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CO-ORDINATED SCIENCES

Paper 0654/01

Multiple Choice

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

General comments

All but one of the questions in the biology section made a meaningful contribution to the test with statistics indicating that they were pitched at an appropriate level for the candidates offering the paper.

Candidates scored a mean mark of 27.7. The standard deviation of 5.9 was a little lower than usual but the reliability coefficient was good. The individual questions varied somewhat in their overall difficulty but this was mainly due to the performance of the lower-scoring candidates and the comments on the individual questions focuses on this consequence.

At 69%, the mean of this paper was very good. Teachers and candidates alike are to be congratulated for such good preparation, especially on the Physics items, which were very competently answered. All the items have appeared on equivalent papers at this level, so the candidates who sat this paper clearly performed at the expected level.

Amongst the Physics questions there were several items which large numbers of candidates answered correctly (facility greater than 70%). These were **Questions 28**, **31**, **32**, **33**, **34**, **35** and **38**. Only **Questions 29**, **37** and **39** posed significant problems for many candidates.

Not all items revealed things worth commenting on, especially as so many had a high facility, but the following points are worth making.

Comments on specific questions

Question 3

This was the question that proved rather easy for all candidates across the full ability range. Although taken directly from the syllabus, the knowledge that the brain and spinal cord comprise the central nervous system was, perhaps, never going to prove a serious challenge to candidates at this level.

Question 8

Although one of the more difficult questions in the biology section, it was reassuring to see that well over half the candidates were able recognise the term 'egestion' or also to see that there was little confusion with 'ingestion' which is so often the case.

Question 11

The only serious challenger to the correct answer was, predictably, the answer that suggested that blood passes from mother to fetus. Clearly this remains an area where candidates show confusion with almost a third erroneously believing this to be the case.

Question 14

This was found surprisingly hard but discriminated effectively despite the fact that some 40% of the higher-scoring candidates chose response **B** rather than the key (**D**). As many as 60% of the lower-scoring candidates also chose **B**. These candidates evidently did not realise that some elements exist as diatomic molecules.

Question 15

This on the other hand, proved to be easy.

Question 17

This was found to be on the hard side. Only a quarter of the lower-scoring candidates chose the key (**C**) with their colleagues favouring response **B**, apparently not realising that partially permeable membranes hold back the larger solute molecules.

Question 18

This seems to have tempted the lower-scoring candidates into guessing with responses **A** and **C** both being more popular than the key (**B**). Carbon does form steel as an alloy with iron but not with metals in general.

Question 24

Fewer than 10% of the lower-scoring candidates correctly identified **C** as the key. The scattering of light by colloidal systems is quite explicit in the syllabus.

Questions 25 and 26

These both discriminated less well than other questions because they were found to be rather easy.

Question 27

This, however, discriminated very effectively as a consequence of the fact that only a quarter of the lower-scoring candidates chose the key (**D**). It is not clear why so many of such candidates – 35% of them – preferred response **C**. This question bears directly on the content of section 16 of the syllabus.

Question 29

Most candidates seemed to know they were looking for an area. Unfortunately, nearly half of all the candidates simply multiplied 20 by 10, and failed to halve the answer.

Question 30

Some candidates struggled with this question, as 42% of them calculated the mass of M by using the relative lengths of the spring, rather than the relative extensions.

Question 36

The vast majority of candidates knew, in this question, that the emergent ray is parallel to the incident ray. Sadly, nearly a quarter of them got the direction of the refraction wrong.

Question 37

This was surprisingly poorly answered, the evidence suggesting that most candidates simply guessed.

Question 39

The ionising properties of the emissions from radioactive materials were not well known.

Question 40

This performed satisfactorily, but 17% answered **A**. This suggests that these candidates thought that if the half-life is 5 days, half of it disintegrates in the first 5 days and the remaining half in the next 5 days.

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 4** and **10** were poorly answered by many candidates. **Questions 5** 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. 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

Section A

Question 1

This question was quite well answered.

(a)(i) Many candidates knew that the gas was hydrogen.

(ii) All combinations of letters were offered by candidates for this part, with the correct combination RQS being the most popular.

(iii) The meaning of exothermic was not known to most candidates. The most common answer was that the presence of bubbles showed it to be exothermic.

(b)(i) There were a number of wrong answers here – the most common being acid.

(ii) This was well known to many candidates. The commonest error was to place a cell between the electrodes.

