CO-ORDINATED SCIENCES

Paper 0654/01
Multiple Choice

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

General comments on whole paper

At 58%, the mean on this paper is reasonably satisfactory and shows that candidates for this paper appear to have been well prepared.

Comments on individual questions (Biology)

General comments

The questions in the Biology section of this paper were generally well-suited to the ability-level of the candidates taking the paper and did an a competent job of discriminating between candidates of differing abilities.

Comments on individual questions

Question 3

That this question should prove to be one of the most difficult of the Biology questions may well have its roots in the time-honoured advice to 'read the question' before answering it. Almost a quarter of candidates, including some quite able ones, chose the first option to begin with the word 'stimulus', which does indeed lead to an impulse – as suggested in that option, but not before, as offered in **C**, a receptor has been involved.

Question 4

Though larynx and epiglottis are both mentioned in the syllabus, their positions and identities were either confused or just not known by almost a quarter of the candidates.

Question 5

This question was not particularly successful, in that only a quarter of candidates were managed to choose the right option. That quarter was, however, amongst the very best of those taking the paper. The problem may have resulted from the question appearing to about circulation as stated, but the answer based on a knowledge of the structure and function of the heart. This may, perhaps understandably, have led to guesswork in an attempt to mask a perceived lack of knowledge on the topic.

Question 7

This was one of the easiest question in the section. But it was, perhaps, significant, even so, that a fifth of the candidates were unable to find a link between protein in the diet and any of the three conditions mentioned in the question.

Question 8

This question, like **Question 7** before it, was also one of the easiest in the section. Again, however, a competent scientist could, perhaps, have been expect to work out that only **P** and **Q** on the diagram could have prevented, or, at least, reduced friction, and 20% of the candidates failed to do that.

Comments on individual questions (Chemistry)

Overall the Chemistry questions on this paper performed quite well, proving, on average to be slightly more difficult that the Biology questions and about the same difficulty as those for Physics.

Questions 16 and **25** proved to be particularly straightforward with a large majority of candidates choosing the correct option.

Question 24 proved quite challenging. It discriminated well but, amongst weaker candidates, option A proved more popular than the correct option C. This may have been due to confusion of the nitrate and ammonium ion tests as both involve the production of ammonia.

Question 18 proved to be difficult with even stronger candidates selecting the wrong option. Few candidates chose B (the correct option) with both A and C proving more popular. The stronger candidates tended to opt for A rather than B. This was probably due to candidates confusing biodegradability with recycling. Weaker candidates opted for option C in quite large numbers. This was probably due to their missing the 'against' in the stem of the question and looking for arguments in favour of the recycling of glass.

Comments on specific questions (Physics only)

In general, the Physics questions on this paper were well answered. The questions which candidates found easy (facility ≥ 70%) were 30, 31, 32 and 34. Questions where the facility showed that candidates found the topic particularly difficult were 36 and 39. The responses to many of thequestions were sufficiently good that no worthwhile comment need be made, but the following comments on selected questions may be of help to teachers.

Careless thinking affected answers to question 29, because only a quarter of candidates answered correctly, whereas nearly two-thirds got the densities reversed. In question 33, virtually all realised that the pressure would change and very few thought that the pressure would be zero at any time. However, almost as many thought the pressure would go down as thought it would go up.

A topic which candidates often struggle with is that of ray diagrams. In question 36 they struggled again. Only a third answered correctly, with a majority of the rest thinking that the ray went on to pass through the other principal focus.

Question 36 was answered correctly by half the candidates, with the remainder tending to go for the common misconception that lamps in parallel must be dimmer. The transmission of electricity using high/low voltage was not well understood (question 39), with the statistics suggesting widespread guessing.

The final question was not difficult, and just over half the candidates answered correctly. However, it is possible that the remainder were put off by having to take information from a table rather than a graph.

CO-ORDINATED SCIENCES

Paper 0654/02

Core Theory

General comments

Most candidates were able to attempt most questions. There was a good range of marks on all questions and candidates generally scored on all questions. Very few gained no marks on any question and very few gained full marks. Although it appeared that candidates often knew the answer to the question, their answers were very vague. Language difficulties played some part here, although the general level of English was reasonable. Performance not only depended on scientific knowledge, but on the ability to understand the question.

Questions 4, **6** and **9** seemed to be the most difficult for the candidates to answer successfully. **Question 5** was the best answered by the candidates.

