COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

Comments on specific questions (Biology)

General comments

All questions in the biology section posed a suitable challenge to candidates. None was too easy, although candidates found **Question 7** very difficult.

Comments on specific questions

Question 2

One of the incorrect options proved appreciably more popular than the correct option in this question. The cause of the error was that many candidates believed that starch is a diffusible substance.

Question 6

A common confusion associated with heart structure is that between left and right, however there is also a basic misunderstanding over the way in which the heart operates. Some candidates opted for the left atrium

being the chamber that pumps blood the furthest. Many candidates chose the correct option, due to their knowledge of the heart in relation to the double circulation.

Question 7

This question was very difficult for most candidates. Well over half the candidates believed that photosynthesis occurred in upper and lower epidermal cells, though it may be that reference to the conversion of light energy to chemical energy was not recognized as a description of photosynthesis. Candidates would benefit from knowledge of leaf structure, particularly with relation to the distribution of chloroplasts.

Question 9

Candidates are familiar with the concept of birth control, but are less aware of how an IUD operates. A few candidates believed that an IUD prevents sperms from entering the uterus.

Question 13

Candidates have an awareness of possible ecological problems created by human activity, and this was the easiest question in the biology section of the paper.

Comments on specific questions (Chemistry)

General Comments

Candidates performed reasonably well on this paper.

Question 14 was easy with most candidates selecting the correct option.

Questions 21, **26** and **27** were the most difficult for candidates to answer.

Comments on specific questions

Question 15

Candidates realised from the information given that there was only one metal, but chose option **A** rather than option **C**.

Question 17

Candidates chose option **A** which was balanced although the formula of hydrogen chloride was wrong.

Question 18

Candidates realised that element **Q** was a metal and chose option **B** which included the fact that it was an electrical conductor, ignoring the rest of the description.

Question 19

Candidates appeared to not understand what an insulator was.

Question 21

Option **A** was chosen by more candidates than the correct response. Potassium has a violent reaction but candidates ignored the flame colour produced.

Question 22

Candidates chose option **B**, rather than option **A** possibly believing that the graph represented rate and that its increasing steepness implied a catalyst.

Question 25

Candidates knew that a catalyst speeds up a reaction but did not understand that it is still there after the reaction is complete.

Question 27

Option **B** was more popular than the correct option **D**. The word 'polymers' was clearly linked, by candidates, to the idea of a plastic without fully understanding what the response states.

Comments on specific questions (Physics)

General comments

Candidates found the following questions difficult in the Physics section **Questions 29**, **33** (particularly difficult), **34**, **35**, **36**, **37** and **39**.

Comments on specific questions

Question 28

Option **B** was incorrect but popular, possibly because candidates considered the volume of the whole tank rather than the water in it.

Question 29

Most candidates incorrectly chose option **C**; perhaps it was thought that force and weight could not share the same unit.

Question 31

Many candidates chose option **A**, as they did not convert minutes to hours.

Question 32

A significant number of candidates incorrectly chose option **D**, presumably simply looking for the number 15 at an output coil.

Question 33

Candidates either did not appreciate that air is a good thermal insulator or that convection will carry hot air upwards Only a few candidates answered this question correctly; with option **A** and option **B** being chosen instead.

Question 34

Option **B** was a popular choice even though the initial rays were not parallel.

Question 35

Many candidates chose option **B**, confusing a loudspeaker and a microphone.

Question 36

There is confusion over currents in a parallel circuit and all options were chosen.

Question 37

A large proportion of candidates did not recognise a standard circuit symbol.

Question 39

Many candidates were unable to recall the order of the regions of the electromagnetic spectrum.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

Comments on specific questions (Biology)

General comments

All questions in the biology section posed a suitable challenge to candidates. None was too easy, although candidates found **Question 5** very difficult.

Comments on specific questions

Question 2

One of the incorrect options proved appreciably more popular than the correct option in this question. The cause of the error was that many candidates believed that starch is a diffusible substance.

Question 5

This question was very difficult for most candidates. Well over half the candidates believed that photosynthesis occurred in upper and lower epidermal cells, though it may be that reference to the

conversion of light energy to chemical energy was not recognized as a description of photosynthesis. Candidates would benefit from knowledge of leaf structure, particularly with relation to the distribution of chloroplasts.

Question 6

A common confusion associated with heart structure is that between left and right, however there is also a basic misunderstanding over the way in which the heart operates. Some candidates opted for the left atrium being the chamber that pumps blood the furthest. Many candidates chose the correct option, due to their knowledge of the heart in relation to the double circulation.

Question 12

Candidates are familiar with the concept of birth control, but are less aware of how an IUD operates. A few candidates believed that an IUD prevents sperms from entering the uterus.

Question 13

Candidates have an awareness of possible ecological problems created by human activity, and this was the easiest question in the biology section of the paper.

Comments on specific questions (Chemistry)

General Comments

Candidates performed reasonably well on this paper.

Question 16 was easy with most candidates selecting the correct option.

Questions 20, **26** and **27** were the most difficult for candidates to answer.

Comments on specific questions

Question 15

Candidates chose option **A** which was balanced although the formula of hydrogen chloride was wrong.

