CONTENTS

CO-ORDINATED SCIENCES

Paper 0654/01
Multiple Choice

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

General comments

Candidate achieved a mean mark of 29.3, with a standard deviation of 5.9. These values are satisfactory, as also was the reliability coefficient. With an entry of such moderate size, conclusions drawn from the statistics of individual questions may be uncertain but it is hoped that the following comments on individual questions will prove helpful.

Comments on specific questions

Question 2 was most demanding, requiring candidates not only to identify chloroplasts on the diagram, but also to know that they are where starch is made. Almost a quarter of the candidates, however, thought that starch is made in the cyctoplasm.

In response to **Question 3** there was just a hint that several candidates, who otherwise did well on the test, did not appreciate the role played by cartilage in reducing friction at a joint.

Although there was ample opportunity to become confused on **Question 4**, almost all candidates unravelled the sequence of respiratory structures with total accuracy.

The mode of operation of the male reproductive organs traditionally poses few problems for ca[illegible]d **Question 11** was no exception, with ninety-seven correctly tracing the path taken by sperms.

Question 14 was a very easy question, perhaps because the correct answer stood out som[illegible] conspicuously from the other less plausible options.

Question 20 was unremarkable in how easy it was found. Response **A** was equally popular with both ends of the ability rang (about 30%). However, carbon dioxide is an acidic oxide and, as such, it reacts with alkalis so that nitrogen (response **C**) is the key. It seems possible that some candidates do not appreciate that nitrogen is in the air blown into a blast furnace.

Question 22 was found decidedly hard; only 39% answered correctly. Nevertheless, the question discriminated very effectively. This is accounted for by the fact that 53% of the lower scoring candidates chose response **B**. From this, it appears that these candidates were very unsure about the different solvent properties of water and non aqueous organic solvents.

Question 28 clearly caused candidates to think, with most choosing either **A** or **D**.

Question 32

There was some guessing about heat transfer in a vacuum flask.

Question 33

The majority reasoned sensibly that the shallow part was likely to be either **A** or **C**, but nearly two-thirds of candidates answered correctly.

Question 34 was poorly answered, with all four responses obtaining strong support, although somewhat more did choose either **A** or **C**, where at least the order of the regions was correct.

Paper 0654/02

Paper 2 (Core)

General comments

Almost all the candidates were able to attempt all the questions. Many managed to gain marks on all the questions, but only the most able candidates achieved full marks on any question. A good spread of marks was achieved by the candidates. Many candidates found one or two of the questions quite difficult. It was evident that some candidates were much better prepared for the examination than others. There was no evidence of candidates suffering from a shortage of time to complete the examination.

A small number of candidates wrote some of the answers in red ink, clearly ignoring the instructions on the front cover of the paper. An increasing number of candidates are beginning to include the abbreviations they use in text messaging within their answers. This is a trend, which must be discouraged.

Comments on specific questions

Question 1

This question was quite well answered by the majority of candidates.

(a) This part was well known by most of the candidates.

(b) Most candidates knew that cell **X** made mucus, but few could explain what the purpose of the mucus was.

(c) Few candidates knew the function of the cilia and therefore what would happen if the cilia stopped working.

Question 2

(a) There was a wide variation between candidates. Some candidates showed little know electrical symbols whilst some had no problem drawing the circuit correctly.

(b) Most candidates were able to give one of the many ways in which the current could be increased.

(c) Many candidates failed to explain their answers in this part and consequently lost marks.

Question 3

This question was poorly answered by the majority of candidates.

(a)(i) The test for hydrogen was well known. There were few candidates who offered an incorrect test.

(ii) The answers to this part indicated that little investigative work had been done by many candidates. Many candidates gained no marks on this part.

(b) This part was also poorly answered by many candidates, who failed to understand what was going on in the experiment. Many candidates answered in terms of the reactive metals rust most.

Question 4

Good data handling skills were shown by many candidates on this question.

(a)(i) The formula for the calculation was well known, although there were many incorrect answers of 66m, because the candidates forgot that the wave was travelling to the moth and back again.