It is becoming apparent that when a numerical answer is required, weaker candidates will merely take any numbers that are given in the question and either multiply them or divide them. Quite often they make up a formula/equation to confirm this. Another problem with calculations is that candidates will often draw a triangle with three letters in it and expect that this will be accepted as a formula/equation. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided.

There was no evidence that candidates had difficulty in completing the paper in the available time.

Comments on specific questions

Question 1

The calculation parts of this question were well answered.

(a) (i) Many candidates knew the correct formula and correctly substituted the data to get the correct answer.

(ii) Many candidates correctly got the answer, although many used formulae which were confusing. The letter m was frequently used for both momentum and mass.

(b) Many candidates believed that the forces were balanced. Of those who correctly determined that the forces were unbalanced, many failed to explain that this was concluded because the ball's speed was changing.

(c) Although many candidates correctly identified carbohydrates and fats as the correct answers, many candidates also added vitamins and minerals.

Question 2

Most candidates gained good marks on some parts of this question, but few answered the whole question consistently well.

(a) The idea of a smooth skin, without scales, feathers or fur was not well known.

(b) Few candidates offered the correct response of Bufo. There were a number of made up answers.

(c) This was well known, but many candidates lost marks because they either drew the arrows the wrong way or they vaguely referred to insects and plants.

(d) (i) This was poorly answered, demonstrating poor data handling skills. Many candidates were unable to read off the normal value as 1550. Some were unable to divide this value by 24 to get the correct answer.

(ii) Many candidates described the relationship between the toad's legs and the distance moved rather than the speed.

(iii) Most candidates managed to correctly identify at least one variable.

(e) (i) Protease was not well known.

(ii) Small intestine was not well known.

Question 3

Most candidates gained good marks on some parts of this question, but few answered the whole question consistently well.

(a) (i) Magnesium chloride was the most common and correct answer.

(ii) Chlorine was a popular incorrect answer here.

(iii) Although many candidates correctly realised that hydrogen was the gas evolved, many candidates gave the incorrect chemical test for hydrogen.

(iv) Most candidates appreciated that an exothermic reaction means that energy is released or that the temperature will rise, but few suggested both.

(b) (i) Few candidates were able to explain that the metals needed to be mixed and melted together.

(ii) This part was poorly answered. Few candidates realised that magnesium alloys are light/low density and the impact that this has on their uses.

Question 4

This question was poorly answered.

(a) (i) There were few correct references to either the nucleus of an atom or to the act of splitting. Consequently, few candidates scored any marks here.

(ii) Most answers here were far too vague. There were few references to reduction in fossil fuel usage/less carbon dioxide emissions.

(iii) Although the context was different, more candidates should have been able to work out the correct answers here.

(b) In parts **(i),** (**ii)** and (**iii),** the candidates seemed very confused by the data given and seemed unable to provide answers which included their own knowledge.

(iv) This part was well answered, showing a good understanding.

(v) Many candidates were far too vague with their answers. For example, suggesting that the radioactive sample would not be able to pass through the lead.

Question 5

There were many good answers to this question.

(a) This was well answered, with many candidates gaining both marks.

(b) (i) Many candidates appreciated that the lining of the uterus was decreasing.

(ii) Few candidates showed that they understood this. Candidates need to be careful that they refer to the data given.

(c) All three parts of this question were well answered. Many candidates gained full marks here.

(d) (i) Although most candidates could suggest that either AIDS was spread by a virus or by transmission of body fluids, few candidates suggested both.

(ii) Almost all candidates gained full marks here. The ideas of protection from sexually transmitted diseases or abstinence were well known.

Question 6

This question was not well answered.

(a) (i) Few candidates scored marks here. Few candidates correctly identified either metamorphic or igneous as the two other types of rock.

(ii) Few candidates realised that rock B needed to be porous.

(b) The majority of candidates managed to identify at least one difference between hydrocarbon molecules.

(c) This was well answered, although a number of candidates still managed to get only one, or zero, marks.

(d) (i) Oil and water not mixing was not well known. Many candidates appeared to be guessing.

(ii) Soap or detergent was the most common and correct response.

Question 7

(a) Many candidates merely rephrased the question and explained that polystyrene kept the heat in. Reference to insulation was required.

(b) (i) Many candidates gained both marks here, but also many candidates did not appear to know the correct formula to use.

(ii) Few candidates realised that the answer to this part should have been the same as the answer to part **(i)**.