(iii) Most candidates understood that metal R would react with water.

Question 2

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

(a)(i) Many candidates gained some credit here. Either they were able to state that the relationship was proportional or they were able to describe this proportionality.

(ii) Most candidates were able to suggest that the fibres would either break or go beyond their elastic limit.

(b) Few candidates were able to answer in terms of insulation or convection or radiation. A common error was to explain that the wool trapped heat or heat particles, rather than air.

(c) Correct answers in terms of environmental factors were common, but few mentioned diet.

(d) Most candidates knew that reptiles had scales, but candidates suggested that amphibians were covered with a full range of skin coatings.

Question 3

(a) All parts were well known, with many candidates gaining full marks. Good data handling skills were demonstrated.

(b) The concept of how sound waves travel through air was not well known. Few candidates were able to describe the process in terms of particles and vibrations.

(c) This part was well answered, although a number of candidates mistakenly used the wrong formula.

Question 4

(a) Even though the question indicated that there was more than one colour, many candidates only gave one of the two correct answers.

(b) This part seemed to confuse many candidates. There were many vague answers that did not involve listing any of the ingredients of glass. The idea that transition metal compounds imparted colour to the glass was very rarely mentioned.

(c) Although a number of candidates realised that glass had a giant structure, few candidates correctly identified substance B as being glass.

(d)(i) Many candidates correctly identified the gas as oxygen but there were many alternative wrong answers offered.

(ii) Very few candidates were able to name sulphur dioxide as the hazardous gas. Many suggested it was sulphur.

Question 5

This question was well answered throughout, showing that this section of the syllabus was well known.

(a) Most candidates correctly named all three parts.

(b) Many candidates knew enough about insect pollination to gain two marks here although few gained full marks. A few candidates described wind pollination.

(c)(i) Photosynthesis was well known.

(ii) Again many candidates had a good understanding of the role of chlorophyll and gained 1 mark although few gained two marks.

(d)(i) Many candidates gained full marks here, although a number unnecessarily complicated their answers by attempting identify the bee-eater and sometimes even offering an organism which would feed on the bee-eater. Another frequent error was to start the food chain with nectar.

(ii) This was well known.

Question 6

(a)(i) This part was not well answered. Many candidates gave vague imprecise answers such as nuclear power produces radioactive waste, which the candidates were told in the question. Specific advantages and disadvantages were not usually described.

(ii) Most candidates gave a correct answer here.

(b)(i) Few candidates knew that a transformer was used although the really top candidates were able to state that it was a step up transformer.

(ii) The reasons for transmitting electricity at a high voltage were not well known.

Question 7

(a) This was usually correctly answered by most candidates.

(b)(i) Few candidates correctly identified the liver. Many stated the kidney.

(ii) Few candidates gained any marks here. The process by which urea is excreted from the body was not well known. A few candidates realised that the kidneys were involved but few described filtration from the blood.

Question 8

(a) This part was well answered by most candidates, although some confused the terms transparent and colourless.

(b) Many candidates gained full marks here, although a number failed to refer to differences between the molecules of the two substances.

(c)(i) A surprising number of candidates did not get this right. Apart from testing for other gases, the idea of a glowing splint was not well explained by some candidates.

(ii) Although a fair number of candidates answered this correctly, there were many who thought that some of the catalyst would be used up or that the catalyst did not take part in the reaction.

(d) Most candidates were able to gain one mark for suggesting the use of soap or a detergent, but few mentioned the use of non-aqueous solvents.

Question 9

There were many good answers to this question.

(a)(i) This part was answered correctly by almost all candidates.

(ii) This was again answered well. The abbreviation amps was accepted in place of amperes.

(b)(i) The quality of answers to this part varied greatly. Many candidates were unable to show the voltmeter connected in parallel with the lamp. A number of candidates did not appear to know what a circuit diagram was and drew 3-D diagrams similar to that at the top of the question.

(ii) This was well answered with many candidates gaining full marks and almost all gaining some marks.

(iii) This was also well answered by many candidates.

(iv) Very few candidates were able to make the connection between power and energy transferred per second.

Question 10

This question was poorly answered by almost all candidates showing a lack of knowledge and understanding of a number of important physics concepts.

(a) Very few candidates understood the idea of conservation of energy or could explain what happened to the energy during a collision. Many confused the idea with that of saving energy.