Question 17

Candidates realised from the information given that there was only one metal, but chose option **A** rather than option **C**.

Question 18

Candidates realised that element **Q** was a metal and chose option **B** which included the fact that it was an electrical conductor, ignoring the rest of the description.

Question 19

Candidates chose option **B**, rather than option **A** possibly believing that the graph represented rate and that its increasing steepness implied a catalyst.

Question 20

Option **A** was chosen by more candidates than the correct response. Potassium has a violent reaction but candidates ignored the flame colour produced.

Question 21

Candidates appeared to not understand what an insulator was.

Question 22

Candidates incorrectly chose option **A** as they recognised acid rain as a result of pollution. They did not fully consider the question, and therefore did not chose the correct option **D**.

Question 23

Candidates knew that a catalyst speeds up a reaction but did not understand that it is still there after the reaction is complete.

Question 26

Option **B** was more popular than the correct option **D**. The word 'polymers' was clearly linked, by candidates, to the idea of a plastic without fully understanding what the response states.

Comments on specific questions (Physics)

General comments

Candidates found the following questions difficult in the Physics section **Questions 28**, **32**, **33** (particularly difficult), **35**, **36**, **37** and **40**.

Comments on specific questions

Question 28

Most candidates incorrectly chose option **C**; perhaps it was thought that force and weight could not share the same unit.

Question 29

Many candidates chose option **A**, as they did not convert minutes to hours.

Question 32

Many candidates chose option **B**, confusing a loudspeaker and a microphone.

Question 31

Option **B** was incorrect but popular, possibly because candidates considered the volume of the whole tank rather than the water in it.

Question 33

Candidates either did not appreciate that air is a good thermal insulator or that convection will carry hot air upwards Only a few candidates answered this question correctly; with option **A** and option **B** being chosen instead.

Question 34

A significant number of candidates incorrectly chose option **D**, presumably simply looking for the number 15 at an output coil.

Question 35

Option **B** was a popular choice even though the initial rays were not parallel.

Question 36

A large proportion of candidates did not recognise a standard circuit symbol.

Question 37

There is confusion over currents in a parallel circuit and all options were chosen.

Question 40

Many candidates were unable to recall the order of the regions of the electromagnetic spectrum.

COMBINED SCIENCE

Paper 0653/21

Core Theory

Key message

Questions requiring few words in the answer were attempted, whereas longer question answers needing more detail and explanation were often left unaswered. Candidates should be guided by the number of marks allocated to each question. It is often beneficial for a candidate to read again through their answer to make sure that the meaning is clear.

General comments

There were some excellent performances on this Paper, with several candidates showing very good understanding of the Core content of the syllabus, and able to answer almost every question competently. A significant number of candidates gained very little credit. There was evidence that poor English language skills made it very difficult for some candidates to understand the questions and to communicate their answers. A significant proportion left many blank spaces throughout the Paper. These candidates often attempted only those questions where answers did not have to be written on answer lines, and could be answered by writing in boxes or drawing lines. **Question 4(b)(ii)**, for example, was answered by almost every candidate, including those who left many other questions unanswered.

Even where English was not an apparent problem, candidates frequently did not answer the question that was asked (instead seeming to be answering a different question that was perhaps more familiar to them), and often did not give sufficiently precise or complete answers.

Some candidates appeared not to have access to a calculator. It is expected that candidates will have a calculator that they can use in the examination.

Comments on specific questions

Question 1

(a) Some candidates correctly stated that the nail in **B** would rust because it had both water and oxygen. They did not always continue their answer to explain why the nails in **A** and in **C** would not rust.

(b)

(i) It was very rare to see a correct response here. Almost no candidate recognised that both **W** and **Y** are hydrocarbons. Usually, only one compound was mentioned, and this was generally one that contained oxygen or nitrogen as well as hydrogen and carbon. A few candidates were able to explain that a hydrocarbon is a substance containing only hydrogen and carbon.

(ii) Some candidates were able to suggest a suitable property, such as not mixing with water, or sticking to the steel chain. Most answers did not give properties, indicating that perhaps the meaning of this word was not understood.

(iii) This question was often omitted. Of those who did attempt an answer, some knew that hydrocarbons are used as fuels, or to make plastics, or for lubrication.

Question 2

(a) Many answers correctly gave the formula relating work, force and distance. Candidates should note that formulae consisting only of units (for example, work = N x m) are not accepted. Some

incorrectly included 'mass' rather than 'force' in their formula. Where the formula was known, the calculation was usually correct.

(b)

(i) Some answers correctly suggested that the motor would still run, but few candidates recognised that it would run in the opposite direction.

(ii) Some candidates noted that the motor would not run. Most did not appreciate this, and stated that it would run twice as fast, or would run so quickly that it would break.

Question 3

(a) This was quite well answered, and many candidates were able to name both the receptor and the effector. Some incorrectly gave the brain as the effector. A significant proportion of candidates made no attempt to answer.

(b)

(i) Some candidates were able to give a suitable definition of an enzyme. A very common error was to describe an enzyme as something that breaks down food, which is only true of a very small number of enzymes. Some candidates thought that enzymes are cells.

