amongst the lower-scoring candidates of whom only 23% answered correctly. A third of them chose **C**: perhaps fewer would have done so if the chloride had been other than “green”.

Question 20

The key (**A**) was the least popular choice amongst the lower-scoring candidates with response **C** being the most popular. This is a rather surprising lack of knowledge.

Question 21

As for **Question 20**, lower-scoring candidates favoured a response other than the key, i.e. **A** rather However, non-metals having acidic oxides is a 'basic' piece of chemical knowledge.

Question 22

Another example of mistaken choice by the lower-scoring candidates, who preferred response **B** over the key (**C**). Such candidates seem irremediably convinced that copper reacts with dilute acid.

Question 24

It is surprising that this question failed to work. Only a third of all candidates answered correctly and the discrimination was negligible. Response **D** was the most popular choice but this seems to reveal a basic misunderstanding of the idea of an electrolyte.

Question 27

This proved to be a hard question but with excellent discrimination. Some 40% of the lower-scoring candidates chose response **A** notwithstanding the fact that the question referred to 'complete' combustion.

Question 30

This revealed a very common misunderstanding about the extensions of stretched objects. Nearly a quarter of candidates answered **C**, which is the new length minus the previous measured length, rather than minus the original length. Teachers can help their candidates by stressing the correct meaning of extension.

Question 33

There was a lot of guessing in answers to this question. Less than half answered correctly, and the rest were equally undecided about the remaining options.

Question 34

A similar comment to **Question 33** may be made about answers to **Question 34**.

Question 35

This produced good statistics, but it is interesting to note from the incorrect responses that 25% of candidates think that sound *can* travel through a vacuum, and that 19% think that sound *cannot* travel through a solid.

Question 37

This was poorly answered, for such a basic question.

Question 38

Another electrical question that indicated guessing on a large scale.

Paper 0653/02

Paper 2 (Core)

General comments

This year's entry was significantly greater than last year. Candidates were generally able to complete the paper in the allotted time, although a surprising number of scripts had been left entirely blank. Some parts of the syllabus had been learned very well by the majority of candidates. The most troublesome questions in this paper involved details of radioactivity, the distinction between sexual and asexual reproduction and much of the fundamental chemistry. On the other hand, candidates tended to score well on questions dealing with electrical circuits, characteristics of living organisms and atomic structure. As in previous years, questions requiring candidates to use experimental data were generally not done well, although they were far more successful in completing routine calculations. The examination produced the mark range expected for this component although this year there seemed to be rather a large number of scores towards the lower end.

Comments on specific questions

Question 1

(a)(i) Although this was intended to be a straightforward opening question, very large numbers of candidates could not place these operations into the correct sequence, **R**, **P**, **Q**. The most common mistake was the reversal of **P** and **R**.

(ii) This proved to be too difficult for the majority of candidates, many suggesting heating for protracted periods. Answers similar to 'when no more gas is produced' did not score the mark, but 'when more solid is added and no more gas is produced' did. Other acceptable answers could have included reference to pH or unreacted solid visible in the mixture.

(iii) Very few candidates could provide H_2SO_4 for sulphuric acid.

(iv) Candidates had generally not learned that compounds of copper have colours different from copper itself. Of those who did gain the mark for identifying copper, very few scored the second mark for stating that copper is a transition metal or that transition metal compounds are coloured.

(b) This question was answered relatively well, with only the weakest candidates failing to score any of the available marks. Many candidates gained half marks or better. The most common mistakes were to substitute anode for cathode and thermal decomposition for electrolysis.

Question 2

In general, details of radioactivity are not learned very well by the candidates entered for this component. This question proved to be the most troublesome on the paper.

(a) Very few candidates indeed suggested either a Geiger counter or a Geiger-Muller tube.

(b)(i) Candidates needed to be very clear that radiation caused other particles to become ionised or charged. This concept had been learned by only a small minority. Of those who attempted this question, many confused the required concept with ionic bonding theory.

(ii) Although virtually all candidates referred to harm caused by alpha radiation, no mark was available for unqualified statements of this type. Candidates needed to state that alpha could cause cells to mutate, damage DNA or trigger cancer. When the mark was awarded it was invariably for reference to cancer.

(c) The majority of candidates had learned the characteristics of these types of radiation, and could successfully match the statements.

(d)(i) Very few candidates were able to describe nuclear fission in terms of the splitting One mark was awarded for 'splitting of an atom' and suggestions such as 'separation of

(ii) This question is frequently asked and yet responses showed that the sequence of transferring energy to water to raise steam, using the steam to turn a turbine which then rotates a generator had not been learned by the great majority of candidates. Many candidates gave generalised answers about energy transfer without any reference to the hardware involved.

Question 3

(a) In general, candidates had learned the characteristics of living organisms very well and most scored two marks in this question. The most common mistake seen from weaker candidates was to suggest anatomical characteristics such as eyes which a bicycle would not have or equipment such as knee-pads.