(b) Again only the best candidates had any idea of what happened to the energy when water was heated and boiled.

(c) Most candidates gained at least 1 mark here for appreciating the risk of electrocution.

(d) A number of candidates were able to explain that the particles would be closer together but few could explain the idea that more collisions with the walls of the container meant more pressure.

Question 11

This question discriminated well amongst the candidates.

(a) Although the candidates were given possible answers to choose from, there seemed to be a lot of guessing.

(b) Many candidates knew that the solution became more alkaline, but very few were able to explain this in terms of the formation of sodium hydroxide.

(c) All parts were generally well answered although very few candidates gained full marks.

Question 12

This question was generally well answered.

(a)(i) The role of the skull was well known.

(ii) Many candidates knew that cartilage was softer, although a number of candidates failed to get the mark due to the vagueness of their answers.

(iii) Most candidates were able to state one part of the body where cartilage was found, although in some cases they were not able to describe it's function.

(b)(i) The function of molar teeth was well known although the reason why food needed to be ground up was not well known.

(ii) Few candidates were able to explain fully why these teeth were more likely to decay, although a number gained 1 mark.

Paper 0654/03

Paper 3 (Extended)

General comments

On the whole, candidates were entered appropriately for this paper, although there was a significant 'tail' of candidates who appeared to be unfamiliar with the content of many questions. These often left entire questions blank. At the top end of the ability range, there were some excellent scripts, although even the best candidates were still stretched by some parts of the questions, in particular **Question 6 (c)(ii)** and rather surprisingly **Question 7 (b)**.

Comments on specific questions

Question 1

(a) Although all candidates were able to write something appropriate in each box, many did not give the degree of precision or detail that was required. For example, it was not enough to state that a disadvantage of nuclear power is that radioactive waste is produced; the candidates needed to take this a little further, for example by saying that it is difficult to dispose of safely, or that it poses a threat to human health.

(b)(i) There was much confusion in **(b)** between generators and motors. However, many did answer this correctly by stating that the moving coil is cutting the magnetic field.

(ii) Candidates found this much more difficult than expected. There was one mark available simply for stating or implying that an alternating current reverses its direction, but even this was rarely given. Candidates were also credited for saying that this happens each half turn, or for explaining why the current reverses. Many answers incorrectly stated that the coil goes half way round and then flips back again.

Question 2

This question was very well answered throughout by many candidates, with part **(c)** proving to be the most demanding section.

(a) This was usually correct, candidates giving the answer of small intestine or sometimes ileum.

(b) On the whole, this was well answered. Some, however, simply wrote out a similar answer that they remembered in relation to alveoli, so that statements such as 'surrounded by blood vessels' appeared regularly. Another frequent error was to state that the villus is 'only one cell thick'.

(c)(i) This was not at all well known, and only a very few answers correctly named the hepatic portal vein.

(ii) This, too, was badly answered. A wide range of answers was accepted, ranging from some detail about the control of blood glucose levels, to the removal of toxins. However, many had nothing relevant to offer. A common mistake was to describe the production of bile. It was very frequent to give no marks for answers to this question.

(d) Both **(i)** and **(ii)** were often answered very well. A few, however, did not realise that they needed to describe respiration. Part **(iii)**, too, was often well answered. Many candidates described the way in which carbon monoxide takes the place of oxygen in red blood cells, or how gas exchange in the lungs is slowed because of damage to alveoli by components of cigarette smoke.

Question 3

(a) Most candidates correctly named at least one of the parts labelled, and many identified both.

(b)(i) The correct answer, neutron, was usually given.

(ii) This proved more difficult for weaker candidates, who often drew a hydrogen atom and a chlorine atom separately, with no bond between them. Others did not show a pair of electrons being shared. For most, however, this question posed no difficulties.

(c)(i) The bromine test is well known, although a few candidates do still refer to the bromine as becoming 'clear' rather than colourless.

(ii) Quite a few answers were incorrect. Commonly, no C*l* atoms were shown, with every carbon bond occupied by a H atom. Many also showed an H at either end, rather than leaving the bonds 'hanging'.

(iii) This discriminated well. Most had some idea of the difference in behaviour between thermosets and thermoplastics. Some, though, incorrectly stated that 'you can heat poly(chloroethene) again and again, but you can only heat bakelite once'. Better candidates were able to go on to explain the differences in terms of bonds between molecules, although they did not always make clear that these are intermolecular bonds and not bonds within the molecule.

