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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**.

UNIVERSITY *of* CAMBRIDGE
International Examinations

CO-ORDINATED SCIENCES

Paper 0654/01

Multiple Choice

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

General comments

The mean on this paper is still very satisfactory. Since all the items were those which appeared on equivalent papers at this level, the candidates who sat this paper had clearly prepared well for it. The Physics items showed a good degree of competence amongst the candidates.

Although four of the Biology questions were correctly answered by fewer than half the candidates, the questions remained within the capabilities of more than 40% of them and performed well, and, in most cases, very well, when discriminating between candidates of differing abilities.

The mean mark was 26.0 and the standard deviation (6.95) and reliability coefficient were equally satisfactory. Indeed, the Chemistry questions call for relatively little comment – see below.

Comments on specific questions

Question 1

This was the easiest of the biology questions, and, as such, provided candidates with a welcoming start to the test. The unwary could easily have lost sight of the question as posed and opted for visible features of the dolphin such as fins and swimming, which would not have answered the question.

Question 3

This was also an easy question, but sound knowledge and/or clear and logical thought saw 90% to the correct answer.

Question 6

This proved the most difficult of the Biology questions, but good candidates experienced no problems. The weaker ones, however, displayed a faulty knowledge of what is carried in the xylem with almost a third opting for ‘starch’, some seemed to have faulty knowledge not only of plant physiology but also of the chemical properties of starch.

Question 7

This question was made to appear difficult only because it tested the traditional, erroneous belief that the voiding of faeces is called excretion. Sadly, more were of this opinion than were aware of the correct term – egestion.

Question 9

This was another question in which there were more candidates opting for an incorrect answer than for the correct one, though there just could have been an element of failing carefully to read the question. Thus, the optic nerve was selected in preference to the retina as the structure responsible for *conducting* impulses produced as a result of stimuli rather than *converting* stimuli into impulses as the question asked.

Question 10

The relative decrease in the amount of urea caused few problems (with almost three quarters of candidates being aware of that fact). Drawing on information from a different syllabus section appeared, however, to lead to much confusion for all except the most able when having to decide on the effect on the oxygen content of blood as it passes through the kidney.

Question 11

The mistaken belief that seeds require light for germination (despite the fact that most candidates would know that seeds germinate in soil, in the dark), probably accounted for the high percentage (38) opting for **A** as the answer.

Question 14

This question proved to be easy.

Question 18

This had very good discrimination but overall was found somewhat hard. This was evidently a consequence of half of the lower-scoring candidates choosing response C – precisely the opposite of the correct answer.

Question 19

It seems obvious from the statistics that the lower-scoring candidates guessed between responses **A**, **B** and **C**.

Question 22

This had disappointing statistics in that the dsicrimination was poor. About a third of the candidates across the ability range chose **C** although the syllabus is explicit in referring to both chemical and physical processes in the weathering of rocks.

Question 27

This also discriminated very well. It was found to be slightly hard primarily because response **A** was relatively popular across the ability range.

Questions 28-32

Candidates found these questions fairly easy.

Question 33

This showed that there is a lot of uncertainty about which waves are longitudinal and which are transverse.

Question 34

A quarter of candidates answered **D**. A triangular prism would indeed move the rays vertically, but they would not remain parallel.

Question 35

Candidates found this question fairly easy.

Question 37

The circuit was somewhat unusual, in that we do not often put switches in parallel with components. Over 40% could cope with this situation, with the remainder being equally divided between the incorrect options.

Question 38

This question caused serious problems for some candidates. No candidate thought that the case of the telephone earpiece moves in order to produce sound, but candidates were equally divided about the remaining options.

Paper 0654/02

Paper 2 (Core)

General comments

Most candidates were able to attempt most questions and often managed to write a considerable amount. Many gained good marks on one question but then gained few marks elsewhere. **Questions 5** and **7** were poorly answered by many candidates. **Questions 6** and **9** were generally well answered. Many marks were lost by a lack of precision in giving answers. Although it appeared that candidates often knew the answer to the question, their answers were very vague. Perhaps language difficulties played some part here. Performance depended not only on scientific knowledge but on the ability to understand the question. There was no evidence of candidates suffering from a shortage of time to complete the examination.

Comments on specific questions

Question 1

This question was quite well answered.

(a)(i) Most candidates knew that the colour seen at **A** was red.

(ii) Violet was not well known here. Common wrong answers were blue and yellow.