(b) The provision of energy from carbohydrates and the role of protein in cell or muscle building were generally well known and many correct responses were seen.

(c)(i) Most candidates could interpret the data in the table correctly and scored the mark for this question.

(ii) This was essentially a very straightforward question, but many candidates read too much into it and tended to repeat what they later wrote in response to part **(iii)**. The two marks were for stating that doping increases the level of red cells in the blood and that haemoglobin is carried on red blood cells.

(iii) This was a fairly challenging question and it was very pleasing to see the majority of candidates scoring marks. Marks were available for stating that increased red cells or haemoglobin would transport more oxygen, that the oxygen would be used in the cells or muscles, that this would benefit the efficiency of respiration (any reasonable reference to respiration scored a mark), that more energy would be generated in cells or muscles and that there would be benefits to the cyclist such as being able to cycle faster for longer without becoming exhausted so quickly. The latter mark was the one most often awarded. Credit was not given for repeating the results of the treadmill experiment, candidates had to discuss the cyclist and why he might do better in a race.

Question 4

(a) Responses to this question were clear cut. Either the rules of atomic structure had been learned or not.

(b)(i) This had been intended to be a straightforward question, and yet it proved troublesome for a surprisingly large number of candidates.

(ii) Accepted answers here were oxidation, combustion or redox. Better candidates scored the mark but there was no particular pattern to the incorrect responses.

(iii) Many candidates were able to explain why zinc oxide would be heavier than the zinc before reaction. Any reasonable attempt to explain the concept was accepted, e.g. 'there are now two elements and not one and so the masses are added', 'material has joined the zinc'.

(c)(i) Although most candidates described that galvanising involved a barrier they needed to state that the barrier is made of zinc. Most candidates did not associate zinc with this method.

(ii) The conditions needed for rusting were generally well known and many candidates scored both marks.

Question 5

This question proved to be the most accessible one on the paper and significant numbers of ca[ndidates] scored full marks.

(a) All reasonable references to devices or instruments which could measure length and time were accepted and most candidates scored both marks.

(b) The format of this question is consistently used in this paper, and in order to score all available marks candidates were required to provide the correct formula in the form of an equation and also to show their working. Words or appropriate symbols were acceptable in the equation which should be a proper equation containing an equals sign. Most candidates were able to score at least one mark in this straightforward calculation although many lost a mark because they did not show either their working or the formula they used. The accepted answer was 60.

(c)(i) The safest way to gain the mark in this question is to state that the section **A** to **B** on the graph is *horizontal* although some other ways of expressing the idea were accepted. Candidates stating that the line is *straight* were not credited.

(ii) Most candidates gave the correct answer of 250.

(iii) This was well answered. The majority of candidates correctly gave 100 to 150 or **B** to **C** and then went on to say that this section of the graph showed speed was increasing.

Question 6

(a)(i) Candidates needed to draw their arrows very carefully. There is only one route from the stoma to cell **X**, and candidates lost the mark if their arrow strayed into cells along the way. Most candidates simply drew an arrow from the upper surface directly into cell **X**.

(ii) Only a minority of candidates scored both marks. Many obtained a mark for reference to either chloroplasts or chlorophyll, but they rarely made it clear that these capture light. It was also acceptable to state that cell **X** is near to the surface of the leaf which increases the amount of light reaching it.

(iii) Most candidates obtained a mark by discussing how the closing of the stoma would reduce water loss. A second mark could have been gained either by explaining that this would prevent the plant becoming dehydrated or by further detail of water loss by evaporation or reference to transpiration. A common mistake was to refer to the closing of the stoma preventing materials from entering the leaf.

(b)(i) Most candidates did not pick up on the requirement to draw *and label* the additional arrows. Many correctly showed arrows linking tomato plants and decomposers to the air but failed to label them. Both arrows could be labelled *respiration* and the decomposers could also return carbon dioxide by *decay*. Candidates should be discouraged from adding extra boxes to diagrams in questions of this type.

(ii) Candidates generally found it difficult to obtain all of the available marks although many showed that they had learned relevant material associated with this important issue. Key marking points were the connection between plant removal and decreased photosynthesis, the reduced removal of carbon dioxide from the atmosphere and the consequent increase in carbon dioxide levels. A mark could also be gained by relevant discussion of the greenhouse effect. Many candidates were diverted into a discussion about oxygen levels.

Question 7

(a) The only answer accepted was *fractional distillation*, both words being required for the mark.

(b)(i) Only a minority of candidates obtained all of the available marks. The accepted answers were carbon dioxide, water and sulphur dioxide. Sulphur oxide was not accepted, neither was carbon monoxide. A wide variety of other incorrect suggestions were made, including many substances which are liquids or solids at ambient temperatures.

(ii) Candidates needed to discuss the environmental problems caused by sulphur dioxide, and it had been hoped that answers to part **(i)** may have helped to focus candidates onto this pollutant. Provided candidates were discussing sulphur dioxide they could gain the marks by reference to atmospheric pollution and further detail such as acid rain formation and the corrosive effects of either acid rain or the gas itself.