Question 4

Parts **(a)** and **(b)** were accessible to almost all candidates, as was **(d)(i)**.

(a) This was usually correctly answered, often in terms of causing mutations or cancer. Many candidates correctly gave an example of a type of electromagnetic radiation that could cause these effects. It is wrong, however, to say that it 'ionises cells'.

(b) All three parts were usually answered correctly.

(c)(i) Most gave a correct answer that referred to particles vibrating. Weak candidates often wrote about 'sound particles'.

(ii) Any answer that suggested the astronaut would feel vibrations in the Moon's surface was credited.

(d)(i) This was almost always correctly answered. A few, however, lost the mark awarded for stating the formula by giving only a 'formula triangle'.

(ii) Not all candidates knew the formula velocity = frequency x wavelength. Even those who did know this often went astray in the calculation because they did not convert to metres or kilometres throughout, therefore ending up with an answer that was out by a factor of 1000. A few did not know the appropriate units.

Question 5

(a)(i) A simple statement that the length of wool increased as force applied increased was made by most candidates, and one mark was awarded for this. To get the second mark, they needed to state or strongly imply that the increase in length is directly proportional to the force applied.

(ii) Many of the better candidates stated that the elastic limit had been reached. Others, however, gave answers that referred to time, such as 'The wool stretches very rapidly', and these were not credited.

(b) There were many good answers here, referring to air trapped between the hairs and acting as an insulator. The phrase 'traps heat' was not given credit.

(c)(i) Good answers to this question referred to factors such as diet or age, which might affect the growth of the wool. Many, however, did not think sufficiently carefully about the circumstances of the experiment and suggested that the initial diameter of the wool fibres or the temperature of the environment should be controlled.

(ii)(iii) A pleasing number of candidates were able to draw out supporting evidence for these statements from the data. For **(i)**, they needed to explain that group A sheep had smaller diameters of wool in both environments (or the reverse for group B). For **(ii)**, they should have stated that both groups of sheep had thicker wool fibres in the hot, dry area than in the cool, wet one. There were quite a few references to 'thick sheep and thin sheep'. Some answers went off in a completely wrong direction, discussing natural selection and evolution, clearly forgetting or not appreciating that the experiment was done over a period of 18 months.

(iv) Although most candidates seemed to have an appreciation of the difference between continuous and discontinuous variation, not all were able to express their ideas well enough to get both of the available marks. The use of examples was often helpful. A considerable number, however, confused continuous variation with something that changes with time.

Question 6

Most candidates were comfortable with part **(a)**, but the topic of hardness of water seemed to be unfamiliar to many.

(a)(i) Most suggested that the mass would remain at 1.0 g, as the manganese dioxide is acting as a catalyst and is therefore not used up in the reaction. It is not correct, however, to state that it 'does not take part' in the reaction.

(ii) Some had difficulty with this because they did not make use of the formulae for hydrogen peroxide given in the first line of the question. Others did not know that the formula for oxygen gas is O_2.

(b) This topic was not well known by most candidates. Some, though, answered the question well, often with the use of labelled diagrams showing calcium or magnesium ions being exchanged for sodium ions as the water flows through a column of resin beads.

(c)(i) Almost all correctly identified **B** as the hardest sample, also explaining that it needed the greatest volume of soap to make a lather.

(ii) This part of the question proved to be very difficult. Only a few candidates realised that **C** contained both temporary and permanent hardness; it became softer after boiling because the temporary hardness had been removed but the permanent hardness still remained.

Question 7

(a)(i) This was almost always correctly answered.

(ii) Although many candidates picked up one of the two available marks here, few gave full enough answers to be awarded both. Some explained that the line should have been straight, or that the relationship between current and p.d. should have been directly proportional, while others explained that the resistance of the lamp increased as it got hotter. Only a very few made both of these points.

(iii) This was usually correct, although weaker candidates sometimes drew a line with the wrong slope.

(b) This relatively straightforward question was not answered as well as had been expected. Quite a high proportion of candidates did not appreciate that electrons were moving from the cloth to the rod. There was frequent reference to 'positive electrons' moving, or to protons moving.

Question 8

(a) A disappointing number of candidates managed to name both parts correctly. The ovary was often named as an ovule, or the anther as a stigma.