(b) The meaning of the term *primary colour* was not known to many candidates. Many candidates clearly confused primary and secondary colours.

(c)(i) This was well answered.

(ii) This was well known to many candidates. Although there were a number of sound and ultrasound answers.

(iii) Infra-red was not well known. All the answer choices were commonly given.

(d) The formula for this calculation was well known and many candidates managed to correctly substitute in the correct numbers. Few candidates appreciated that the distance calculated using the data needed to be divided by two to get the correct answer.

Question 2

There were some good answers to this question but many candidates struggled, especially with part **(d)**.

(a)(i) Many candidates correctly answered glucose, although cellophane was often given.

(ii) Many candidates were able to identify the three elements.

(iii) This part was quite well answered with many candidates correctly drawing out part of the structure.

(b) The correct answer of three was the most commonly given answer.

(c)(i) Covalent bonding was well known.

(ii) The connection between covalent bonding and non-metals was not well known. Few candidates got this right.

(d) Although many candidates realised that it was water and toxins which passed through the membrane, few were confident enough to explain that the membrane was selective and that only certain molecules could pass through, nor did they appreciate that other essential blood components could not pass through. Many candidates suggested that the cleansing solution went through the membrane.

Question 3

All parts were fairly well understood, with some candidates gaining good marks. Good data handling skills were demonstrated in part **(d)**.

(a) Vena cava and left atrium were fairly well known. There were no common wrong answers.

(b) This was well answered. Most candidates managed to correctly position the muscular wall of the left ventricle.

(c) Many candidates gained some credit here. The need for oxygen for respiration was quite well known as was the fact this would eventually lead to the heart muscle contracting and the heart pumping. Few candidates were able to associate respiration with a supplying of energy.

(d)(i) This was well answered.

(ii) This was also well answered.

(iii) Most candidates were able to state one other factor.

Question 4

(a)(i) Most candidates were able to describe acceleration in terms of increasing velocity.

(ii) This was not well answered. Few candidates realised that if the squirrel was accelerating the forces on it would not be balanced and that air resistance would have to be less than the weight of the squirrel.

(b)(i) Similarly, few candidates appreciated that for a steady speed, forces needed to be balanced and that therefore air resistance would be equal to the weight of the squirrel.

(ii) Most candidates showed good data handling skills here, gaining full marks.

(c)(i) This was not well answered. The formula was relatively complex as were the mathematical skills required.

(ii) Many candidates had a reasonable idea of what happened to the energy, although a number of answers lacked clarity.

Question 5

This question was poorly answered throughout, showing that this section of the syllabus was not well known.

(a) Many candidates gained one mark here but few gained both.

(b)(i) Many candidates knew that the other metal was iron.

(ii) The answers of many candidates were that magnesium was more reactive than iron rather than magnesium was more reactive than titanium.

(iii) This part was poorly answered. Few candidates mentioned argon and even fewer seemed to be aware of its lack of reactivity. Few candidates could explain that the titanium would be reacting with oxygen.

(c) Many candidates were able to provide at least one property of titanium alloy which made it a suitable material, but few were able to give a valid reason. Consequently, candidates scored few marks here.

Question 6

(a) This part was not well answered. Many candidates managed to show the rays of light bending at either the cornea or lens and a few showed the rays being focused onto the retina. Very few candidates gained all three marks.

(b)(i) The better candidates showed their understanding of genetics and gained full marks here. Many candidates gained one or two marks.

(ii) Many candidates successfully drew a genetic diagram and gained two marks. To gain full marks the candidates needed to either identify the genotypes of the parents or the genotype of the yellow eyed offspring.

(c)(i) Mutation was generally well understood.

(ii) Many candidates were able to identify a suitable radiation, but few were able to explain that it damaged DNA.

Question 7

(a)(i) This was well answered by many candidates. Common errors were to ignore the switch or to put an extra wire in parallel with the two lamps.

(ii) Many candidates gained the mark here. Those who did not generally lost the mark due to giving an answer which was too vague.

(b) This was well answered.

(c) Candidates found this difficult. Marks were available for knowledge/understanding of a number of concepts – the nature of alternating current, the production of electromagnets, and the interaction of magnetic fields. Very few candidates scored two or three. A number of candidates scored one mark but most scored zero.

(d) A number of candidates appreciated that there would be more particles, but the idea that these particles would collide with the tyre walls was not well known. Most answers explained that the particles would be closer together and therefore the pressure increased.