(ii) The concepts of digestion and absorption are not well understood. It was very rare to see the idea that digestion breaks down nutrients to small molecules, so that they can be absorbed. Common suggestions were that digestion allows you to get rid of all the waste material in food, makes it easier to swallow your food or allows the food to move through the body safely. All of these suggest that candidates did not understand that nutrients need to move across the walls of the intestine before they can be used by the body; digestion allows this absorption to take place.

(c)

(i) Many candidates were able to make a correct statement about the function of molar teeth. Care is needed with language; molar teeth do not 'cut' or 'slice' food. Candidates frequently showed that they did not understand that the breaking down of large pieces of food to smaller ones is part of digestion, and it was common to see statements that the crushing of food 'makes digestion easier'. Reference to making digestion by enzymes easier was credited.

(ii) Most answers correctly mentioned calcium. A few candidates also stated that calcium is an important component of enamel.

Question 4

(a)

(i) Almost all candidates attempted this question. It was generally well answered, although the term 'compounds' was often used instead of 'nuclei' in the second space. Occasionally, poor writing, or crossing out and rewriting over the top, meant that it was not possible to decide whether the candidate had written 'fission' or 'fusion' in the first space. Candidates who wish to change an answer should clearly cross out the first one and then write the new one nearby, not over the top of the first one.

(ii) Relatively few candidates could describe the use of the heat energy mentioned in the question to produce steam, which turns a turbine which turns a generator. Some described the combustion of fossil fuels. Many candidates made no attempt to answer this question.

(b)

(i) This was generally quite well answered, and most candidates were able to make at least one correct statement about the effect of radiation on the body, such as mutation or cancer.

(ii) Almost all candidates attempted this question, and it was often answered entirely correctly.

(iii) Only a few candidates attempted to answer this question. Very few candidates gave a suitable response. Some were able to state that alpha radiation cannot pass through paper, but this was not relevant to the badge as it does not contain paper. A small proportion of candidates correctly stated that the radiation would not pass through the plastic cover.

Question 5

(a) This was well answered. A majority of candidates were able to link all three organisms to the correct position in a food chain. Dung beetles could be identified as either consumers or decomposers. The most common incorrect response was to suggest that cattle are decomposers.

(b) This was also quite well answered, and many candidates were able to write a suitable word in at least two or three of the spaces. A very common incorrect choice for the first space was 'digestion'. Most correctly chose carbon dioxide for the second space, but this sometimes was said to enter the plant through its roots.

(c) There were some good answers to this question, including the ideas that overgrazing would occur, and that the cattle would trample the soil. Soil erosion was often correctly mentioned. Some candidates were more concerned about the cattle's dung, suggesting that this would harm the soil.

Question 6

(a) Many candidates identified at least one of the useful products correctly, and some were able to name both.

(b)

(i) This question was frequently not attempted. Very few candidates were able to give a correct difference between a mixture and a compound. Where a correct statement was made, it was commonly repeated the other way round in the space for the second difference.

(ii) Some candidates correctly stated that the gases have different boiling points.

(c)

(i) Many answers correctly described the effect of a catalyst on the rate of reaction, but most stopped there rather than trying to make a second point to gain further credit. Some candidates also stated that the catalyst is not used up and so can be reused.

(ii) Most candidates knew that a high temperature speeds up the rate of the reaction.

(iii) This was left unanswered by many. A very few candidates correctly gave 'acid' in the first space, and even fewer gave 'neutralisation' in the second.

Question 7

(a) Candidates must recognise that they are expected to give answers that are a little more discerning than simply that the length of the spring increases as the load increases. Good answers stated that the length is proportional to the load.

(b) This was well answered, most candidates correctly drawing a downward pointing arrow.

(c) The great majority of answers addressed only part of the question, stating that the two forces would be equal, but making no comment on their direction.

(d) Most candidates could state the formula relating density, mass and volume and showed their calculation clearly.

(e) Most answers correctly identified diagram **Y** as representing the spring. Many explained this by saying that all the particles are touching, but few mentioned the regular arrangement of the particles. Some tried to use the movement of the particles in their explanation, but this is not shown on the diagram and so was not an appropriate answer.

Question 8

(a)

(i) A large number of candidates made no attempt to answer this question. Of those who did, some correctly mentioned chromosomes, and some also knew that there are 23. Many candidates wrote down structures that are found in a cell, rather than in a nucleus, such as 'nucleus' and 'cytoplasm'.

(ii) This question was also unanswered in many cases. Labels were often correct, but there were also many incorrect labels such as cell wall or vacuole.

(iii) Many candidates identified the role of the tail in helping the sperm to swim to an egg, and a few also mentioned the pointed head which reduces friction. Some did not look carefully at the question, and gave answers about what happens after the sperm has reached the egg.

(b) Most candidates correctly named the testes.

(c) This was quite well answered, and most candidates correctly mentioned fertilisation. A few were able to give more detail, such as the formation of a zygote.

Question 9

(a)

(i) Quite a few candidates correctly counted up 13 atoms in the formula of potassium feldspar. A common incorrect answer was 11, perhaps obtained by simply adding 8 and 3.

(ii) Some candidates recognised that a lilac flame indicates potassium, and therefore correctly identified potassium feldspar. Answers needed to imply that it was the colour of the flame that enabled the identification, so statements such as 'because potassium is lilac' or 'because potassium turns lilac' were not credited.