(c)(i) An unexpectedly large number of candidates had not learned a standard definition of a catalyst. Many discussed the purpose of a catalytic converter rather than the meaning of catalyst. Those who did discuss the speeding up of a chemical reaction often did not gain the second mark for saying that the catalyst suffers no permanent change. Many references to enzymes were given although these did not necessarily negate any credit.

(ii) Few candidates correctly identified transition metals.

Question 8

(a) Generally, this was well answered and many candidates scored at least two marks. It was important to draw the cell symbols the correct way in order to match the polarity shown in the diagram. Most candidates could draw correct lamp symbols. Virtually all candidates scored the mark for showing a simple series circuit. A minority of candidates simply made a fair copy of the diagram.

(b)(i) This was reasonably well answered. It was essential for candidates to explain somewhere in their answer that the circuit was open or broken.

(ii) Most candidates correctly gave the answer 8 ohms.

(c)(i) Most candidates scored this mark. Acceptable answers included oil (but not petroleum), coal, gas and nuclear. Unqualified *fossil fuel* was not credited.

(ii) Virtually no candidate had learned that the sun's energy comes from fusion. Common mistakes included *solar panels* and *wind turbines*.

(iii) This also proved to be a syllabus section which had not been learned by many candidates. Acceptable answers included the need for a medium or matter to allow conduction and that there is a vacuum in space.

Question 9

(a)(i) Urethra was known by many candidates but the most common error was penis. Candidates should be encouraged to look very carefully at the labelling lines in questions of this type.

(ii) Most candidates scored two marks here. They had to specify urine rather than the vaguer term *waste* when describing the function of **B**. Both production and storage of sperm were accepted for **C**.

(b)(i) There were several differences which candidates could give when answering this question. The most common way of obtaining one mark was for referring to the need for only one parent in asexual reproduction. Candidates could also describe offspring from asexual reproduction as clones or identical in appearance. A mark was also available for discussing the involvement of gametes or the need for fertilisation in sexual reproduction. Common misconceptions included the idea that sexual reproduction involves two gametes but asexual involves one gamete. Most candidates obtained at least one mark in this question.

(ii) The majority of candidates failed to gain these marks because they confused self pollination with asexual reproduction. Many described sexual reproductive methods. Only a very small minority were able to describe a correct example of asexual reproduction, the most common example being the formation of runners from strawberry plants. In this case, the second mark was for further detail such as root formation from the runner.

Paper 0653/03

Paper 3 (Extended)

General comments

Although there were some excellent scripts, many Centres appeared to have entered candidates who had not been prepared for this paper, or who would have been more appropriately entered for Paper 2. Large numbers of candidates appeared to be unfamiliar with most, if not all, of the material from the supplement of the syllabus, and these candidates often gained fewer than 20 marks out of the 100 available. Their inability to understand difficult parts of a question often seemed to adversely affect their answers to what should have been more accessible parts.

Numerous candidates wasted significant time and space in their answers by beginning with a repeat of the question. For example, answers to **Question 5 (b)(i)** often began with 'Alternating current is used rather than direct current because...'. There is no need for such openings to answers, and candidates should simply begin with their answer, which does not have to be a complete sentence. For example, this answer could be 'Because it can be used with transformers'.

Comments on specific questions

Question 1

Candidates often scored highly on this question, although (as was true throughout the paper) a significant proportion were unable to gain more than 1 or 2 marks.

(a)(i) Most candidates answered this part correctly, although some did not do as the question asked and made the question more difficult by attempting to name the processes shown in the diagram.

(ii) This highlighted an apparent lack of experience of this practical work by some candidates, whilst others correctly explained that you would keep adding copper carbonate until no bubbles were seen, or until no more would dissolve.

(iii) Weaker candidates gave a general answer to this part – for example stating that it separated solid from liquid – while others correctly stated that this would remove any undissolved copper carbonate.

(iv) The symbol equation caused problems for many, who did not know the formula for sulphuric acid. Most, however, correctly entered the formulae for carbon dioxide and water in the two boxes on the right of the equation.

(b)(i) This was not well known, with many candidates saying that sulphur or sulphur dioxide would be produced. In fact the question was not asking what would be produced, but what would be *observed.* All that was required was a statement that bubbles would be seen. Some candidates thought that sulphur was a gas.

(ii) While many candidates correctly stated that the copper ions would move to the cathode, relatively few were able to describe how they would take electrons from the cathode, two electrons per ion.

Question 2

Radioactivity is not well known, and candidates from numerous Centres struggled throughout. Others clearly got to grips with this topic, and it was pleasing to see some excellent answers.

(a)(i) Many answers did not answer the question at all, describing which of the three materials would absorb most beta radiation rather than how the candidate would compare their ability to do this. There were marks available for naming a suitable piece of apparatus (for example a Geiger counter), measuring the count rate behind each material and then comparing the amount of radiation behind each one.