(b) By no means all candidates recognised that this was an insect (or bird) pollinated flower. Some confused pollen with seeds, while others continued on past pollination and tried to describe fertilisation. However, overall this was well answered, and full marks were often awarded.

(c)(i)(ii) A large number of candidates still believe that the whole pollen grain goes down this tube. Better candidates described the movement of the male nuclei down the tube, and their fusion with the female nucleus in the ovule to form a zygote.

(d)(i) Many candidates thought that the pesticide might harm the plant, and this was credited even though it is not likely to happen in reality. A better answer was that the pesticide could kill pollinating insects, so that there would be less fertilisation and therefore fewer bean seeds developing. Some thought that aphids themselves could be pollinators, and this was given credit.

(ii) The best answers here referred to biological control methods, and many candidates described this well. Some suggested covering the plants with nets that would not allow aphids through, but this was not credited because the net would also prevent pollination.

Question 9

This was probably the least mark-yielding question on the paper. Most candidates did finish it, and there was no evidence that lack of time played a significant part in the relatively poor performance.

(a) Those candidates who used the information that could be gleaned from the table – looking at the materials that differed in, say, violet glass and green glass – were able to suggest that manganese dioxide and iron oxide would not be used. Some went further and explained their answer by stating that these are transition metals. Most, however, simply guessed and it was rare to award three or even two marks here.

(b)(i) The oxide ion was usually shown correctly, although some candidates included an extra shell. Others tried to show two iron ions and three oxide ions.

(ii) Where the oxide ion had been drawn correctly, this part of the question usually fell into place easily, as candidates explained that the possession of a full outer shell of electrons made the oxide ion stable.

(iii) A large proportion of candidates were not able to work out that the formula of an iron ion in this compound is Fe^{3+}, and even those who did get this correct often could not explain their answer. However, many did answer this entirely correctly, explaining that the overall charge of the compound must be 0.

(c) This posed a challenge for many, as moles often do. There was one mark available for calculating the M_r of calcium oxide as 56, and another for stating that 14 g is therefore 0.25 moles. Quite a few of the better candidates got this far. They then needed to show that they recognised that 1 mole of calcium carbonate would produce one mole of calcium oxide, which leads to the answer of 0.25 moles. Some arrived at this answer by first calculating the mass of calcium carbonate required and then converting it to moles – a long way round but still correct, so they could still gain full marks.

Paper 0654/04

Coursework

General comments

Nature of tasks set by Centres

Twenty Centres submitted coursework for the June examination. Most of this year's entry have provided coursework in previous years and have acted on advice given.

Two of the new Centres provided a very comprehensive portfolio of practical exercises – possibly an endorsement for the distance-learning programme. In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates' work was of a similar standard to previous years.

Teacher's application of assessment criteria

In most Centres the assessment criteria were understood and applied well for all of their activities. There has been a steady improvement in the Centres' application of assessment criteria. Only two Centres (one new to the scheme) tried to assess both Skill C1 and C4 in the same investigation. Advice has been given to help the Centre avoid confusion in future.

Recording of marks and teacher's annotation

Following suggestions made encouraging the use of annotation on candidates' scripts many more Centres are using this technique to indicate or justify marks awarded. There is still scope for further improvement with some Centres writing comprehensive summaries but not indicating the point at which the mark was awarded. Tick lists remain popular particularly with Skill C1.

Good practice

Some Centres make very useful comments about individual candidate's performance on a summary sheet. Many Centres have developed a booklet of tasks and dedicated assessment criteria.

Paper 0654/05

Practical Test

General comments

Candidates seemed to find this paper slightly easier than last year and the performance of most candidates was very good. Supervisors prepared well and appeared to overcome any local difficulties. The improvisation of some is to be commended. The Examiners are able to take into account any problems encountered so long as they are notified on the report form. The results obtained by the Supervisors were particularly important in this paper and will be referred to later in this report. **Question 1** proved to be the most well liked of the questions although some scored well on all three.

Comments on specific questions

Question 1

The diagrams were generally very good although the sepal was sometimes obscured because of the angle of the drawing. There were some interesting suggestions as to the function of the sepal but the mark was awarded for "protects the flower in bud". The diagrams in part **(b)** were usually satisfactory although some were very small. Few tried to make the drawing fill the box provided. A good number ignored the instruction to draw one stamen simply making the drawing more complicated. Most knew which part to label as the anther. Again, a large number ignored the instruction to label the point of attachment with the letter **X**. This omission cost a mark.