(ii) Although many candidates were able to give a vague explanation about how ultrasound waves travel through the air, there were very few precise answers gaining full marks.

(iii) This part was well answered, showing a good understanding of the ideas of frequency and amplitude.

(b) The formula for the calculation was again well known, although many candidates lost a mark because they failed to convert the mass of the locust into kilograms before carrying out the calculation.

Answers: **(a)(i)** 33m; **(b)** 11.25×10^{-3}J.

Question 5

This question was well answered by many candidates. A common cause of lost marks seemed to be that the candidates were ignoring the mark allocation shown and often giving only a brief answer.

(a)(i) This was well answered.

(ii) This was generally well answered.

(iii) Most candidates realised that the line needed to be above the original. Some candidates lost marks because they allowed their line to drift down to value below the original line.

(b)(i) Surprisingly poorly answered by many candidates. The difference between canine and incisor teeth did not seem to be well known.

(ii) Almost all candidates gained at least one mark here, with many gaining full marks.

(iii) Many candidates gained one mark here, but few were able to gain full marks.

Question 6

(a)(i) This was well answered. There was some confusion between groups and periods.

(ii) This too was well answered but again there was some confusion between groups and periods.

(iii) This was well answered with many candidates gaining full marks

(b)(i) Few candidates realised that glass mixture **A** would give colourless glass, even fewer realised that glass mixture **B** would give coloured glass.

(ii) Many candidates found this difficult, picking the wrong two phrases, indicating a lack of understanding on this topic.

(c) This was well answered. Many candidates showed a good awareness of the environmental issues involved.

Question 7

This question was well answered with many candidates gaining full or nearly full marks.

(a) This was well answered. The majority of candidates gained full marks.

(b) Although many candidates did gain full marks, a number of candidates lost marks for poorly drawn diagrams.

Question 8

This was probably the best answered question on the paper. Atomic structure seemed particularly well known.

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

(ii) Surprisingly, many candidates gave a compound as their example. Water was a very common choice. Most candidates managed a good explanation.

(b) All three parts of this were well answered by almost all the candidates.

Question 9

(a) The better candidates gained full marks but weaker candidates were confused. Although most knew the correct substances many were unable to choose between reactants and products.

(b) The most common reason for losing marks here, was merely stating that chlorophyll was a catalyst. More detail was required.

(c)(i) Many candidates answered xylem here rather than phloem.

(ii) Many candidates gained full marks here. There were three possible reasons, the most commonly given correct answer referred to production of nectar to attract insects to the flower.

(d)(i) Many candidates gained two of the three marks available here, showing a good understanding of the idea of global warming.

(ii) Most candidates gained one mark here, although few were able to give both marking points.

Question 10

(a)(i) Only the weakest candidates found the calculation difficult. Many candidates gained full marks here. The commonest error was to use 100m as the vertical height.

(ii) Whilst many candidates correctly gave gravitational potential energy as the correct answer, there were a number of candidates who gave a wide assortment of other answers.

(b) This part was answered well by many candidates. Weaker candidates failed to follow the instructions, failing to mention pressure, force and area at all.

(c) This part was well answered.

Answer: **(a)(i)** 32 500J.

Question 11

(a) This part was poorly answered. Many candidates referred to chemical weathering and acid

(b)(i) This was not well understood. Common wrong answers were that hard water was poisonous contained bacteria.

(ii) This again was not well answered, suggesting a lack of even basic knowledge on the topic. A common wrong answer was to filter it.

(c)(i) Few candidates were able to give the correct answer of thermal decomposition. Oxidation was a popular wrong answer.

(ii) Few candidates described an experiment here. Many referred to an equation only.

Paper 0654/03

Paper 3

General comments

There was a very wide range of performance on this paper. Few candidates appeared to have any trouble with time, and the question paper was always completed.

Most candidates appeared to be familiar with the topics from the Supplement which were tested here. Calculations were a strong point.

Comments on specific questions

Question 1

This question was intended to be a friendly beginning to the paper, but unfortunately this was not the case. Most candidates picked up at least 2 or 3 marks, but it was very rare to see an answer which scored well in all four parts.