(iii) Some answers correctly gave potassium or calcium. Many gave elements that were not in any of the formulae. Many gave substances that are not elements, such as dolomite.

(b)

(i) This was frequently left unanswered. A small number of candidates were able to identify this as a decomposition reaction and provide a suitable explanation.

(ii) Some candidates correctly circled 'less than' and a few of these were able to explain a correct reason for this. In general there seemed to be little recognition that the total mass of substances at the start and end of a reaction is the same.

(iii) Only rarely was a chemical reaction mentioned in the answer to the question relating to observation 1. The term 'exothermic' was known by a very small number of candidates. Observation 2 was slightly better understood, with some candidates recognising that an alkaline solution had been produced. Some said that the indicator had become alkaline, which is not correct.

Question 10

(a)

(i) Very few candidates were able to give the meaning of the term 'frequency' in relation to waves.

(ii) Some candidates recognised that the range of frequencies for speaker **A** was less than that for the other two speakers.

(iii) Very few candidates recognised that frequencies above about 20 000 Hz are not detectable by the human ear, so that the difference in ranges of **B** and **C** would not be audible. Most answers focused on the lower frequency being the same, which does not answer the question.

(b) Very few answers correctly stated that 0.28 m refers to the wavelength. Many thought that it was the distance between the MP3 player and the radio station. Others simply suggested that it stood for 0.28 metres, or 0.28 minutes.

COMBINED SCIENCE

Paper 0653/22

Core Theory

Key message

Questions requiring few words in the answer were attempted, whereas longer question answers needing more detail and explanation were often left unanswered. Candidates should be guided by the number of marks allocated to each question. It is often beneficial for a candidate to read again through their answer to make sure that the meaning is clear.

General comments

Although there were some very good performances on this Paper, there was evidence that the poor English language skills of many candidates made it very difficult for them to understand the questions and to communicate their answers. A significant proportion of them left many blank spaces throughout the Paper. Some answered only those questions that did not contain answer lines, such as **1(b)**, **2(a)** and **7(b)**.

In general, the majority of candidates appeared to have been appropriately entered for the Core paper rather than the Extended paper.

Some candidates appeared not to have access to a calculator. It is expected that candidates will have a calculator that they can use in the examination.

Comments on specific questions

Question 1

Most candidates showed some understanding of the motion of the parachute jumper, but often insufficient care was taken to ensure that answers were precise.

(a)

(i) This was generally answered correctly. Wrong answers included potential, gravitational potential and friction.

(ii) Some candidates correctly conveyed the idea of balanced forces, generally by saying that the upwards and downwards forces were equal. Many said that it was because his weight did not change, or because gravity stays the same.

(b)

(i) The letter **X** was very frequently placed at 50 s, which is a point at which speed is changing rather than remaining constant.

(ii) The letter **Y** was usually correctly placed at 88 seconds. Some candidates wrongly placed it between 90 and 100 seconds, on the curved part of the graph.

(iii) The letter **Z** was usually correctly placed at 110 seconds.

Question 2

(a) Almost all candidates correctly linked the first box to the nucleus. Many candidates were able to link all four boxes correctly, but others wrongly thought that the nucleus controls what enters and leaves the cell, that the cell wall is partially permeable and that the cell membrane is fully permeable. Some drew only three lines.

(b)

(i) The term 'enzymes' was not well known. Many candidates did not attempt to answer this question.

(ii) There were some good descriptions of the damage caused to enzymes by high temperatures. Many candidates simply repeated the statement that the reactions cannot take place at a high temperatures.

(c)

(i) Almost all candidates said that the mineral content of bone increases with age, but relatively few described a steady or linear increase, or used the term 'proportional'. Some candidates gave excellent answers including a calculation of the increase over the time period shown in the graph.

(ii) Most answers included a mention of calcium, and some also stated that this is needed for strong bones. A few were more concerned that eating dairy products would make you fat.

(iii) Almost all candidates knew a good source of vitamin C, generally a citrus fruit. Wrong answers were usually animal products, such as fish or beef.

Question 3

(a)

(i) Some candidates said that a 'squeaky pop' would be heard, but were not always able to link this to the presence of hydrogen. There was confusion with tests for oxygen and carbon dioxide.

(ii) Relatively few answers related to the candidate's observations, as required by the question. Those who did look carefully at the observations recognised that neither **A** or **C** reacted, and so could not be placed in order of reactivity.

(b)

(i) A minority of candidates correctly named limewater. A very wide range of wrong answers were provided, including water, hydrochloric acid, copper sulfate and carbon dioxide.

(ii) A majority of candidates had no understanding of how to complete the word equation. Copper, carbon and sulfur often appeared in the three boxes. Those who did recognise that carbon dioxide and copper sulfate were produced did not always include water, often giving hydrogen instead.

Question 4

(a)

(i) Very few drawings showed arrows leading upwards from the heater and then downwards around the sides of the room. Candidates gained partial credit for upward arrows from the heater. Many candidates made no attempt to answer this question, perhaps because they did not notice it. Candidates must look carefully for the bracketed marks, and not rely solely on the presence of answer lines to show them where the questions are.