Question 8

(a)(i) **T**here were many correct answers here.

(ii) The common wrong answer here was three, showing a lack of understanding of atomic structure.

(iii) Many candidates gained one mark here, although few gained both.

(iv) Chlorine was not well known.

(b)(i) Lithium oxide was not well known.

(ii) Many candidates were able to state that the products of the reaction would be lithium hydroxide and hydrogen but were not then able to identify hydrogen as being the hazard, nor explain why hydrogen was a hazard.

(iii) This was quite well answered.

Question 9

There were many good answers to this question.

(a)(i) This part was poorly answered by almost all candidates. Few gave the correct response.

(ii) This was answered well. Many candidates gained full marks and most gained at least one.

(iii) Many candidates gained full marks here for an accurate, well labelled diagram. A few candidates attempted to draw the complete structure of the leaf.

(b)(i) The quality of answers to this part varied very much. Overall few candidates correctly identified an ammonium salt or a nitrate. A large number of candidates offered ammonia as an answer.

(ii) This part was poorly answered. Few candidates scored any marks here, showing poor knowledge of this part of the syllabus.

(c)(i) This was well answered with many candidates gaining both marks and almost all gaining one mark. A number of candidates drew the arrows backwards.

(ii) This was very well answered by almost all candidates.

(iii) The only answers that the candidates gave were that it would be cheaper and do less harm to other organisms.

Question 10

(a)(i) Many candidates gained both marks here.

(ii) Although many candidates correctly gave the three products, a large number of candidates seemed to be guessing on the basis of the name of the reactant.

(b) Most candidates gained at least one mark here for appreciating the difficulty in forming a lather.

Paper 0654/03
Paper 3 (Extended)

General comments

A full range of performance was seen on this paper. A significant number of candidates showed a sound mastery of the material that was tested. However, there were also many candidates who had been inappropriately entered for this extension paper, who were not familiar with the material from the supplement or who did not have the skills required to tackle any but the least demanding questions.

Examination technique let many candidates down. Many did not appear to understand what is meant by the different command words used. For example, in **2 (c)(i)** they often attempted to explain rather than describe; in **6 (a)** they tried to explain instead of state; and in **8 (a)** they frequently described rather than explain. It is most important that candidates answer the question that is asked, and not one that they would prefer to have been asked, or that they think ought to have been asked.

<u>Comments on specific questions</u>

Question 1

This was, for most candidates, a straightforward beginning to the paper. However, it was rare to see full marks for parts **(a)** or **(b)**.

(a) It was very surprising to see so few entirely correct answers here. Many stated that secondary colours could be made by mixing secondary colours, without specifying that *two* primary colours should be mixed. Most were able to name another primary colour (blue or green) but relatively few could name another secondary colour (cyan or magenta). Many chose colours such as pink, orange, brown or purple.

(b) Once again, it was surprising to see so many errors here. Some confused longitudinal and transverse waves. Many thought that gamma radiation is given out by hot objects.

(c)(i) Most answers began with *a* $d = s \times t$ equation, but many failed to take the 'double journey' into account and did not divide their answer by 2. Others tried to use an equation involving frequency.

(ii) This was usually answered correctly, although some did not know the correct formula and some were not able to give a unit with their answer. A common error was to write a formula involving frequency and time, which led to an erroneous calculation and answer.

Question 2

Many weaker candidates had difficulty with the longer answers required here, as well as interpreting the data.

(a)(i) The left atrium was usually named correctly. Some candidates appear to be using an incorrect spelling 'autrium'.

(b) Answers to this question were disappointing. They frequently began by copying the first sentence in the stem of **(b)** and then going on to say that this would not happen if a coronary artery was blocked. Better candidates explained that the heart muscle needs oxygen for respiration, to release energy so that it can contract. Most answers, though, were long and rambling and never succeeded in making any of these points. Some candidates seemed to think that the coronary arteries supplied blood to the rest of the body.

(c)(i) All that was expected here was a statement that the risk of heart attack increases with age, and then some statement involving the numbers in the table, for example that the risk goes up by about 2% every 10 years. Weaker candidates often invented and answered a more difficult question, attempting to explain *why* smoking has this effect.

(ii) This was very well answered by a pleasing number of candidates, and the full three marks were often awarded. A range of answers was acceptable. Once again, though, weaker candidates completely missed the point and answered a different question, not using the information in the table as they were asked to do.