Despite the calculation of magnification being a common question, many candidates do not understand it is possible to have a magnification which is less than one, and routinely invert the ratio. Some even subtracted the numbers!

The answer to part **(c)** required a reference to bright or vivid colour rather than the simple statement that the petal was coloured.

Most candidates understood the test for sugar but often only gained one mark. One mark was awarded for separating the petals and cutting or grinding with water. The second mark was for warming the Benedict's solution. Many placed the mixture in a water bath without mentioning that it needed to be a hot water bath. The correct colour change provided the third mark. The weaker candidates simply dropped Benedict's solution onto the petal.

Question 2

The height of the ruler above the floor was sometimes omitted, sometimes measured in cm and occasionally not between 40 and 50 mm less than h_o. In a few cases the value was the same as h_o. Many missed the instruction to weigh the pieces of plasticine to the nearest gram, consequently losing a simple mark. If the instructions were followed, it was virtually impossible to have four pieces of plasticine with identical mass. This was penalised. Although most were able to provide a good set of results it was sometimes difficult to work out what exactly had been done.

Graphs were good. Correct labelling of axes and sensible scales were chosen. A small number ignored the instruction to draw a straight line. One mark was allocated for making use of the origin. Part **(i)** was badly answered. Most simply stated that the deflection increased as the mass increased. Very few used the word proportional.

Question 3

Any local difficulty in providing powdered metal was taken into account, as was the quality of the powder. Supervisor's results were invaluable in this question. Very few candidates measured to 0.5°C consequently losing a mark. The temperature changes were marked against those provided by the Supervisor with an increasing allowed error at the higher temperatures. Many candidates did not write the result of the lighted spill test despite the instruction to test the gas given off with metal C and record the result. Part **(f)** was usually answered well. Most correctly named the gas although carbon dioxide was sometimes recorded. In **(iii)** candidates continue to confuse amount of bubbles with rate of reaction. In **(iv)**, weaker candidates wrote a list, which was in contradiction to the results in their table. However, it was essential to have C as the most reactive and D as the least reactive whatever the temperature changes unless the Supervisor gave reasons to suggest otherwise. A test of how well the experiment was conducted. Although part **(g)** was often well answered, some forgot that they were asked to describe an experiment. It was therefore important to actually mention that E is placed in the copper sulphate solution. Some tried to describe an electrolysis experiment but became rather confused in how they would actually deduce that E was more reactive than copper.

Paper 0654/06

Alternative to Practical

General comments

As in previous reports, the Examiners are at pains to point out that this examination is an alternative to the practical examination, not a substitute for practical science. There was evidence that some candidates had very little experience of practical work. They were, for instance, unable to copy the outline of a biological specimen or measure its length using correct units, accurately read a thermometer or ruler or describe very simple and familiar chemistry experiments.

Despite these failings of a minority of candidates, there were very many excellent candidates who gained high marks on every question, showing that they have studied the syllabus material effectively and have confidence in practical work of all kinds.

Every question in the paper contained some easily gained marks to enable the less able candidates an opportunity to score. The gradient of difficulty in each question included harder and more subtle ideas so that A and A* candidates had an opportunity to shine. The Examiners were pleased to see a high proportion of good grades in the overall results, especially in the 0654 group.

Almost all candidates completed the paper except perhaps for a few whose limited grasp of English slowed their rate of working.

Comments on specific questions

Question 1

This question involves some practical botany, a part of the syllabus content that is easy for candidates to undertake as part of their course even without the resources of a fully-equipped laboratory. The parts of a flower are easy to observe and draw, sometimes without the use of a hand lens.

(a) Many candidates did not see the instruction to label a sepal. The suggested functions of the sepals were many and varied; the Examiners gave a mark for almost all answers that mentioned protection, though this rôle is over once the flower has opened.

(b)(i) An artistic drawing was not needed. The approximate shape of the petal, drawn with clear lines, gained the mark. The stamen should show the correct ratio of lengths of stamen and filament.

(ii) Some candidates tried to find evidence of the anther or the filament somewhere on the petal; often the labels of filament and anther were reversed.