(ii) Many candidates correctly identified **C** as the hottest part of the room and **A** as the coldest. Many others got this completely the wrong way round, generally giving the reason that **C** is furthest from the heater and is therefore the coldest. Those who did understand often said that 'heat rises' rather than 'hot air rises' and so could not be awarded credit.

(b) This was well answered, and most candidates were able to identify a danger and explain it.

(c)

(i) Knowledge of electricity production from nuclear fuel was limited. Only a very small minority of candidates were able to give an advantage, such as the lack of production of carbon dioxide, or the need for only a small amount of fuel to produce a large amount of electricity. A significant number of candidates suggested that electricity produced from nuclear fuel is 'more powerful' or has a higher voltage.

(ii) Once again, very few candidates were able to give a disadvantage of using nuclear fuel for electricity generation, such as the risk of radiation leaks if accidents occur, or the problem of storing radioactive waste.

Question 5

(a)

(i) This was quite well answered, with many candidates able to name petals or nectaries.

(ii) This was much less well known. Many candidates suggested that the stigma makes pollen. Quite large numbers of candidates did not offer an answer.

(b)

(i) Many candidates correctly mentioned photosynthesis, but were unable to take their answer any further. Once again, many left this answer space entirely blank.

(ii) This question was answered correctly by rather more candidates, many of whom mentioned the use of sugars to attract insects to the flower, or for energy.

Question 6

(a)

(i) Most candidates could name coal as a solid fossil fuel. Common wrong answers included oil and gasoline. Several candidates were distracted by the word 'fossil' and suggested dead animals or 'old bones'.

(ii) This was not well answered. Some candidates correctly explained that fossil fuels take a long time to form, which is not true of wood, or that fossil fuels are formed as a result of intense heat or pressure, or through the action of microorganisms.

(b)

(i) While some candidates knew the term fractional distillation, many offered incorrect processes such as combustion or filtration.

(ii) Very few sensible suggestions were made, generally in relation to the greater viscosity of crude oil.

(c)

(i) Some candidates gave an answer within a suitable range, but many made suggestions that were far too high (often confusing oxygen with nitrogen and suggesting 78 %) or too low.

(ii) This was not well known, with only a small proportion of candidates explaining that the oxygen had been used to burn the fuel.

(iii) Most candidates correctly stated that toxic gases would be produced, and some named carbon monoxide.

(d) Most answers correctly gave the formula for CO_2. It was relatively rare to see $2O_2$, and O_2 or O_4 often appeared instead. Similarly, while some candidates correctly wrote $2H_2O$, many others gave H_4O_2.

Question 7

(a)

(i) The circuit symbols were well known, and many candidates gained full credit.

(ii) This was also very well answered. A few candidates made things a little more difficult than necessary by drawing the torch as well as the circuit.

(b) This was almost always answered correctly.

Question 8

(a) These terms were not very well known. Candidates especially confused habitat with community, ecosystem with habitat and decomposer with producer.

(b)

(i) Very few answers gave any correct information about how oxygen enters the blood of a mammal. Credit was given for mention of air sacs (alveoli) and diffusion, but it was rare to see either of these. Many answers explained instead how blood moves around the body. Several gave the answer 'by respiration'. A significant number of candidates thought that the guanaco would get its oxygen by eating grass.

(ii) A minority of candidates recognised that red blood cells transport oxygen, and were able to suggest that having more of them helped the guanaco to survive in an environment where oxygen is in short supply. Many answers went along the wrong track altogether, suggesting that this would help the guanaco to keep warm.

(c) Some candidates made good suggestions, generally relating to the effect on food chains if guanacos became extinct, or the idea that we should try to ensure that guanacos are still there for future generations to enjoy or to study. Very few mentioned the idea, stated in the syllabus, of maintaining biodiversity.

Question 9

Knowledge of radioactivity is generally very poor.

(a)

(i) This was quite frequently left unanswered. Very few candidates recognised that beta and gamma radiation are too penetrating, so would continue to pass through the air even when it contained smoke particles. A few also recognised that it would be insufficiently ionising.

(ii) This was better answered than **(i)**, and many candidates made a correct statement about the harmful effect of radiation on the body, such as causing mutations. Few mentioned that alpha radiation is highly ionising.

(b) This was very poorly answered, with only a very small number of candidates giving an appropriate answer. The most common correct answers were rocks and cosmic radiation.

(c) Once again, only very few candidates were able to make an appropriate suggestion such as wearing a lead apron.

Question 10

(a)

(i) Most candidates could correctly give the group number of lithium, but they found determining the period number much more difficult. Many gave 7 or 3, apparently using the numbers that they could see associated with lithium in the Periodic Table.

(ii) Many answers correctly stated that lithium is stored under oil because it is very reactive, but few went on to give an explanation. Some were able to explain that the oil prevents reaction with oxygen or water.

(iii) This was often answered well. Many candidates correctly recognised that the inner shell should contain only two electrons, and some also said that the total number should be three. Some were distracted by the fact that only electrons were shown, and attempted to explain how the candidate should have shown neutrons and protons, which does not answer the question.

(iv) Few candidates recognised that lithium is a metal, and therefore would conduct electricity.