(iii) This was well answered, although weaker candidates often stated 'eat a healthy diet' without stating what this entails.

Question 3

This question ranged over several different topics, and some candidates appeared to be disorientated by this. However, there were many excellent answers.

(a)(i) This was usually answered correctly, although some candidates gave the number of electrons instead of the number of shells.

(ii) Many candidates simply described why the lithium ions move to the cathode, which did not answer the question. Better answers stated that the ions gained one electron to become atoms.

(b) The majority of candidates appreciated that the reaction of lithium with water releases hydrogen, which is flammable or which could cause an explosion. Incorrect answers often suggested that either hydrogen or lithium hydroxide are toxins.

(c)(i) This was often well done, but there was a surprising number of candidates who could not even write the formula of the carbonate ion (despite being given the formula for lithium carbonate). Some tried to work out the charge by thinking about the structure of the carbonate ion, rather than simply stating that lithium carbonate has no charge, and therefore the 2+ charge of lithium must be balanced by a 2– charge of the carbonate ion.

(ii) Almost every candidate answered this correctly.

(iii) It was surprising to see so many candidates unable to calculate the relative formula mass of lithium hydroxide. Most who got as far as calculating the relative formula mass did then go on to multiply it by 1260. However, some attempted to answer the question using the relative formula mass of carbon dioxide.

(iv) Most candidates answered this incorrectly, in terms of the relative reactivity of lithium. The correct answer is that lithium is lighter, and therefore the mass of the spacecraft's load can be reduced.

Question 4

Many candidates had no difficulties with this question. Others became too tied up in the context and forgot the physics that they may have known.

(a)(i) Most were able to answer this correctly.

(ii) Better candidates suggested a value less than 20 N, explaining that there must be a resultant force if the squirrel is still accelerating. Others, however, suggested 20 N or a larger value, attempting to explain that the squirrel must not fall too quickly or it would hurt itself.

(iii) Those who remembered the fomula f = ma usually calculated the value correctly, but unfortunately many gave their answer as 5 N/kg, which is not a suitable unit for acceleration. Numerous candidates used wrong or inappropriate formulae.

(b)(i) This question required candidates to understand that, if speed is steady, there is no resultant force on the squirrel. Some confused velocity with force and gave a value of 3 N, or – even more often – 6 N, presumably obtained by multiplying the squirrel's mass of 2 kg by its velocity of 3 m/s.

(ii) This was poorly known. The expected answer was that air resistance increases as speed increases. Some candidates suggested that the squirrel had spread out its flaps, which is not an appropriate answer to this question.

(iii) Candidates were expected to use their answer from **(i)** in this calculation, and most did so. Once again, units let several candidates down. Either N/m^2 or pascals were appropriate.

Question 5

This question brought to light much misunderstanding about the structure and function of the eye.

(a)(i) Most candidates correctly stated that A (the ciliary muscle) will contract, but it was relatively rare for them to know that B (the suspensory ligaments) slacken.

(ii) This was very poorly answered. Marks were awarded for a statement that the lens refracts light, that light rays from a close object are diverging and therefore need to be refracted more in order to focus them onto the retina, and that a fat lens refracts more than a thin one. These marks could be awarded for diagrams that clearly showed these events. However, many diagrams showed light rays going past the outer edges of the lens instead of through it; parallel light rays approaching the eye instead of diverging ones; and an image focused somewhere in the middle of the eye rather than on the retina.

(b)(i) It is important that candidates realise that a Punnet square is only *part* of a genetic diagram. A complete genetic diagram clearly shows the genotypes of the parents, then the gametes and offspring (which is what the Punnet square does) and finally a statement that answers the question. Here, many candidates did not give the genotype of the parents, or did not identify the young with yellow eyes. Several incorrectly stated that the parents would have three offspring with brown eyes and one with yellow eyes, clearly not appreciating that the Punnet square shows *chances* of these genotypes arising.

(ii) This was not well answered. Candidates were expected to state that the radiation can damage DNA, genes or chromosomes.

(iii) Some candidates answered this very well, explaining that as the mutation was a change in the DNA in the iris cells, it would not affect the gametes and therefore could not be passed to the offspring. Some, however, suggested that the change was an acquired characteristic and did not affect the DNA at all, even when they had previously answered **(i)** correctly.

Question 6

Many candidates wasted a lot of time trying to answer a different question in part **(a)**. In general, hardness of water appears not to be well understood.