(c) (i) Most candidates were able to give the name of a part of the electromagnetic spectrum. Some however stated sound.

(ii) Very few had any idea about this. There were no popular wrong answers apart from 0 m/s

Question 8

Most candidates gained good marks on some parts of this question, but few answered the whole question consistently well.

(a) (i) Many candidates gained both marks here, but a significant number reversed the two gases..

(ii) Diffusion was well known

(b) Most candidates either thought that oxygen was released by the red blood cells in the lungs or explained that the red blood cells carried oxygen around the body, which did not answer the question.

(c) (i) Most candidates repeated the question as their answer. Few stated that respiration was occurring at night and that photosynthesis (and respiration) were occurring during the day.

(ii) Few candidates indicated that gases would travel to the cells through the stoma. Most answers showed gases entering the leaf from the top or side.

(iii) Many candidates were able to identify transportation of minerals and water as functions of the xylem vessels. Fewer candidates were able to clearly describe the role of xylem vessels in supporting the plant/leaf.

Question 9

This question was not well answered. Candidates seemed unable to use the data they were given.

(a) This was answered poorly by many candidates. Many just tried to rearrange the information given.

(b) (i) Many candidates were able to explain what synthetic meant but very few candidates realised that they needed to explain what a dye was.

(ii) This was well answered.

(iii) Chromatography was commonly known by the candidates.

(c) Diagram 3 was the correct and most common response, but many candidates were unable to explain why in terms of electrons being shared.

Question 10

(a) Most candidates were able to correctly draw the circuit diagram using the correct symbols. The commonest error was not knowing the symbol for the cell. A small number of candidates also used squares rather than circles as their symbols for the voltmeter and ammeter. It was encouraging to see so many candidates able to connect up the ammeter and voltmeter correctly.

(b) (i) Most candidates managed this part well and were able to give at least one suitable answer.

(ii) Candidates did know the answer to this but many were far too vague in their description of reversing the poles of the magnet.

(c) (i) Calculating the power put into the motor was usually done well.

(ii) Ideas about efficiency were not shown in this part.

Question 11

This question was not well answered. Answers given suggested that many candidates were not familiar with these parts of the syllabus.

(a) (i) Very few candidates correctly identified an ionic compound as being suitable to produce an electrolyte.

(ii) Few candidates have obviously met this situation before. Very few were able to suggest that having two identical electrodes would mean that the voltage would be reduced to zero and even fewer were able to explain the situation.

(b) (i) Many candidates were able to work this out.

(ii) Almost as many candidates thought that zinc gained electrons rather than lost them. Few candidates went on to suggest that two electrons were lost.

(c) Zinc was commonly identified as the substance oxidised as was manganese and more worryingly magnesium. Few candidates were able to explain why zinc had been oxidised.

CO-ORDINATED SCIENCES

Paper 0654/03
Extended Theory

General comments

Although there were numerous candidates that answered this Paper with confidence, showing excellent knowledge and understanding of both Core and Supplement, a high proportion appeared to have been inappropriately entered. These candidates struggled to answer any of the questions involving material from the Supplement, in many cases apparently having no knowledge of it at all. They also frequently showed great confusion over Core topics, and would almost certainly have been better served if they had been allowed to concentrate on these and become secure with them, rather than attempting to prepare for a Paper including more difficult topics.

Time did not appear to be a problem for any candidate, and there also appeared to be no significant difficulties for candidates in understanding the questions.

Although mistakes in grammar and spelling are largely ignored, candidates do need to be able to use correct technical terms appropriately. Legibility of handwriting is a frequent problem for Examiners attempting to interpret what the candidate is attempting to communicate.

Most candidates do now take care to show their working in calculations and give a unit with their final answer.

Candidates should be reminded that the equations they write, such as work = force x distance, must either be written in full or use generally accepted abbreviations. Examiners cannot be expected to guess what symbols mean if they are not the ones in general use. The syllabus contains a page listing symbols, units and definitions of physical quantities; these are the symbols that candidates should become accustomed to using.

Numerous candidates waste time and answer space by repeating the question before they begin to answer it. For example, they may begin their answer to **1(a)** by writing: 'As the red blood cells pass through the capillaries in the lungs, they...' This is poor examination technique and should be discouraged.

Comments on specific questions

Question 1

(a) Many answers made this much more complicated than necessary. The syllabus asks candidates to know about the carriage of oxygen by haemoglobin, so mention of carbon dioxide was not required. Many did know that oxygen diffuses into the red blood cells in the alveoli, and some did mention haemoglobin. However, numerous answers suggested that the cells themselves diffused through the alveoli, or suggested that the red blood cells gave up their oxygen in the alveoli.