(iii) There are always candidates who attend the examination without the simple mathematical instruments needed for questions such as this one. Many candidates measured the petal and then expressed the length in centimetres, so gaining 1 mark instead of 2; others did so and multiplied by 100 to turn centimetres into millimetres.

"Magnification" posed a problem for candidates who drew diagrams that were smaller than the object, but of course the fraction $\frac{\text{size of drawing}}{\text{size of object}}$ gave the factor that is needed here.

Those who then multiplied by 100 to find the percentage were not penalised. If the magnification was expressed as a ratio in the form 1:x, credit was also given. Too many candidates thought that the magnification was obtained by subtracting one measurement from the other.

Many good candidates gained full marks on this question, but far too many could not use a ruler correctly.

Question 2

The 0653 Syllabus contains two references to magnetism. In the section on electric circuits and current, candidates are to be able to draw and interpret circuit diagrams containing magnetising coils. In the section on electromagnetic effects, they are to be able to describe the turning effect of a current-carrying coil in a magnetic field.

The Examiners constructed the question in the examination paper with the details of both the 0653 and 0654 Syllabuses in mind. A minimum of knowledge about magnets and their effects is needed, such as would be gathered by candidates whose preparation includes the material, admittedly limited, contained in the 0653 Syllabus. These details are referred to in the following paragraphs.

(a) The candidate must know that a magnet (or a coil acting as a magnet) will repel and attract another magnet. It is this force that causes the turning effect in a motor. This will enable the completion of line 1 of the table. Line 2 must involve soft iron since it cannot be in line 3. No candidate can be in ignorance of the magnetic attraction of ferrous metals to either end of a magnet, since soft iron is used in the armature of a motor and in the core of a transformer. Line 3 can then be completed even if there is uncertainty about the magnetic properties of aluminium. Most candidates answered this part of the question well, though many were unsure whether soft iron would repel when reversed.

(b) The repulsion or attraction between two magnets can be used in answering part **(b)**. Forces and their effects are referred to elsewhere in the syllabus. Examiners looked for an appreciation of the idea that like poles repel or unlike poles attract, then for some common-sense approach to the use of the third magnet to test the relative strength of two magnets. This may be done by finding the minimum distance from each of the other magnets when a noticeable attraction or repulsion is seen. Almost all candidates gained at least 2 marks here, but too many did not read the question carefully and described the use of paper clips or iron filings.

(c) Although the magnetic field is mentioned, no experience in mapping the field around a magnet is necessary. A compass points north; but so do all magnets when used as a compass, so a compass needle will be repelled from a north pole of another magnet and will be attracted to its south pole. 1 mark out of 2 could be gained if the needles pointed in the opposite direction.

Question 3

On first glance, this is an easy question for candidates who have done a minimum of simple heating experiments in chemistry, but it was the least well answered question in the paper. The diagram was rudimentary and gave only a hint of the function of the test-tube containing cold water. Very many candidates thought that the test-tube was being heated. Much ignorance was revealed by this question. The fascination of chemistry is epitomised for the young scientist by the excitement of heating things just to see what will happen.

(a) There was a problem for those who had never seen solid iodine or solid sulphur, so they labelled iodine as yellow (the colour of its solution) and sulphur as black or blue. Only a few candidates had heated copper sulphate crystals, so the "colourless liquid" was thought to come from any of the solids. The white residue could be identified as "anhydrous copper sulphate" by the better candidates, who then gained all 6 marks for this part of the question. It was almost impossible NOT to score at least 2 marks for part **(a)** merely by filling in the table at random, as long as the items were placed in the correct column!

(b) Only a very few candidates gave the answer “water vapour” or “steam”, and there were many fantastic suggestions.

(c)(i) A choice of 2 out of 3 was another gifted mark, but so many wrote “sulphur” because they had not realised that in the experiment described by the candidate, the sulphur had burned in air, so the reaction was not reversible. Either of the other two solids earned a mark, but many named substances that are not even mentioned in the question.

(ii) To earn the mark here, the candidate had to correctly describe the cooling of iodine vapour to make it sublime (even “condense the vapour” was accepted) or the addition of water to the white solid, to become hydrated copper sulphate. A very few candidates were able to answer this part.

(d) The original intention of the question was the eliciting of the hazard in burning sulphur or heating iodine in the open laboratory. An answer like this was very rare. However, a mark was given for the use of goggles for eye protection when heating chemicals, a practice that now seems to be universal, and also for tying back long hair lest it should catch fire. A lot of answers mentioned the hazards of heating the test-tube, showing that its function in providing the cold surface had not been correctly understood. One answer suggested that “the test-tube should be held by the tongue”!