(a) Most candidates appreciated that this question was about surface area, but relatively few wrote about rate of reaction, instead reiterating the wording in the question that the large piece of wood 'burns slowly'.

(b) Once again, most candidates were able to make one correct point, stating that the car battery is rechargeable. Most did not make a statement about the battery in the stereo, for example that the reactants are used up or that the reaction cannot be reversed.

(c) This question discriminated well. Better candidates gave full explanations, stating that the splint tests for (free) oxygen, and that in water oxygen is combined with hydrogen, or that heating does not decompose water molecules. Weaker candidates were distracted by the water, often saying that the steam would put the splint out because it got wet.

(d) This was the least well answered part of the question, which was not unexpected as the concepts tested are not easy ones. Only very few answers clearly referred to the giant structure of magnesium oxide or to the molecular structure of carbon dioxide. Weaker candidates' answers often referred to magnesium being a metal and tried to explain in terms of metallic bonding, or of the covalent bonds in carbon dioxide. However, they could still gain marks if their answer referred to the greater energy required to break bonds, as long as it was reasonably clear that these referred to inter-molecular bonds in carbon dioxide.

Question 2

(a) This was not well answered. Marks were given for the ray being refracted and dispersed surface, and also for the red and blue ends of the spectrum being indicated. Relative answers showed dispersion at all, and those which did normally only showed it as the ray ex the prism.

(b) Accepted answers here included statements that they had different frequencies or different wavelengths. There was no need to say which had the greater frequency or longer wavelength, but if this was given then it had to be correct. Very many answers incorrectly stated that they travelled at different speeds, or that they were different colours.

(c) The numbers here were handled well, and better candidates usually scored all 3 marks. Sometimes, however, the unit was missing. Some did not know the formula.

Answer: 5×10^{14} Hz.

Question 3

(a)(i) There was usually no problem here. The word 'reflex' was looked for, and most 'extras' such as spinal, arc or unconditioned were ignored.

(ii) This question, which tested knowledge of a spinal reflex arc, was surprisingly poorly answered. Most had no idea, and it was relatively rare to give both marks.

(b)(i) As always, many candidates found it difficult to cope with questions requiring them to bring knowledge from one area of the syllabus into a question which they perceived to be testing another part. Even when they did realise this was about moments, they often used a distance of 25 in their calculation. Another pitfall was the failure to convert the mass of 2 kg to a weight.

(ii) This was better dealt with, and three marks were frequently given. A wide range of answers were credited, including those involving food chains (Sun, photosynthesis) and those involving respiration. It was pleasing to see this so well understood.

(iii) Here 1 mark was commonly given, but the second was much rarer. The majority of answers explained that one muscle contracts while the other relaxes (although some wrote 'expands', which is wrong) but few explained how the contraction of one muscle causes straightening while the other causes bending.

Answer: **(b)(i)** 120N.

Question 4

(a) Both parts were answered very well and full marks were frequently awarded.

(b) Here, too, many candidates answered very well, answering all three parts entirely correctly. Sometimes candidates confused ethane and ethene, which threw their calculations out. However, a few had no idea how to answer any of this, although most did try to do so.

(c)(i) This was poorly known. Quite a few wrote about polymerisation, cracking or fermentation. Some did get one mark for mentioning steam, a catalyst or that this involves an addition reaction, but it was rare to give two marks here.

(ii) This was better known, and most could at least state that the compound must be unsaturated or have double bonds. Alternatively, the idea that it could be an alkene was credited. For the second mark, some kind of 'explanation' was needed, such as a description of the double bond breaking and joining with the bromine.

(d) Most correctly stated that the plastic would melt on heating. As in **Question 1 (d)**, it was often very difficult to be sure which 'bonds' candidates meant when they wrote about these breaking or being relatively weak. The answer needed to make clear that these were forces between molecules, not those linking the monomers together.

Answers: **(b)(i)** 10, **(ii)** 9, **(iii)** 252g.

Question 5

This question was often very well answered, with only **(b)(ii)** regularly causing difficulties.

(a)(i) Apart from a few candidates who thought that the electricity being used to run the tumble dr somehow got into the clothes, this was usually well explained.