(b) This was generally answered correctly.

(c) (i) Although there were some entirely correct answers, they were relatively few. Many candidates mentioned the diaphragm and the intercostal muscles, but not all of these answers correctly stated that both contract during inhalation. Cause and effect of the increase of volume of the chest cavity was frequently reversed. Some candidates did not describe the process of inhalation at all, instead simply listed the structures through which air would pass on its way into the lungs.

(ii) The idea that these fibres would allow the alveoli to expand during inhalation was often suggested. However, some attempted to relate the fibres to the capillaries in some way, for example stating that they allowed the blood to flow through.

(d) Most candidates did have some idea about the adaptation of alveoli as a gas exchange surface, but accounts were often muddled and used poorly chosen terms. For example, it was common to read that the 'cell wall' of the alveoli is thin, which is incorrect. (A cell wall is a structure around a plant cell.) Good candidates picked up all three marks in a two line well-targeted answer.

(e) This was poorly answered. Candidates were expected to use their knowledge of leaf structure and its adaptations for photosynthesis. Mentions of diffusion, stomata and air spaces would have earned them all three marks. Numerous answers involved guard cells, often incorrectly doing things such as pumping air in and out. It was not uncommon for the answer to consist simply of an entirely inappropriate description of photosynthesis.

Question 2

(a) Many candidates appeared to have no experience of this simple experiment. They frequently suggested making the steel bar or the magnet part of the circuit. Those who correctly suggest using the wire to attach the coil to the ammeter, and putting the magnet inside the coil, did not always state that the magnet must be moved to produce an electric current.

(b)(i) and (ii) It was relatively rare to see correct answers to either of these questions. If candidates mentioned 'magnetic field' they were often well on their way to at least some marks. There was often confusion with the motor effect.

Question 3

(a) (i) This was often correct. However, 'hydrogen chloride' sometimes appeared, and this was not credited.

(ii) Although most candidates were able to describe one effect seen during the reaction (for example the temperature rise, or the appearance of bubbles) far fewer went on to *explain* the observation.

(iii) Most candidates did not pick up on the fact that the acid was probably in excess, because the magnesium had 'reacted completely' 'within a short time'. Further reaction would therefore be expected.

(b) This was surprisingly poorly done. An ionic lattice was often drawn but rarely labelled, and even then the labels were often incorrect, such as 'magnesium molecules'. Movement of electrons was often not mentioned.

(c)(i) and (ii) These questions were often well answered, even by candidates who had done poorly elsewhere in the Paper. Calculations were always shown, and answers written either in the answer space or in the table, often both.

Question 4

(a) This was not well answered, with many candidates suggesting that the toad's webbed feet or the position of its eyes indicated that it was an amphibian. The only relevant visible feature is the skin, which has no scales, feathers or fur. It would appear that this part of the syllabus had been taken for granted by many candidates and not carefully revised.

(b) This was not well known, and few candidates appeared to understand the binomial system.

(c) Once again, there were many surprising errors in this relatively easy question. Numerous candidates showed arrows going in the wrong direction in their food chains. Extra organisms, not mentioned in the question, were frequently introduced. The cane toad and *Bufo marinus* were sometimes shown as two separate organisms. The terms producer and consumer were often applied incorrectly.

(d) (i) The graph was usually read correctly. Most calculations were correct and an answer was provided with a unit.

(ii) This was almost always answered correctly.

(iii) A very wide range of answers was seen to this question. Many candidates gave excellent answers, describing natural selection clearly and appropriately. Others suggested that the toads had intentionally grown longer legs so that they could run faster or catch more prey. Some answers suggested that the development of longer legs had an environmental rather than a genetic cause.

Question 5

(a) (i) It was relatively rare to see a correct definition of nuclear fission as the splitting of a nucleus. Many answers stated that it is the splitting of an atom, which was not accepted.

(ii) Most answers were too vague to be awarded any marks. For example, a candidate might suggest that an advantage of nuclear reactors is that they 'generate a lot of electricity'. This is not enough for a mark, but the fact that they 'generate a lot of electricity using a small amount of fuel' would be. Many did correctly mention difficulties with the disposal of radioactive waste. The statement that nuclear reactors emit harmful radiation was not credited, unless it was clear that this would be an unusual event, for example as the result of an accident.