(ii) This was better known, and there were many entirely correct answers. Some candidates confused the charged plates with a magnetic field.

(b)(i) A common misconception is that the radiation itself is ionised. The expected answer was that the radiation removes electrons from atoms.

(ii) There were numerous ingenious (but usually wrong) attempts to explain why alpha radiation is more dangerous than gamma if swallowed. Good answers simply stated that alpha is more ionising than gamma and so will cause more damage to DNA or to cells.

(c) The topic of nuclear fission appears to be better understood than in the past, and many candidates were able to state simply that a nucleus is split. Many, however, got carried away and used most of the remaining space on the page to give detailed (and frequently entirely incorrect) descriptions of chain reactions, bombs, and how electricity is generated.

Question 3

This question required candidates to apply their knowledge to an unfamiliar situation. Whilst many rose to the challenge and provided excellent answers, other could only give general answers which did not relate to the context.

(a)(i) The expected answer was that a reflex action is an automatic response to a stimulus. A common misconception is that reflex actions do not involve the brain. This is not true; for example, the iris reflex or the blinking reflex involve neurones in the brain. Reflex actions do not, however, involve conscious thought. Candidates who read on should have noticed the word ‘voluntary’ in **(ii)**, which could have helped them to use the word ‘involuntary’ here.

(ii) This was not a difficult question, but many candidates made it so by answering a different question, giving examples of reflex actions (which often took up much more than the two lines provided). A simple comparative statement was all that was required, for example that reflex actions are faster than voluntary actions.

(b)(i) A range of answers was accepted here, and many candidates correctly stated that this would help to stop the blood spoiling. Fewer gave a sufficiently full answer for the second mark, which required some explanation of how low temperatures would slow the activity of enzymes or bacteria.

(ii) Answers to this frequently spilled over the four lines provided, mostly because candidates did not really start to answer the question until they arrived at the third or fourth lines. One mark was available for a simple statement that haemoglobin concentration increases, and then another for an explanation of why this happens. Some candidates wrongly thought that, when blood was taken out, the haemoglobin was somehow left behind, so that its concentration increased in the lower blood volume.

(iii) This part of the question required candidates to state that haemoglobin transports oxygen in the blood, so that muscles would obtain more oxygen and therefore be able to respire more, providing energy for muscle contraction. The cyclist could therefore cycle faster or for longer. There were many long and involved answers, which often completely missed the point, or were too general to be awarded many marks. For example, many candidates stated that the *cyclist* would have more oxygen so that he would have more energy, with no mention of the muscle cells. This was quite a demanding question, and discriminated well between candidates at the top end of the achievement range.

Question 4

There were many excellent answers to this question, but others were able only to answer **(a)** correctly.

(a) This was answered correctly by most candidates.

(b) Quite a few candidates did not understand the command word 'Deduce'. They read it as 'reduce' and wrote highly inventive answers in relation to this term. Most, however, correctly stated that the zinc ion has a positive 2 charge, explaining that the compound must have an overall charge of 0 and that this balances the negative 2 charge on the oxygen ion.

(c)(i) The expected answer was 'displacement'.

(ii) Many candidates understood this well, and appeared to have had experience of displacement reactions. Others had no idea, and either left this section blank or simply described the observations rather than explaining them.

(iii) If displacement reactions were understood, candidates usually gave the correct answer (lead) here. The most common incorrect answer was zinc nitrate.

Question 5

(a)(i) Many answers did not *explain* why the lamp did not light, simply stating that this is a series circuit. They needed to say that the circuit was no longer complete.

(ii) This was usually answered correctly, although some candidates forgot to state the unit.

(iii) Many candidates did not know how to calculate the combined resistance of resistors in parallel.

(b)(i) It was rare to see a correct answer to this question. Candidates were expected to state that the current keeps changing direction.

(ii) Again, this was answered poorly. Marks were awarded for a statement that transformers require a.c., and then a further statement relating to the need for stepping voltage up or down as electricity is transmitted from the power station and into a home.

Question 6

This question covered a range of topics, and candidates quite often did well on one part but poorly on others.

(a)(i) This was usually answered correctly, although many candidates wrongly drew an arrow through the upper epidermis to the palisade cell.

(ii) This, too, was often well answered. Most candidates stated that the cell contained many chloroplasts, which absorb light energy for photosynthesis.

(b) There is still misunderstanding about the meaning of the term 'genetic diagram'. A complete genetic diagram contains more information than a simple Punnet square. Marks were awarded for a clear statement of the genotypes of the parents (which only very few candidates showed), the genotypes of the gametes and of the offspring (normally shown in a Punnet square) and a statement that half of the offspring would have the substance and half not.

(c) Arrows should have been drawn from the tomato plants and the decomposers to the air, each labelled respiration. Other labels were acceptable for the decomposers arrow, such as decomposition or decay. Numerous answers added extra boxes to the diagram, or repeated arrows that were already there (for example, another 'respiration' arrow from the insects) or failed to label the arrows that they drew. Relatively few candidates appeared to know that plants respire.