(b)

(i) The great majority of candidates found this very difficult, and only a very small minority were able to explain the difference between an atom and an ion in terms of charge, numbers of electrons or whether the outer shell was complete. Many seemed to be trying to use differences between elements and compounds in their answer, or between compounds and mixtures.

(ii) A very high proportion of candidates did not answer this question, probably because they did not see it. Once again, candidates should be reminded to look carefully for bracketed marks and not only answer lines, to indicate where a question is being asked. Those who did answer only rarely did so correctly, often labelling the anode or electrolyte, or leaving the end of their label line in mid-air rather than ending clearly on the cathode.

(iii) This was well answered. The most common error was to give 'chlori**d**e' instead of 'chlori**n**e'. Candidates are reminded to use correct scientific terminology.

COMBINED SCIENCE

Paper 0653/31

Extended Theory

Key messages

Candidates generally wrote answers of appropriate length and in comparison with previous years, there was much less evidence of time being wasted on unnecessary extended writing. Candidates should be guided by the number of marks allocated to each question. It is often beneficial for a candidate to read again through their answer to make sure that the meaning is clear.

Some candidates would benefit from improving the way they lay out their working in numerical questions so that they can gain credit for it.

General comments

Some excellent scripts were seen from candidates who had mastered all aspects of the syllabus, and who demonstrated good examination technique. There was no evidence that candidates had any difficulty in completing the paper in the available time. Candidates generally wrote answers of appropriate length. As is often the case in Physics questions involving the use of a formula leading to a numerical answer, some candidates used incorrect symbols in the formula or did not write the correct units in their final answer and so could not be awarded full credit.

This paper contained several questions in all three Science disciplines which required candidates to apply their knowledge in relatively unfamiliar contexts. This caused difficulties even for well-prepared candidates who had clearly acquired good factual knowledge. Candidates would benefit from in experience applying knowledge in different contexts.

Comments on specific questions

Question 1

(a) This proved to be a difficult question and many candidates did not transfer their knowledge of the carbon cycle into the dung beetle context. It was important that candidates discussed the processes involved in terms of carbon dioxide gas, beginning with respiration in the beetles, transfer of carbon dioxide into the air followed by absorption into the leaves and photosynthesis. A common incorrect response was the idea that carbon entered the plant via the root system.

(b) The majority of candidates stated that the dung provided fertiliser and then repeated the question by stating that this fertiliser made the plants grow better. Candidates would have received further credit if they had explained how nitrates entered the plant via the root system and that nitrates were used to make nitrogen-containing compounds such as proteins.

(c)

(i) This was very well answered and the majority of candidates gained full credit.

(ii) Only the most able candidates realised that insecticides would kill dung beetles and that this would reduce the transfer of dung underground. The most common incorrect responses included ideas that an insecticide would damage the grass or that the removal of insects would encourage more grazing by cattle.

Question 2

(a) A good proportion of candidates did very well in applying their knowledge in this rather unfamiliar context. Many incorrect but reasonable suggestions based on the chemistry of the alkali metals were seen from candidates who may have been less familiar with flame testing. A common and

important misconception was that chemical reactions of the free elements, sodium and potassium, were suggested as a means of distinguishing between compounds of these elements. Thus it was often suggested that the two feldspar samples could have been added to water to look for a difference in reactivity.

(b) Almost half of the candidates were able to calculate the relative formula mass of calcite. Some candidates added incorrect units, usually grams, but this was not penalised on this occasion.

(c)

(i) The balancing of the symbol equation presented few problems for the most able candidates. The most serious error was the alteration of chemical formulae to try to make the equation balance.

(ii) About half of the higher scoring candidates recognised thermal decomposition as the reaction type, although a much smaller number were able to explain their answer in terms of a complex compound changing into several simpler ones. Common incorrect answers included combustion because carbon dioxide was made and reduction because the reactant had been made into smaller compounds. Candidates should be discouraged from using vague terms such as 'smaller compounds' when they really mean to refer to compounds with simpler formulae.

(d)

(i) Only the better prepared candidates gained credit here, the two accepted answers being hydroxide or OH^-. The question asked for the **ion** and so OH without its ionic charge was not credited.

(ii) Those candidates gaining credit for **(i)** invariably received full credit for this word equation. Some able candidates decided to write a balanced symbol equation although the question clearly asks for a word equation. Where the symbol equation was correct in every respect the candidate could only be awarded partial credit.

Question 3

(a) Half of the candidates gave the required answer. Many others would have received credit if they had remembered to write in the correct units. Many candidates seemed to confuse the extension of the spring with its length and suggested that the answer should be 58 mm.

(b) Most of the candidates found it difficult to gain full credit here. Credit was awarded for reference to the proportional relationship between load and spring length, for stating that this relationship was observed up to a load of between 8 and 8.4 N and that after this loading, the pattern changed because the elastic limit had been exceeded.

(c)

(i) Nearly half of the candidates correctly used the graph to find the weight of the bird. No margin of error was allowed on this occasion. A significant proportion of candidates were not awarded credit as they had not included correct units in their answer.