(ii) This rarely caused any difficulties.

(b)(i) Most calculated this correctly, although some did not convert 30 minutes to seconds and so arrived at a very high number.

(ii) Wrong answers to **(i)** could be carried forward to here without penalty. Weaker candidates often did a calculation all over again, not understanding that they already had the answer in **(i)**. This calculation usually arrived at a different answer. Units were essential for the mark, either given as W or Js^{-1}.

(iii) Once again, incorrect answers from earlier parts of the question could be brought forward to here with no penalty - even though this sometimes gave huge numbers which a candidate should have appreciated could not possibly be correct. Some did not know the units in which current is measured, the most common error being ohms.

(iv) Most knew the formula relating voltage, resistance and current, and usually picked up marks here even if all of the previous calculations had been wrong. Sometimes, however, the formula was not given. Formula triangles, while being very useful aids for recall, are not a formula and are not credited.

Answers: **(b)(i)** 2000, **(ii)** 2000 W, **(iii)** 8A, **(iv)** 2A.

Question 6

Many candidates worked their way very effectively through this question, clearly understanding the context and successfully applying their knowledge of populations, genetics, thermoregulation and heat transfer and natural selection. It was pleasing to see so very many good answers, even from candidates who had not done so well in other parts of the paper. Goats did sometimes change into sheep part way through an answer, but this was ignored.

(a) This was perhaps the least well done part of the question. Nearly all candidates drew a line rising up and then flattening or falling (either was acceptable), but relatively few showed the typical sigmoid shape of a population growth curve. Whilst most correctly showed a limiting factor acting at or close to the point at which the curve began to flatten or drop, others placed this point well after this, apparently not appreciating that this factor was the *cause* of the change in gradient.

(b)(i) Better candidates gave full answers including the idea that a mutation is a change in genetic material, and also that it is sudden, random or unpredictable. This second point, however, was not always made, and weaker candidates did not make the first one either, answering in terms of the appearance of the organism rather than its genetic material.

(ii) Not surprisingly, candidates often found it difficult to put their answer into suitable words here, even when they understood. Examiners did their best to interpret meanings. Some candidates used genetic diagrams, squeezing them into the space at the bottom of the page, which was perfectly acceptable as long as it was clear what they were intended to show. 2 marks were very often awarded.

(iii) Once again, it was not always possible to disentangle answers here, but most did understand what was happening and were able to use a genetic diagram to explain the appearance of long hair in the next generation of goats. Unfortunately, there were sometimes so many unlabelled genetic diagrams that it was not possible to pick out which one was intended to explain what process. Nevertheless, full marks were often given.

(c)(i) Here, too, there were many good answers. This was a particularly discriminating part of the question. Most candidates realised that the long hair acted as insulation, but only the better ones went on to explain that this reduced heat loss from the body. Even fewer then related this correctly to the requirement for food, explaining that food is required to generate heat, via respiration.

(ii) It was pleasing to see such a good understanding of natural selection by mos... Answers usually included the idea that the short-haired goats were more likely to die... winter, and that therefore the long-haired goats would breed more and would pass their g... to their offspring.

Question 7

This question was quite poorly answered on the whole, with the greatest difficulties in **(d)** and **(e)**.

(a)(i) Many candidates found this surprisingly difficult. Some apparently did not see it and made no attempt at an answer.

(ii) The expected answer here was that nitrogen is unreactive. This was intended to be a fairly easy lead in to the question, but very many candidates did not give this answer and struggled to make any sensible point.

(c) Better candidates had no difficulty here, and easily picked up all 4 marks. Others struggled, confusing atoms and ions, anodes and cathodes, giving and receiving electrons.

(d) Unfortunately some weaker candidates did not realise that this question no longer referred to electrolysis. Even those who did understand were often not able to state that a white precipitate would form, which would then dissolve in excess.

(e) This was perhaps the least well answered question on the paper. There were many diagrams showing the electron shells of a copper atom, or attempts to explain why brass might be a better conductor than copper. Those who realised that this related to malleability often could not explain it in terms of the arrangements of particles within copper and brass. Well-drawn and annotated diagrams easily picked up all 3 marks.