Question 7

As in **Question 6**, several different topics are touched on in this question, and answers to the sections were often uneven.

(a) This was generally well known. Wrong answers included cracking and 'fractal distillation'.

(b)(i) Only a small proportion of answers stated that transition metals have catalytic properties. Many incorrectly stated that they would be able to withstand the high temperatures.

(ii) This was surprisingly poorly answered, presumably because the context prevented many candidates from thinking in an appropriate way about the problem. The expected answer was simply that reactions take place faster at higher temperatures.

(c)(i) There were many correct answers to this. However, there were at least as many incorrect ones, and some candidates apparently did not see the question and made no attempt to answer it.

(ii) This question proved to be more difficult than might have been expected. Only a small proportion of candidates stated that this would be produced by a reaction between oxygen and the fuel, although more did explain that the CO is a result of incomplete combustion.

(iii) This was often well answered, with candidates able to explain that the NO was reduced because it lost oxygen, whilst the CO was oxidised because it gained it.

(iv) There was a range of answers here. Candidates who realised that double bonds were involved usually ended up with a correct diagram. Others showed single bonds (they could still get a mark if the number of electrons on each atom were correct), whilst some drew completely incorrect diagrams.

Question 8

The final part of this question was the most challenging on the paper.

(a)(i) This was usually correctly answered. However, a large number of candidates said that the line on the graph was 'straight'. They needed to say that it was horizontal, or that the speed remained at 1 mm per s.

(ii) This was almost always correctly answered.

(iii) Candidates needed to show that they were calculating the area beneath the graph. Some could not deal with the triangular area between B and C. Some did the calculation completely correctly, but then lost a mark by giving no unit or giving the wrong one, usually metres.

(b)(i) This was very poorly known, and most candidates gave an incorrect answer of 2 cm.

(ii) This proved very difficult. Relatively few candidates were able to extend the rays backwards and then show the position of the image correctly. Quite a few made no attempt. The most common incorrect response was to draw more lines from the lens to the eye, or from the caterpillar to the eye, through the lens. Some treated the lens as though it were a mirror.

(iii) This was also disappointingly badly answered, with few candidates able to state that the image could not be projected onto a screen.

Question 9

(a)(i) There was confusion between the urethra and ureter, and it was important to use the spelling so that there was no uncertainty about which the candidate meant. Structure C usually correctly named.

(ii) Many candidates gave names again, which were not required. Many did not recognise the bladder, and so could not give its function. Even those who did know what it was, often said that it 'produced urine', which is incorrect. The function of the testis was well known.

(b)(i) It was disappointing to see so many candidates who think that self-fertilisation is asexual reproduction. If gametes and fertilisation are involved, even if both gametes come from the same parent, then this is sexual reproduction. It is therefore not strictly correct to say that sexual reproduction always involves two parents.

(ii) Many candidates simply repeated their answer to **(i)**. Others said that 'good characteristics would be passed on', as though only good characteristics and not 'bad' ones would be inherited by offspring. Better answers stated that, if an organism was well adapted to its environment, then the offspring would also be well adapted. Other acceptable answers revolved around the idea that energy that would be used up in searching for a mate could be saved. Marks were not awarded for any arguments that asexual reproduction is faster than sexual, which is not true in general.

Paper 0653/04

Coursework

General comments

Nature of tasks set by Centres

Only a small number of Centres submitted coursework for the November examination. All the assessments set were appropriate to the requirements of the syllabus and the competence of the candidates. The nature of the tasks was well understood.

The standard of candidates' work was comparable with previous years with candidates covering the whole mark range.

Teacher's application of assessment criteria

The assessment criteria were understood and applied well for all of their activities. No Centre tried to assess both skill C1 and C4 in the same investigation.

Recording of marks and teacher's annotation

There was good use of annotation on candidates' scripts to indicate or justify where marks have been awarded.

Good practice

Well constructed mark schemes.

Paper 0653/05

Practical Test

General comments

The paper was very similar to previous years in terms of the degree of difficulty. All three questions were readily accessible and there was no indication of shortage of time. The mark scheme produced a good spread of marks and the overall performance of candidates was similar to past years. Most Supervisors played their part by submitting their own answers although two or three produced the very minimum. One omitted any results for **Question 2** altogether. Failure to provide sufficient information can cause problems in assessment.

Comments on specific questions

Question 1

Almost all candidates recognised the tests being used and scored well on the colours and conclusions. Concern was expressed by a small number of Supervisors that the test in **(b)(i)** did not work very well but this was not born out by the answers of the candidates. There was some difficulty over the use of the word green. Often the answer to **(a)(ii)** and **(b)(i)** was simply green. It was difficult to decide whether this was the colour of the reagent, a definite change or candidates hedging their bets. Sometimes the conclusion clarified the observation. It was necessary to make certain that there was a change of colour and green did not necessarily score a mark. It should be noted that 'no change' is not an answer to the question. It was rare to award all four marks for **(b)(ii)**. A complete answer would have included reference to the one or more of the following; a need for sugar in respiration, energy for growth, starch broken down to sugar in seeds, by enzymes and sugar produced by shoots, etc. Most simply repeated what had already been recorded, viz. no sugar in **A** whilst **B** did contain sugar.