(b) (i) This was poorly known, and relatively few candidates achieved full marks. Many described the ability of these three types of radiation to pass through different materials, with no mention of an electric field.

(ii) Again, this was not well answered, with relatively few candidates stating that alpha particles are large or the most charged particle.

(iii) This was usually answered correctly, the most common answers relating to mutation or damage to DNA.

(iv) Many answers suggested that the lead stopped the *radioactive sources* escaping, rather than the radiation from them. Relatively few stated that lead stops all types of radiation, including gamma.

Question 6

(a) This was not well known, and lengthy descriptions of the formation of fossil fuels from dead organisms, or of sedimentary rocks, were quite commonly seen.

(b) Although there were many correct answers, quite a few candidates appeared not to know what a graphical (displayed) formula is, or simply forgot to answer this part of the question.

(c)(i) and (ii) This was usually correct, although some gave cracking and fractional distillation the wrong way round. 'Frictional distillation' appeared on more than one occasion, and this cannot be credited.

(iii) Not all candidates knew a test for alkenes, which made it difficult for them to get any marks at all here. Those who did often made the common error of suggesting that alkenes make the bromine water go clear rather than colourless. Many had difficulty in giving an answer appropriate to the context. Some tested the catalysts rather than the alkenes. Nevertheless, there were numerous entirely correct responses.

Question 7

(a) Most were able to label the diagram correctly, although 'ovules' sometimes appeared for **part B**.

(b)(i) and (ii) This was surprisingly poorly answered. Most candidates appeared to be trying to remember dates from a diagram they had learned, rather than working them out from this one. The graph shows clearly when the thickness of the lining of the uterus begins to decrease, but many did not associate this with menstruation.

(c) A disappointing number of candidates understand how AIDS is transmitted. Fewer than half mentioned a virus or HIV. Many seemed to think it is present in the DNA of sperm cells.

(d) (i) Most correctly explained the meaning of 'external' but relatively few also explained 'fertilisation'. This is poor examination technique. Candidates should be encouraged to define all parts of a term.

(ii) Few candidates appeared to understand that sperm need water in order to be able to swim or survive.

(iii) Many gained one mark here – either for the mention of loss of fish eggs that are not fertilised, or the loss of young fish because there is no parental care – but few gave both ideas. Some suggested that mammals do not produce eggs.

Question 8

(a) This was often answered correctly, with a simple statement that polystyrene is an insulator. Some, however, merely said that it would not let heat out. Some went into great detail about thermosets and thermoplastics.

(b) (i) The formula was generally known, but there were many errors in substitution. Some candidates multiplied 900 N by 10. Some used the distance of 20 m in their calculation, rather than 6 m. Some did the calculation correctly but then gave inappropriate units, or no unit at all.

(ii) This was often correct even when the answer to **(i)** was not.

(c) (i) Most candidates answered this correctly, although some wrote about lack of forces acting on the luggage rather than the fact that it is not moving.

(ii) This was almost always correct.

(iii) Better candidates knew that momentum is a vector quantity, but this was relatively rare.

(d) (i) The term 'frequency' was generally known, but numerous answers appeared to confuse it with wavelength or amplitude.

(ii) Many candidates did not know the appropriate formula, or they wrote a formula whose symbols they did not appear to understand. There were difficulties in substitution, especially when handling the value in MHz. It was relatively rare to see a correct answer with a unit.

(iii) Candidates who had learned an appropriate definition were able to get a mark here, but many struggled and appeared very confused.

(e) (i) Numerous candidates appeared not to know the term 'moment', confusing it with momentum. Those who did understand what to do frequently made substitution errors, or were not able to give an appropriate unit with their answer. N/m is not correct.

(ii) This was usually answered correctly, even when **(i)** was not.

Question 9

(a) This was not well done. Many answers did not suggest a compound at all, instead giving an element such as magnesium. Others correctly suggested an ionic compound but were not able to explain their choice.

(b) (i) Better candidates were able to use the data to work out the order of reactivity of the metals, but most found this difficult. Some gave the names of metals, rather than using X, Y and Z.

(ii) This was done well in general, with most candidates choosing the metal they had listed as the most reactive in their answer to **(i)**.

(c) There were some good answers to this question, but weaker candidates were often completely at sea and had no idea how to even attempt to answer.

(d) This too, discriminated well. There were many excellent answers, but also many that demonstrated much confusion.