Question 8

(a) The most frequent correct answer was the Sun, while others correctly gave cosmic rays. Sun*light* was not accepted, nor any reference to rocks as this had already been stated in the question.

(b)(i) It is unfortunate that a large number of candidates appeared not to have a ruler or other straight edge, and so could not read accurately from the graph. Values of 2600 ±100 were accepted. A unit (counts per second) was required.

(ii) Here again a lack of care in reading the graph often resulted in incorrect answers even though the method was correct. An answer of 52 s ±1 was accepted. Working was accepted either on the graph or within part **(ii)** itself.

(iii) This was usually well known and explained.

(c)(i) A range of possible answers were credited here, including reference to ionisation, damage to DNA, mutation, or cancer. Some candidates were worried by their knowledge that alpha radiation does not pass through skin, not realising that if radon is inhaled there is no protection for cells inside the body.

(ii) Better candidates answered this well, but many did not know how to go about it all. Credit was given for stating the number of protons and neutrons in a radon atom, that an alpha particle contains 2*n* and 2*p*, and then stating the number of protons and neutrons remaining after alpha emission. A few had the right idea, but showed confusion between the mass number, the number of protons and the number of neutrons.

Answer: 84 protons 132 neutrons.

Question 9

(a) A wide range of answers was accepted here. These included references to the positions, permeability and composition of the cell membrane and the cell wall. Candidates frequently showed confusion over permeability, often stating that the cell wall is impermeable. Relatively few thought to say that the cell wall is made of cellulose. (They were not expected to know the composition of the cell membrane, although credit was given for this if it appeared in an answer.)

(b)(i) Weaker candidates often answered **(ii)** here, not concentrating on the entrance of [illegible] root hairs. Marks were awarded for mention of osmosis, passage through a partially [illegible] membrane, the different concentrations of the solutions in the soil and in the cell and a refe[illegible] a diffusion or osmotic gradient.

(ii) As elsewhere in this question, the standard of answers varied considerably. Most mentioned xylem, but fewer wrote of the transpiration stream.

(c) Candidates needed to think about *cells* here. If they did, they usually picked up at least 1 mark and some gave a clear explanation referring to water loss and therefore loss in turgidity.

Question 10

(a) The mark scheme here simply looked for the idea that the pointer would move one way and then the other, but still some candidates scored 0 or 1.

(b) The most frequent error here was lack of clarity, for example stating the 'size' of the magnets or the coil. Others forgot that this referred to a generator, and gave answers such as the size of the current.

(c) Only a very small proportion of candidates were able to answer this well. Understanding of transformers appears to be very poor indeed. There were often long answers which did contain all the terms given, but with no sensible meaning at all. Some picked up marks by drawing a transformer with two coils and an iron core (a surprising number wrote 'iron ore'), showing that there were more turns on the secondary coil than on the primary. Some also mentioned the need for a.c.

Paper 0654/05

Practical

General comments

Although it seemed many candidates found insufficient time to fully answer **Question 3**, there was a sufficient spread of marks to discriminate between the candidates. There were some very good answers and also some less good. It should be pointed out that the paper is a two hour paper and not necessarily divided up equally into three parts. **Question 2** was thought to occupy less than one third of the allocated time whilst **Question 3** slightly more than one third. It was apparent that a number of candidates were unable to attempt **Question 3** for reasons other than time. There cannot be an excuse for leaving the question blank.

Comments on specific questions

Question 1

Most were able to record sets of temperatures showing a steady fall and a greater fall for test-tube **B**. Some were uncertain about the initial temperature being equivalent to 0 minutes and recorded the temperature of the water before any heating.

In **(b)(i)** it appeared that very few were familiar with a cooling curve. Whilst most could correctly plot their points, almost all candidates joined up their points ignoring the reason for plotting a graph and ignoring the instruction to draw a smooth curve. Zig-zag lines will always be penalised. This error was also apparent when answering part **(e)**.