Question 2

A good number of candidates recorded the value **P** outside the limits requested. This incurred the loss of what was meant to be an easy mark. However, the main problem for candidates was their inability to associate the time for 20 swings measured to the nearest second, with the time for one second. Most candidates thought it necessary to calculate the time for 1 swing to two decimal places. Quite absurd in the context of the experiment and as a result it made the plotting of the graph more difficult and the straight line was less obvious than it should have been. Too many thought 0.05 of a second was important. A significant number appeared to try and measure experimentally the time for 1 swing judging by the number who had a time that bore little relationship to that of 20 swings. The plotting was usually correct but relatively few had the courage to draw a straight line through their points. Far too many joined up the points producing a zig zag, failing to understand the reason for drawing a graph. An increasing number of candidates are starting the horizontal axis with the largest value and decrease from left to right. This is considered to be a very unwise procedure, and was penalised. A large number were unable to conclude that the mass made no difference to the time of swing because of their failure to draw a straight line. As has already been said, if times differing by 0.05 second were thought to be significantly different, a straight line was not likely to be drawn. Of those who did produce a straight line, many were not prepared to commit themselves with the correct conclusion, hedging their bets by saying there was a small difference.

Question 3

The majority recorded the solid turning yellow on heating with fewer observing it turning white on cooling. Most observed the limewater turning milky and concluded carbon dioxide but many of these were unable to conclude the presence of a carbonate. Part **(c)** was poorly answered. A large number of answers were very descriptive but not making appropriate observations. Several observations are possible when solid **B** is heated strongly. The following were worthy of a mark each: water condenses on the side of the tube, the solid turns white, smoke is given off, the solid turns brown. Most answers suggested that the solid was not heated strongly enough. Some thought chlorine was evolved and a small number concluded the evolution of ammonia! Very few candidates scored both marks in part **(d)** because the solid was not first dissolved in water to make a solution. Although the notes on page 12 give the test required, it is assumed that if a precipitate is to be observed one must start with a solution. This was particularly pertinent in this test as one could not accurately refer to the solid turning green when it was green to start with. Year after year answers suggest that most candidates do not understand the use of the word precipitate. Another example of its misuse was found in **(a)(i)** when recording that solid **B** formed a yellow precipitate. A small number did not heed the instruction to carry out the test for iron. Describing what could be done and what might happen was not acceptable.

Paper 0653/06
Alternative to Practical

General comments

Many candidates are to be congratulated on the good standard achieved in this paper. The answers showed that candidates had "hands-on" experience of practical work in all three subject areas, biology, chemistry and physics.

The Examiners try to construct questions that ask how to do experiments, demand a recall of well-known reactions and results, give opportunity to record and process data and suggest extensions to experimental methods. They try to devise a gradient of difficulty to let weaker candidates score the easy marks and enable others to truly achieve the higher grades.

Questions involve practical rather than theoretical details. As a result of this, candidates without the relevant laboratory experience have, as usual, been at a disadvantage. Whole groups of candidates have answered some questions badly, showing their lack of experience of laboratory work in sections of the syllabus such as chemistry or biology. A "whole-subject" approach to science is essential if candidates are to be well-prepared for this examination. It should certainly not be regarded as an easy option to the Practical Examination or to Coursework.

The importance of practical details is well illustrated by **Question 5** parts **(c)** to **(e)**. The Examiners needed a diagram showing litmus paper held in the mouth of a heated test-tube; the description of a wood splint being lit and then the flame blown out to leave it glowing; and an explanation of the testing of solid **B** by first dissolving it in water and then adding aqueous sodium hydroxide to produce a precipitate of a characteristic colour. Far too many candidates who had never seen or carried out these tests relied on rote-learned knowledge that did not correctly answer the questions.

Some candidates showed a lack of experience in the techniques of answering the questions set in this paper. They did not read the questions all through before beginning to write, they failed to read balance and volume scales and they attempted to complete tables of data without understanding how to do so. Teachers are urged to provide practice in exercises of this type so that their candidates can demonstrate their true abilities.

Comments on specific questions

Question 1

This question tested the understanding of the role of starch as a storage substance in seeds, and conversion to a reducing sugar during germination. This was not well understood. Instead, candidates suggested that the germinating seed was photosynthesising to produce sugar.

(a)(i) Glucose is a reducing sugar. Candidates were expected to suggest the addition of Benedict's reagent followed by warming the mixture.

(ii) Most candidates concluded that starch was present but many were unable to give the unchanged colour of the Benedict's reagent.

(b)(i) This was better known, even if the name of the reagent had not been given in **(a)(i)**.