CO-ORDINATED SCIENCES

Paper 0654/04
Coursework

(a) Nature of tasks set by Centres.

Only one centre submitted coursework for this November examination.

The Centre offered candidates near 40 different assessment opportunities. The recommendation made last year to reduce the number of practicals submitted was not acted on.

All the assessments set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates work was comparable with previous years with candidates covering the whole mark range.

(b) Teacher's application of assessment criteria.

The assessment criteria were understood and applied well for all activities with the exception of assessing both skills C1 and C4 in the same investigation. Internal moderation of a Centre with 99 candidates selecting from over 30 practicals is a concern.

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

The use of annotation on candidates' scripts to indicate or justify where marks have been awarded has been encouraged for the last few examination periods.

CO-ORDINATED SCIENCES

Paper 0654/05

Practical Test

General Comments

A slightly disappointing performance, overall, and not as good as last year. Certainly there were some difficulties in the preparation of material for **Question 1** producing considerable variation even within a Centre. This may have accounted for the decline in standard achieved. Supervisors often failed to enclose a complete set of their answers and this can easily have an adverse effect on the marking of the candidates work. There was no evidence of a shortage of time.

Specific Comments

Question 1

Clearly the samples of seedlings grown locally did not always produce the expected results but there were some very poor answers. It was surprising that so few were able to score the first mark. The obvious answer was temperature but the majority simply wrote the one word 'water'. The same amount of water was an acceptable answer. Many of the drawings were poor, often in ink, and many failed to show the difference in appearance of the seedlings. The word 'one' was written in bold yet many tried to draw the complete set. The measurements of height were not at all consistent, even within a centre. Many were unable to calculate the magnification. Of those who did, it was common to simply write a figure with no working. It was not necessary for candidates to know about phototropism in **part (b)**, but it was assumed that they could make a reasoned response to their observations. In the event it was poorly answered. Most were able to describe two boxes, one with red light and the other with green light but few went on to say how a comparison would be made.

Question 2

Far too many candidates are unable to handle millimetres and centimetres. The extension recorded in **part (a)** was frequently in centimetres which lost the mark. A good example of failing to follow instructions occurred in this part. The figure clearly shows the base of the rule at zero. If this is done it is impossible to have the mass with 200 g added greater than with no mass. Nevertheless, some managed the impossible! The majority were able to obtain four times for 20 oscillations and complete the table. Graphs were satisfactory although often the labelling of axes was missing or incomplete. A surprising number were unable to calculate a gradient and of those who could, a large number failed to show clearly how it was calculated. One mark was given in (g) for a correct substitution and calculation using the candidates figures. Very few obtained a mark for accuracy, largely due to the inability to correctly calculate the gradient. The most common answer to (h) was 'repeat the readings'. Providing it was made clear which readings, a mark was awarded. Few considered the use of further masses or increasing the number of oscillations.

Question 3

The use of the word precipitate appears to be a word that candidates would prefer not to use. Each year it is pointed out that milky, cloudy etc. are unacceptable. For this reason the first mark was often not scored. The majority scored the marks in **(a) part (ii)** and **(iii)**. A good number deduced the presence of sulfate but few deduced that B was an acid. **Part (b)** was easy and many scored the three marks although the descriptions of the test were often very brief. Although the necessary test is given in the notes many recorded a brown colour rather than a precipitate, thereby losing a mark. Once again candidates do not read the question. It asks for 'an experiment' not two. Although not penalised it was an unnecessary addition. In **part (c)(i)**, the word clear was not accepted, nor was 'returned to its original colour'. Descriptions such as 'turned white', 'colour was removed' were acceptable. **Part (ii)** usually scored one mark for the white precipitate but very few noticed a decrease in the amount of precipitate when the acid was added. Good candidates scored the marks for (c)(iii) and (d). The expected answer for (d) was simply that iron(III) had been changed into iron(II).

COMBINED SCIENCE AND COORDINATED SCIENCES

Paper 0654/06
Alternative to Practical

General comments

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

Comments on specific questions

Question 1

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

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

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

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

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

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

Question 2

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

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

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

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

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

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

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

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

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

Question 3

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

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

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

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

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

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

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

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

Question 4

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

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

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

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

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

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

Many candidates scored high marks for this question.

Question 5

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

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

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

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

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

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

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

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

Question 6

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

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

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

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

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

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

(i) Better candidates correctly described the brown precipitate.

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

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

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

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

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