Most scored the easy mark in part **(c)** for simply answering 'yes'. It was necessary to answer the rest of the question in terms of heat transfer and using the results. Many scored a further 1 mark but few gave sufficient detail to score 2 marks. Part **(d)** was well answered. As already stated, very few drew smooth curves for the plotted points so it was not surprising to see further zig-zags in **(e)**. Many actually used a series of fictitious points to extend their graph. Some scored both marks in the last part and a reasonable number scored 1 mark. The most likely answers were to ensure the same starting temperatures and to measure identical volumes of water.

Question 2

A surprising number were unable to score the first mark for obtaining a blue solution when the copp was dissolved in the nitric acid. There were green precipitates, black precipitates and green solutions. majority correctly observed that hydrochloric acid did not react with **X** although few went on to conclude absence of a carbonate. Considering the test for a chloride is stated in the notes provided, it is surprising that candidates persist in poor descriptions of what happened. Milky, cloudy, white solutions and white substances were all seen, none of which scored. Part **(b)(iii)** was almost always correct. A surprising number were unable to answer part **(c)**. Again, the tests for copper are written in the notes yet few candidates were able to score the easy six marks available, despite their correct conclusion that the cation was copper. Clearly the addition of aqueous sodium hydroxide for one test and aqueous ammonia for the other were expected. The full observations were necessary if 3 marks each were to be scored. A significant number said it turned blue. Hardly a relevant observation when the solution was already blue. Some gave an anion test as one of the answers, missing the wording asking for two tests to enable you to identify the metal etc.

Despite the majority correctly identifying ammonia and chloride in **(b)**, very few were able to put these together and make ammonium chloride. Almost all identified copper as the metal although in some cases it may have been a guess as evidence was sparse.

Question 3

Answers varied from nothing at all to almost full marks. Despite the claim that there was insufficient time, there must have been enough time for all to have started the experiment and produced at least two readings. The fact that so many did not do so suggests a problem totally divorced form the matter of time. The solubility of potassium nitrate is well documented and the temperatures corresponding to the concentrations given cannot be disputed. However, a large leeway of 8°C was given enabling many of those who attempted the question to score. As with **Question 1** it showed that candidates were unfamiliar with a cooling curve as any graphs drawn were a series of straight lines joined together. Some were able to deduce the answer to **(f)(i)** but few were able to continue the curve to the vertical axes and read off the solubility at 0°C. There were only a few answers to part **(g)** and only a small proportion of those appreciated that cooling down was slower and smoother than heating. A number were wise enough to spot that there were three easy marks to be gained by answering **(h)** and a good number scored all three marks.

Paper 0654/06

Alternative to Practical

General comments

Many Centres prefer to enter their candidates for this examination, rather than either the Practical examination or Internal Assessment of Practical Work. The Examiners accept that this examination is also preferred for candidates who have been unable to undertake regular laboratory work. Careful preparation for the examination is no less necessary than for real practical exercises.

The Alternative to Practical examination contains questions based on the four experimental skills, C1 to C4, to be found in the syllabus section entitled Assessment Criteria for Practicals. Candidates need to be able to demonstrate the following skills:

- using and organising techniques, apparatus and materials
- observing, measuring and recording
- handling experimental observations and data
- planning, carrying out and evaluating investigations.

Analysis of the questions in the November 2003 examination will reveal how the Examiners have attempted to test these skills. Not all can be tested in any one question, but overall, the paper explores all of them.

The answers are marked with the practical nature of the situation very much in mind. For example, in **Question 3 (e)**, potassium nitrate can be obtained by evaporating the solution to dryness; a more suitable technique for crystallisation is partially evaporating and then cooling, or by evaporation over a boiling water bath. The full marks are only obtained by a careful description of one of these processes. Similarly, in **Question 4 (d)**, candidates are asked for their conclusions about the effectiveness of huddling. Answers that were not based on the results of the experiment described in the question, but referred instead to animal behaviour, merited no marks.

The evaluation of an experiment and amendment of its design to give more accurate or reliable results can also be found, for example in **Questions 1 (e)** and **6 (f)**. The accuracy of almost all experiments can be improved by repeating and averaging the results. Candidates can also gain marks by referring to conditions that should be kept constant, and to greater accuracy of measurement.