(ii) The reasons for the different results were rarely adequately explained. Many candidates merely repeated the results of the tests and then suggested that the appearance of the reducing sugar after germination was because photosynthesis had begun in the "shoots". This gained no marks. The Examiners needed the idea that starch, the storage substance, had been converted to a reducing sugar during germination so that the energy-dependent process of growth could begin.

Question 2

This question tested the knowledge of series and parallel circuits and their different effects on the current passing through the components. There were many good or excellent answers. The most disappointing aspect of the answers was a lack of understanding of the concept of resistance, although most candidates were able to calculate the resistance of a lamp given the potential difference and the current passing through it.

(a)(i)(ii) Many candidates correctly read the ammeters and assigned the current values to the correct switch combinations. The most common error was to write "0.6 A" for the current passing when all three switches were closed. This meant that for one lamp, the current passing would be 1.8 A. The candidate therefore gained 3 marks out of 5, losing two marks because of one error.

(iii) Errors in completing Fig. 2.3 were carried forward in marking this part of the question, so that a candidate who wrote "1.8 A" for one lamp could then score by putting this value into the formula R = 3.0/current. However, a candidate who used "0.6 A" in this formula but had *not* assigned this current to *one* lamp in Fig. 2.3 lost the mark even though this gave the correct answer for one lamp, 5 ohms.

(b) Most candidates were able to draw a circuit with three lamps in series with the ammeter. A few also included a voltmeter in series with the other components, losing a mark since they should know that its high resistance would not permit any current to flow.

(c)(i) Only a minority of candidates could explain that the series circuit had a higher total resistance than the parallel circuit. Many less able candidates wrote that the current was split up between the lamps or that the first lamp used up most of the current, leaving only a small current for the other two lamps.

(ii) These last mentioned candidates went on to say that the series lamps were progressively dimmer! However, most candidates correctly answered that lamps in the parallel circuit would be brighter.

Question 3

The Examiners designed this question as one that would combine balance scale reading with c knowledge and calculation of percentage composition. It is gratifying to note the many completely c answers. The most disappointing aspect of the chemistry was the failure to describe the colour of cop metal. A significant number of answers that were otherwise faultless included the assertion that "copper is a blue solid".

(a)(i)-(iii) Most candidates read the scales and subtracted to find the mass of brass. A few candidates read the scales from top to bottom, failing to notice the integers increasing from bottom to top.

(b)(i)(ii) What was needed here was the idea that the zinc would react with the acid producing bubbles of hydrogen, the obvious immediate *observation*. It is important that the word "observation" is correctly interpreted by candidates. The observation that "a colourless solution would be produced" is not relevant in this case, since the acid that was added was already colourless. Similarly, the second answer follows from the first, that the bubbling would cease when all the zinc had been dissolved. "The mass of brass had decreased" was also unacceptable as an answer, since at this stage, the beaker and its contents were not being weighed. A minority of candidates gave correct answers to both parts.

(iii) The appearance of copper residue was not often correctly described. The most common incorrect answer was "blue". Suggestions that it was pink, rusty, brown, golden-yellow, etc. were accepted, but not "copper-coloured".

(c)(i)(ii) Rather more mistakes were made in calculating the mass of the copper left over than had been made in calculating the mass of brass. A significant number of candidates calculated the mass of zinc dissolved, probably because they had not appreciated the logic of the question.

(d) A pleasing proportion of candidates calculated the percentage of the brass that was copper, earning two marks. Errors in **(c)(ii)** and elsewhere were carried forward in marking this calculation. One mark was awarded if either the quotient or divisor was incorrect in the formula "**x**/**y** x 100", or if the correctly-stated formula was wrongly calculated.

Question 4

Data, for the variation in pulse rate after exercise, was provided for the candidates. They had to fill incomplete boxes by simple deduction involving arithmetic, then plot a graph of the variation in pulse rate after a period of exercise, followed by searching questions about the investigation.

(a)(i) Some candidates tried to use the existing figures in the same column to deduce the missing values, instead of calculation from the 15s or 1 minute count.

(ii) This was deliberately kept simple by the provision of the labels of the axes. As a result, most candidates drew an acceptable graph. Some, however, plotted the wrong column of figures from Fig. 4.1. There were a few unsuitable scales chosen, for example, 2 cm = 32 counts!

(iii) This was found more difficult. A few candidates wrote that the pulse rate and time after exercise were inversely proportional. This was not accepted, since the phrase "inversely proportional" refers to the strict mathematical relationship stated as **x** = 1/**y**. All that was needed was a statement such as "the heart beat rate decreased as the time after exercise increased". The graph displays information but is not intended to find a relationship that can be expressed by a mathematical formula; this is the essential difference between it and the graph exercise in **Question 6**.

(b)(i) Many candidates failed to explain in terms of the student's metabolism why his pulse rate increased, contenting themselves with statements such as "he was running fast". The suggestion that oxygen was needed came nearer to the answer, and there were some clear explanations of energy production by cells using oxygen and nutrients supplied in the increased flow of blood.