(ii) This calculation involved several steps, but a number of candidates received full credit. Many candidates were able to state and then rearrange the density formula and would have gained further credit if they had converted their answer from **(i)** from weight to mass before substituting into the formula. Errors carried forward were allowed where appropriate.

Question 4

(a) Candidates needed to be very careful in drawing their labelling lines to show the cell membrane and cytoplasm. Common incorrect responses included re-labelling the nucleus and including features found in plant cells, particularly cell wall and large vacuole.

(b) The majority of candidates stated testis, although some suggested penis.

(c)

(i) The required answer to this question was much simpler than many candidates thought. Only one mark was available and yet able candidates wrote at length about variation between individual sperm and the need for statistical reliability gained by using data for large numbers of sperm. Others discussed the fact that sperm are produced in large numbers at a time. Candidates' answers needed to refer to the impossibility of making measurements on a single sperm cell.

(ii) Candidates always need to be very careful in wording answers which involve the concept of energy. In this question many candidates knew that the answer needed to refer to respiration and so many gained at least partial credit. Further credit was available for making it clear that oxygen combines with sugar of some kind to release energy. Phrases such as 'energy is made' or 'oxygen produces energy' or 'respiration makes energy' should be strongly discouraged and candidates encouraged to write about the 'release or conversion of energy'.

(iii) The calculation of power proved to be a rather difficult question. Many candidates had learned the relationship between power, energy and time and gained credit for this. It was noticeable that many candidates were confused about the time units that should have been used in the power equation. They needed to remember that joules per hour given in the table of data needed to be converted into joules per second in order to calculate the power correctly. Errors carried forward were allowed where appropriate.

(iv) Many candidates had learned a great deal about the way that sperm cells are adapted for their role in reproduction and their answers sometimes moved away from a discussion about the sperm shape. The award of full credit was rare. Many gained credit for referring to the pointed head or streamlined shape, and they could have gained further credit by describing the consequence of this shape on reducing friction or drag.

Question 5

(a)

(i) Accepted advantages of nuclear-generated electricity included the conservation of fossil fuel and the consequent absence of carbon dioxide emission and contribution to global warming and climate change. Disadvantages included reference to the potential environmental hazards posed by nuclear accidents and the technical difficulties presented by the need to handle and store nuclear waste in a safe and appropriate manner. Large numbers of candidates gave non-specific, vague answers such as 'it makes lots of nuclear waste' or 'power stations can explode' which are more emotive than scientifically relevant.

(ii) In answering questions about nuclear fission, candidates need either to state or to strongly imply that it is the atomic nucleus that divides. Candidates should be discouraged from writing answers such as 'the atom splits'. Only a minority of candidates gained credit here although many did show that they had learned many of the other details describing nuclear chain reactions.

(iii) Many candidates correctly suggested one of the two statements in the passage that could be considered a mistake. Some candidates thought that the suggestion that gamma was harmful only to wildlife was a mistake, and others thought the mistake lay in suggesting that gamma was harmful.

(b)

(i) Candidates showed they were able to interpret the response of the badge to beta and gamma radiation.

(ii) This was not answered quite so well as **(i)**, largely because candidates did not transfer their knowledge of the behaviour of alpha radiation into the context of the photographic badge. Instead of simply stating that alpha would not penetrate the plastic cover, candidates made unrelated statements about how far alpha penetrated into air or that it could be stopped by paper.

(c)

(i) Most knew that gamma radiation carries no charge and so is not deflected. Weaker candidates suggested that gamma moves too quickly for deflection.

(ii) This was usually answered very well. Candidates needed to make sure that they did not reverse the electrical charges carried on alpha and beta particles.

Question 6

(a)

(i) This was well answered by all candidates.

(ii) Candidates generally found it quite difficult to transfer their knowledge of fractional distillation into the less familiar context of separation of gases from liquid air. Credit was awarded for any implication of heating and differences in boiling point.

(b) Some very comprehensive answers were seen for this question. Many had learned the collision theory very well and more able candidates expressed their answers in terms of increased molecular speed and increased collision frequency. The most common weakness was to make vague statements such as 'the molecules move more' or 'collide more'.

(c) Covalent bonding theory had been very well learned and candidates were very well practiced in completing bonding diagrams with many gaining full credit.

Question 7

(a)

(i) The required answer was 'reflex' but this was relatively rarely seen even from able candidates. Answers which were frequently seen but not accepted included, 'involuntary' and 'hunger'.

(ii) Most candidates gained partial credit for their answers to this question and a significant number did very well and gained full credit. Credit was awarded for references to electrical impulses passing via nerves or sensory neurones to the brain or central nervous system (not spinal cord) and then back to salivary glands via motor neurones. The most common incorrect response was the complete omission of any reference to the nervous system.

(b) The question was particularly about the action of molars and so candidates needed to discuss the grinding or crushing action of this type of tooth. Many candidates gained partial credit but could not then develop the role of molars in increasing the surface area of food and therefore facilitating the action of enzymes. A significant number of candidates suggested that the action of molars simply made food easier to swallow or digest, and answers like this are not specific to molars.

(c) A majority of candidates wrote good answers to this question and showed that they had learned very well how to define an enzyme. Some gave answers specific to a particular enzyme rather than keeping their answers general and so could not be awarded credit. Hence they wrote statements such as 'an enzyme breaks down large molecules like starch', which although not incorrect, is not the required answer to this question.