Candidates are urged to make use of the Notes for use in Qualitative Analysis wherever possible.

Comments on specific questions

Question 1

An experiment with water fleas was described in the question. The candidates were asked to calculate the average heart rate in beats per minute, plot the results on a graph and then draw conclusions from the data.

(a) A few candidates did not know how to find the average.

(b) Most candidates chose sensible scales for the axes and plotted all the points. The Examiners noted an improvement in the standard of graph drawing compared to previous years, and few candidates made serious errors.

(c) An increase in alcohol concentrations caused progressively greater decrease in heart rate of the daphnia. Most candidates were able to deduce this from the graph.

(d) This question draws attention to the social implications of the experiment, and nearly all candidates responded, pointing out that the speed of reaction of the human nervous system decreases when under the influence of alcohol.

(e)(i) The Examiners were looking for a clear analysis of a source of error, such as the difficulty of counting heart beats, the way in which small errors are magnified by multiplication, the possible inaccuracy of the concentration of the alcohol solution unless all water is first removed from around the flea, variations in the water fleas used and so on.

(ii) The improvement suggested need not be linked to the error noted in **(i)**, but many candidates chose to make the connection. Among the answers credited were ideas such as counting for a full minute, using more fleas at each concentration and using a constant temperature.

There were many good answers to this question, but few candidates scored the maximum ten marks.

Question 2

The question depended on the candidates reading and then understanding the significance of the change of volume in each of the graduated syringes in terms of the absorption or production of gas. Some candidates read the syringes correctly, but appeared not to notice that the initial reading of the syringe was 25 cm^3, not 0 cm^3. Thus they believed that all of the experiments involved the evolution of a gas, whereas a gas was absorbed in *Experiment 2*. Candidates were told that there may be more than one correct answer each time, so some of them tried to give two or even more names of metals that would behave as described. This error was ignored if the explanation was correct.

(a) Most candidates read the syringes correctly, though some gave 20.5, 0.3 and 40.4 as the answers.

(b)(i) Copper or zinc have no reaction with cold water.

(ii) Iron would react with water in the flask, absorbing oxygen and forming rust.

(iii) Calcium or magnesium would react with water and give off hydrogen.

Candidates could score a part mark by showing that they understood when oxygen had been absorbed or hydrogen had been evolved, even if they chose the wrong metals.

(c) The name of the "gas" given off was variously described as calcium oxide, magnesi zinc oxide, carbon dioxide, and even methane or ammonia.

A commendable proportion of candidates obtained full marks in this question.

Question 3

This question involved finding the solubility of a salt. This technique is not in the syllabus, but sufficient information was supplied for the candidates to answer the question.

(a) Most candidates were able to read the thermometer scales correctly.

(b) The calculation of the solubility at 70°C was found by simple proportion. Many candidates found the mean of the solubilities for *Experiments 1* and *3*; this gave the wrong answer. Others, unable to do the calculation, read the value from the graph. This was credited if the value given was the correct answer, 140g per 100g water.

(c) Candidates were expected to plot the points with an accuracy of +/–1 g or 0.5°C; most were able to do so. If a value for *Experiment 2* was stated in **(b)**, this point should appear on the graph. A smooth curve results. Extrapolation of the curve through the origin was ignored, though wrong.

(d) The point **P** was correctly interpreted by most candidates.

(e) The answer "evaporate to dryness" was awarded one mark here, since the Examiners were seeking a more detailed answer. Two marks were gained by describing evaporation over a boiling water bath or by suggesting partial evaporation followed by cooling.

Question 4

The introduction to this question was detailed and it was necessary for candidates to thoroughly understand it. Failure to do so was shown by candidates who thought that the beakers were filled with water or that that the temperature was read every ten minutes.

(a) All but a few candidates read the thermometer scales correctly.

(b) A few candidates tried to draw a graph instead of constructing a table. The most common errors were the omission of the units from the headings and the omission of the reading at time 0 minutes. The clear display of data is essential for a well-organised investigation, and teachers are urged to give their candidates practice in the construction of tables such as this one, including zero readings and properly labelled headings.