(a) All that was required was a brief statement referring to the appearance of liquid in tube B and the limewater becoming cloudy in tube C. Weaker candidates, however, tried to *explain* these observations rather than stating them.

(b) Most answers correctly gave water as the other product, and explained this in terms of the number of atoms in the equation, or the need for the equation to balance.

(c)(i) This was answered correctly by only a very few candidates. Precipitation or double decomposition were the expected answers.

(ii) Most answers to this were entirely incorrect. Some candidates did appreciate that this had something to do with the calcium ions, but relatively few explained that hardness is caused by soluble calcium ions (or soluble calcium chloride) which are removed when the calcium carbonate precipitates.

(d) This, too, was poorly answered. A few candidates did state that these are giant structures, and that strong bonds need to be broken to change the solid to a liquid. Only very few candidates stated that there are *many* bonds that need to be broken. A few did explain that high temperatures are needed because a lot of energy is needed to break the bonds. Weaker candidates tried to explain this in terms of sodium and silicon as elements.

Question 7

Part **(b)** proved to be the most difficult section on the paper.

(a)(i) Candidates found this surprisingly difficult. Many diagrams showed the lamps in series rather than in parallel. A few did not know the correct circuit symbols, or added extraneous voltmeters or ammeters. Quite a large number included the rear lamps in their circuit; these were ignored so long as they did not interfere with the part of the circuit containing the front lamps.

(ii) Although most candidates appeared to appreciate why the other lamp would still light, many had trouble in expressing their ideas. A simple statement that there is an alternatively pathway for the current was all that was required.

(iii) This was usually answered correctly.

(b) Only a very few candidates showed any understanding of this topic. They needed to say that the current in the coil would produce an electromagnet. Once this had been grasped, they were often able to at least partially explain the why the cone vibrates, but those who did not realise that electromagnetism is involved could not usually make any correct points.

(c)(i) Candidates from many Centres had no problem with this. Others, however, appeared to have no knowledge of how to explain pressure in terms of the particle theory. Some got part way there, but explained pressure as being caused by the particles colliding with each other, rather than with the wall of the tyre.

(ii) Answers followed a similar pattern to those in **(i)**. A significant number of candidates described the particles ‘expanding’ and ‘trying to get out’ of the tyre. Others spent time in attempting to explain why the tyres got hotter, rather than answering the question.

Question 8

This question proved to be demanding, and weaker candidates often got no marks at all for the entire question.

(a) Candidates needed to realise that photosynthesis was involved before they could get very far with this, and weaker candidates often did not make this link. Others merely described the patterns shown by the graphs. Better candidates were able to mention limiting factors as part of their answer.

(b)(i) Surprisingly few candidates could write this word equation. Many missed out oxygen, or invented products such as methane oxide.

(ii) Although many answers correctly gave an increased concentration of carbon dioxide as one reason, relatively few thought of heat as another (presumably forgetting, or never taking in, the information that this context is about growing plants in a *cool climate*). The suggestion that extra water would help was not credited, as plants would normally receive plenty of water in other ways.

(c)(i) Once again, it was surprising to see so few correct answers to this. The most common correct answer was ammonium nitrate. Some just gave ‘nitrate’. Others suggested substances that did not contain nitrogen, such as phosphorus.

(ii) There were many good answers here, explaining that nitrogen is needed for making proteins, and then giving a reason why this increases growth rate. However, many candidates had no idea, and a great deal of nonsense was seen.

(iii) Here again, many candidates were so at sea that they could only write nonsense, for example saying that nitrogen is a poisonous gas and kills animals. Others, however, gave good descriptions of eutrophication. A common error is to suggest that algae use up oxygen, whereas the real culprits are the aerobic bacteria that feed on dead plants.

Question 9

This question was not well answered. It is possible that some candidates were short of time, but for most this did not appear to be a problem.

(a) Better candidates had no trouble with this, but there were many incorrect answers. Many candidates did not do as the question asked, and wrote words or numbers in the boxes rather than 'high' or 'low' as they had been asked to do.

(b)(i) This was usually answered correctly.

(ii) Once again, many candidates answered this correctly. Weaker candidates drew a single chlorine atom, showing the electrons in all of the shells.

(iii) Only a few candidates answered this correctly. Many thought that a covalent bond would be formed between the magnesium and the chlorine. Better answers did state that the magnesium atom would lose the two electrons in its outer shell, but very few also stated that it would then have an electron arrangement of 2.8.