(ii) A simple reference to "oxygen debt" gained the mark here, but the Examiners would have preferred the more complete explanation that anaerobic respiration had occurred, giving lactic acid that must be oxidised during the time that the heart rate gradually decreases. "It takes time for the body to return to normal" was not accepted.

(c) The intention of this question was to elicit the answer that that the experiment woul d after the drinking of a measured amount of coffee, then the results would then be co those shown in the question. However, some candidates did not suggest that exercise s taken after drinking coffee. In this case, the candidates were not penalised providing tha answer was reasonably detailed. Several candidates suggested comparing the heart rates o person who had drunk coffee and someone who had not done so, an unacceptable answer.

Question 5

This question, like **Questions 1** and **6**, was based on the corresponding question in the Practical Examination, Paper 5. Candidates in the Practical examination were provided with samples of two solids, A and B, which were zinc carbonate and iron(II) sulphate. The Paper 6 questions mirrored the tests and their results. Paper 6 candidates are required to learn the tests and positive results for gases and ions.

It was not enough, however, to have learned the tests “parrot-fashion” since there were “traps” for the unwary.

(a)(ii) The litmus paper stayed red! So the gas could be acid or neutral, but an answer suggesting the presence of a named gas, such as carbon dioxide, was not accepted.

(iii) Most candidates found it easy to write that the lime-water turned milky or white.

(b)(i) A mark could be earned by writing that the crystals gave off water vapour or that they were hydrated or became anhydrous. The identification of “an iron salt” was not accepted. Fewer candidates answered this part correctly.

(iii) The splint did not re-kindle! So the candidate must conclude that the gas could not have been oxygen. Again, the suggestion of a named gas that does not re-light a glowing splint, such as nitrogen or carbon dioxide, was not accepted.

(c) Now the candidate had to show a test-tube being heated, with a piece of red litmus paper held in the *mouth of the tube.* Some fantastic drawings were submitted, including the collection of the gas over water before its testing with litmus, which would not have worked.

(d) This provided many more candidates with a dilemma, how to do the glowing splint test? The splint has to be lit in a flame and then *blown out* to leave a glowing end. Without this step in the answer, no mark was awarded. Very few candidates scored this mark.

(e) The final hurdle for the “rote-learners” was in describing how to test solid **B** for iron(II) and iron(III) ions. Solid **B** must first be *dissolved in water* before adding aqueous sodium or ammonium hydroxide. Very many otherwise correct answers began “Add aqueous sodium hydroxide to both iron(II) and iron(III) compounds.....” thus losing a mark. Sometimes, the colours of the precipitates were given in the wrong order; one mark was earned, instead of two, for this answer.

Despite the problems encountered in this question, some candidates had been well-prepared and earned commendable scores.

Question 6

This question described the investigation used as the physics experiment in Paper 5. The time t 20 swings of a weighed pendulum was found, then the mass of the plasticine used as the pendulum bo progressively reduced and the time was again found. The Examiners chose a clock that depicted wh seconds only. The results therefore varied a little with the accuracy of the experimenter.

(a)(i) Most candidates were able to fill in the masses and times of 20 swings.

(ii) The times for 1 swing shown in the table were correct to the second decimal place, so a similar accuracy was required for the candidates' answers.

(iii) The majority of candidates made mistakes in plotting the graph. In **Question 4**, the data for pulse rate and time-lapse after exercise could have no associated mathematical relationship, so the graph was used merely as a display tool. In this question, the time of swing and the mass of the pendulum could be mathematically related, as is the case for most graphs in physics investigations.

Most candidates ignored this possible relationship and instead chose to display the variation in the time of swing. They used a small range of time on the *x*-axis such as 1.5 to 2.0 seconds. The resulting graph plot showed a wildly fluctuating swing, whereas in fact the total variation of only 0.1 s was within an experimental error of 5%.

A disappointing number of candidates plotted the mass of the pendulum in the same order as the lines of data, beginning with 87 g at the origin and ending with 43 g at the right-hand side.

Candidates must be taught that, to establish a mathematical relationship between variables, the origin, "0", should be included in the graph plot and due regard shown for experimental errors.

In assessing the candidates' graphs, one mark was awarded for the use of the range 0 to 2 seconds on the *x*-axis, with the axes properly labelled. The second mark was earned by plotting all five points accurately according to whatever scales had been chosen. The third mark was gained only by candidates who drew the best horizontal straight line.

(c) The effect of changing the mass on the time of swing could only be correctly judged if a straight-line graph had been drawn. Any other answers were ignored. However, candidates could earn the mark by saying that variation in the mass did not alter the time of swing very much.

(d) The teaching-point that the time of swing of a pendulum depends on the acceleration due to gravity appears to have been missed. A very few answers mentioned this possibility. Rather more candidates gave the correct answer that the length of the string has an effect, but these were in the minority; most could not get away from the errors they had made in interpreting the results of the experiment and said that change in mass would change the time of swing. Candidates who wrote that inaccuracy in timing had an effect on the time taken for 1 swing were credited with a mark.