(c) A few candidates with language problems failed to answer this question, but most gave tube **A** as the correct answer.

(d) The first mark was a clear indication that the candidate understood that huddling is effective. For the second mark, the Examiners were looking for an acknowledgement that in this model of "huddling", test-tube **A** stayed warm longer, therefore retained heat energy. Some reference to the slower conduction or radiation of heat to the outside, or to the insulating effect of the surrounding test-tubes, gained the third mark. Answers that did not refer to the experiment but described actual animals huddling together for warmth did not gain the second and third marks.

(e) A number of points were made by candidates to suggest improving the accuracy of the experiment. Placing the same volume of water in each tube, placing stoppers in the tubes, starting tubes **A** and **B** at the same temperature, using more sensitive thermometers, repeating the experiment and finding averages, all gained marks. Marks were not awarded for proposals to use larger numbers of huddled tubes, or to read the temperatures more frequently and over a longer time period.

Question 5

This question is based on the Notes for use in Qualitative Analysis found in the syllabus. Candidates are expected, wherever possible, to have carried out these experiments in order to observe the tests and deduce conclusions. As in previous years, the standard of answers to questions about this aspect of experimental work was poor, and very few candidates gained a satisfactory mark in this question. Many answers consisted of guesses.

(a) The expected conclusions to *Tests 1*, *3*, *4* and *5* were as follows: copper or a transition metal, no carbonate or hydrogencarbonate present, chloride present and ammonia given off. Some slight variations to these answers were credited.

(b) Any test that could reasonably be expected to work, such as Universal Indicator turning blue or purple, was awarded 2 marks, even the repeating of the "red litmus paper turning blue" mentioned in the observation to *Test 5*.

(c) Some candidates gave verbatim the words learned from the Notes "light blue ppt., soluble in excess, giving a dark blue solution." This was offered both in **(i)** and **(ii)**, although the information was applicable when correctly separated into the effects seen when a few drops of aqueous ammonia then later, excess of ammonia is added to a solution of copper ions. This shows the hazards of rote learning when not coupled to practical experience.

(d) The very first line of the question should have given candidates strong clues, but alas, most of them forgot what they had read or had not read it at all. Copper oxide and ammonium chloride were the expected answers.

Question 6

This question attempts to explore the candidates' understanding of the transfer of energy by waves. Much depends on the correct understanding of the diagram. Many candidates did not appreciate that point **X**, at which a gun is fired, is 1000 metres away from point **Y**. The use of a cathode ray oscilloscope is suggested in the syllabus. Enough information is given in the question to enable candidates to deduce all the answers.

(a) Far too many candidates could not answer this question satisfactorily.

(i) The words "radio wave" or "radio signal" gained the mark here.

(ii) "Sound wave" was the expected answer, but "longitudinal wave" was an alternative.

(b) Most candidates did not realise that the sound would be too weak to be heard at a distance. The weaker candidates said that the microphone at point **Y** was sending the sound to point **X**.

(c) The diagram of the c.r.o. screen posed great problems, because candidates did not understand the function of the time-base.

(i) The six squares between inputs **A** and **B** gives a time lapse of 3.0 seconds. The better candidates could deduce this, but most failed to give the first decimal place and so lost a mark.

(ii) Seven and a half squares between inputs **A** and **C** gives a time lapse of 3.75 seconds.

(d) Here, the calculation of speed is a simple matter of dividing the answers to **(c)** into 1000 to give the answer in metres per second. Errors in part **(c)** were carried forward so more candidates were able to score. This gives a speed of sound as 333.3 m/s in **(i)**, 266.7 m/s in **(ii)**.

(e) Candidates were invited to consider how the slow response of the observer at point **Y** would invalidate the result, making the answer to **(d)(i)** more accurate.

(f) A more reliable answer will be achieved by repeating the experiment several times and finding an average. Other suggestions accepted were timing over a longer distance and using a c.r.o. screen with a more accurate scale.

Answers to this question were often rather disappointing. Some candidates had perhaps to hurry their answers because they had not carefully allocated the time allowed for the examination.