Question 4

This was a beautifully simple experiment describing the conditions of photosynthesis in *elodea*, providing easy marks for the less able candidates; but the later parts of the question were more difficult.

(a)(i) Most candidates correctly gave all three averages, but some candidates conjured numbers out of thin air, or drew a straight-line graph and then read them off!

(ii) The graph exercise was deliberately kept as simple as possible, and the vast majority of candidates gained all 3 marks for correct choice of scale so that the maximum length of the axes was used, for correct plotting of all the points and for drawing a smooth curve.

(iii) The instruction “use your graph” was ignored by many candidates who merely said that “increased light intensity increased the rate of photosynthesis”. The marks were awarded to those who referred to the distance of the lamp and/or the number of bubbles of oxygen counted, in order to show that more light increased the rate of photosynthesis.

(b) Now the candidates had to refer to the conditions of the experiment in order to find reasons why, at the same distance, the bubble count had varied. Change of temperature, since the lamp also warmed the water, or change of carbon dioxide concentration, were most often suggested. Credit was also given to candidates who said that the current to the lamp might have changed, or that the response of the plant to changed light intensity might have been delayed.

Question 5

This question was the most complicated of all the questions in the paper; it was based on the corresponding question in the Practical Paper 5, just as were **Questions 1** and **6**. Despite the length of the question, it was in this question that most good candidates excelled, gaining 9 or 10 marks.

(a) 1 mark was awarded for reading and recording the two masses, and then 1 mark each for the heights. They were to be recorded in millimetres, though like real metre rules the scale was marked in centimetres. This was a problem for a few candidates. There were others who did not know how to find the deflection by subtraction; these candidates often read the deflection from the graph and then filled in the boxes later. Alas, this did not gain them the marks.

(b) There were very many creditable answers for this part, and the Examiners are pleased by the apparent improvement in graph plotting that has taken place over the years. Candidates who chose unsuitable scales lost a mark, as did those who plotted mass on the vertical axis. Others decided to use the whole of the vertical axis, say, for 90 mm deflection, only to find to their horror that they could not then answer part **(c)** by extrapolation. It was important that a straight line was drawn, passing through the origin.

(c)(i) This could easily be answered by extrapolation of the straight line, if the scales had been carefully chosen (the Examiners had been at pains to set the size of the graph grid so that this could be achieved).

(ii) The required answer is that the deflection is proportional to the mass added. Some candidates calculated an equation to relate deflection and mass; this was an acceptable answer. It was not enough to say, for instance, that "as the mass increases, so does the deflection". Proportionality is an important mathematical concept that applies elsewhere in the syllabus.

(d) This "thought experiment" was worked out by almost all the candidates who had answered the previous parts of the question, so they wrote that the deflection would be decreased.

Question 6

As noted above, this question corresponds to one in the Practical examination, Paper 5.

(a)(i) The thermometers were read with varying accuracy. All the temperatures had to be given to the first decimal place, so "20" was not accepted for the initial temperature for the experiment with metal **B**. The commonest errors were in reading the temperatures for metal **C**, where candidates did not realise that the scale of the thermometers was graduated in 2-degree intervals.

(ii) The temperature rises were usually correctly calculated.

(b)(i) Oxygen and carbon dioxide were the wrong answers sometimes supplied, though most candidates knew it was hydrogen.

(ii) It was unfortunate that a few candidates did not connect this part of the question with the experiment, so they answered the question "Which metal is most reactive with hydrochloric acid?" in a general sense. The vast majority referred back to the data in Fig. 6.1. and gave good reasons why metal **C** was the most reactive.

(c) The Examiners looked for *observations* that would be made when metal **E** is added to aqueous copper(II) sulphate. These were rarely given, even by candidates who wrote that "metal **E** will displace copper". This answer was given no credit. A mark could be gained by mentioning a brown or copper-coloured precipitate, or by saying that the blue solution would lose its colour; these, together with an expected rise in temperature, are ways in which it can be *shown* that **E** is more reactive than copper. Only a handful of candidates answered this part of the question by giving two observations. There were many other suggestions involving all kinds of chemical tests on copper and metal **E**, none of which conformed to the conditions mentioned in the question.