(c) Most were able to get at least one mark here for guessing that the alloy would be stronger. Some went on to explain that the alloy would be less mealleable because it contains particles of different sizes that cannot slip easily over one another.

Paper 0654/05

Practical Test

General comments

The standard of the paper was thought to be very similar to previous years and the achievement of candidates was also close to that of the last few years. No one question proved more difficult that the others and all the marks were accessible, producing a good spread. Supervisors generally played their part and it must be said that their results and comments are very important and taken very seriously.

Comments on specific questions

Question 1

The majority of candidates recognised the tests and scored well on these parts. Although the majority did, a small number did not record the colour change with Benedict's in **(b)(i)**. Consequently the concern expressed by some Supervisors that the test might not work, was unjustified. The Examiners were looking for a marked difference between the results in **(a)(ii)** and **(b)(i)**. This was particularly important when the word green was used. It was not always possible to decide whether a change had actually occurred or the word was being used to describe the colour of the reagent. Some actually used the words 'stayed green'. It should be noted that 'no change' was not accepted when the question specifically asked for the 'colour observed'. Very few candidates scored all four marks in part **(b)(ii)**. Most were satisfied to repeat what had in fact already been established, namely that **A** did not contain sugar whilst **B** did. Some added that one had started to photosynthesise but few commented on the fact that sugar is required for respiration and or energy for growth. A further scoring point was gained by indicating that enzymes break down starch into sugar. Many correctly stated that the shoots contained protein but only a small percentage stated that all living cells contain protein. A minority were confused between Benedict's and the biuret test. Some actually stated biuret A and biuret B.

Question 2

The value for length **P** was often outside of the limits required and those who were careless enough to make this mistake lost an easy mark. The majority of candidates failed to appreciate the kind of accuracy that was required in this experiment. Having been told to measure the time for 20 swings to the nearest second it was pointless recording the time for 1 swing to two decimal places. The consequence of this was to make the rest of the exercise more difficult than intended. The answer to part **(g)** required rather more than just the sentence 'it is more accurate'. The actual plotting of points on the graph was fine but as already indicated, plotting to two decimal places meant that the line did not appear to be straight. Very few could see that within the accuracy of the experimental measurements, the results were suggesting a straight line. Without such a line the mark for answering part **(i)** was not awarded unless accompanied by suitable explanation. Perhaps more surprising was how few were courageous enough to actually say that the mass made no difference even when a straight line was drawn. Some even recorded times exactly the same but still insisted that the mass made a difference. An increasing number of candidates are scaling the *x*-axis on the graph from high to low values. This is thought to be bad practice and usually leads to difficulty when reading from the graph. The last part presented few problems and a good number scored both marks.

Question 3

The majority noted that solid **A** turned yellow on heating with fewer recording a return to white on cooling. Throughout the paper many candidates showed a misunderstanding of the word *precipitate* highlighted here by stating that **A** became a yellow precipitate. It also resulted in a lost mark in part **(d)**. Ammonia was a common answer to **(iv)** resulting from litmus paper turning blue, although some of these candidates then tested for a carbonate in part **(b)**. One wonders why! Part **(c)** was poorly answered. There were some lengthy descriptions but a lack of chemical detail. If heated strongly, solid B decomposes by first losing water, visible on the sides of the tube, then turning white followed by production of smoke and finally turning brown. The common mark for this part was one only. Very few scored both marks in part **(d)**. If the solid was not first dissolved in water only one mark was possible. Although most knew what test to use they failed to understand that one can only produce a precipitate if the starting point is a solution. Adding a solution to a solid does not produce a precipitate, particularly in this test as the solid was green and a green precipitate was produced.

Paper 0654/06
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 its 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 chemical knowledge and calculation of percentage composition. It is gratifying to note the many completely correct answers. The most disappointing aspect of the chemistry was the failure to describe the colour of copper 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 would be repeated after the drinking of a measured amount of coffee, then the results would then be compared to those shown in the question. However, some candidates did not suggest that exercise should be taken after drinking coffee. In this case, the candidates were not penalised providing that their answer was reasonably detailed. Several candidates suggested comparing the heart rates of a 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 taken for 20 swings of a weighed pendulum was found, then the mass of the plasticine used as the pendulum bob was progressively reduced and the time was again found. The Examiners chose a clock that depicted whole 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.