Question 8

(a) In order to gain full credit, candidates needed to state clearly that rust formation requires the presence of both water and oxygen (air). Hence rust appears in tube **B** but not in **A** because water is absent and not in **C** because oxygen (air) is absent. Some candidates left too much for the Examiner to assume, for example responses such as 'only tube **B** contains what is needed for rusting'. This question is a clear example of how candidates should take note of the number of marks available as a guide to the amount of detail required.

(b)

(i) Many candidates arrived at the answer Cr_2O_3 and an increasing number explained their answer in terms of charge balance. Only a minority of candidates suggested the vague shortcut method of crossing over the ionic charges as their justification of the final formula.

(ii) Candidates need to be very careful in their use of the word '**it**' in their answers. Hence the answer 'it has gained two electrons' has to be taken by the Examiner as the **ion** gaining the electrons rather than the atom. More able candidates referred to the fact that the ion contained two more electrons than protons.

(c)

(i) The use of bromine to test for double bonds in hydrocarbons was not very familiar and consequently few candidates gained credit in this question.

(ii) This was not answered well. Candidates simply needed to imply that water and / or oxygen do not mix with hydrocarbons, or that a hydrocarbon oil easily sticks to the steel chain.

Question 9

(a)

(i) Candidates generally had learned an acceptable definition of frequency and credit was usually awarded. Several candidates suggested that frequency was the same thing as pitch but this was not accepted.

(ii) This question was usually well answered and large numbers of candidates correctly referred to the lower frequency range of speaker **A**.

(iii) To gain credit, candidates had to refer to the frequency limits associated with the normal range of human hearing and explain that both speakers **B** and **C** extended well beyond the upper limit. A significant number of candidates were distracted by the common lower limit for these speakers.

(b) Most of the more able candidates were very well practiced in carrying out parallel resistor calculations, and gained all of the available credit. A recurring error was in the writing of the formula as $R = 1/R_1 + 1/R_2$.

COMBINED SCIENCE

Paper 0653/32

Extended Theory

Key messages

Candidates generally wrote answers of appropriate length and in comparison with previous years, there was much less evidence of time being wasted on unnecessary extended writing. Candidates should be guided by the number of marks allocated to each question. It is often beneficial for a candidate to read again through their answer to make sure that the meaning is clear.

Some candidates would benefit from improving the way they lay out their working in numerical questions so that they can gain credit for it.

General comments

Some excellent scripts were seen from candidates who had mastered all aspects of the syllabus. Many candidates showed evidence of good examination technique such as writing answers of appropriate length.

As is often the case in Physics questions involving the use of a formula leading to a numerical answer, some candidates used incorrect symbols in the formula or did not write the correct units in their final answer and consequently could not be awarded credit.

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

Comments on specific questions

Question 1

(a)

(i) The required answer was population. Incorrect responses included words such as 'herd' and 'species'.

(ii) The required answer was community. Incorrect responses included words such as 'species' 'diversity' and 'population'.

(iii) The required answer was consumer. Many candidates suggested 'carnivore' but this was not accepted.

(b) Many candidates showed that they had read the question stem carefully and used the information to produce relevant answers.

(i) Many candidates realised that this question involved oxygen and they needed to convey the idea that the high red blood count in the guanaco compensated for the low oxygen level in the air at altitude. This idea of compensation was not seen very often. Further credit was then available for the idea that the guanaco's blood will then be carrying enough oxygen to sustain it or to make a sensible reference to the process of respiration.

(ii) Candidates across the ability range gained credit for a reference to the idea that the guanaco hair counteracted the low temperatures at altitude and maintained the body temperature. The other acceptable points that could have been made included a general reference to homeostasis and the description of the hair as an insulator.

(c)

(i) The most common suggestions were deforestation and hunting, neither of which could be accepted. Candidates should have studied the photograph a little more carefully where they

would have seen the guanaco in a treeless environment. Hunting is not a direct attack on the guanaco habitat. Examples of human activity which could impact on the habitat included agriculture, mining, building and tourism.

(ii) Candidates needed to discuss the importance of species diversity and disruption of food chains if one species such as the guanaco were to be removed. Many candidates knew that they should answer along these lines and should have made their answers more detailed in order to gain further credit. Thus answers such as 'it would unbalance the food chain' should be avoided in favour of a discussion of the negative effect the loss of guanacos would have on the puma population. Credit was available for arguments based on the negative effect on tourism or the moral arguments for conservation.

Question 2

(a) Candidates needed to draw the mirror at an angle of approximately 45° on a level with the torch such that a reflected ray could be drawn in the direction of the observer's eye. A majority of candidates did this very well.

(i) Location of the mirror in a vertical position was not accepted.

(ii) Candidates needed to draw light rays so that the angles of incidence and reflection looked the same and the reflected ray was in the direction of the observer. It was possible to gain credit here even if candidates had not gained credit in **(i)**.

(b)

(i) The great majority of candidates gained some credit. 'Power pack' was not accepted for the cell symbol. Candidates should be encouraged to use the term 'cell' for this symbol and not the term 'battery'.

(ii) Candidates performed well on this question. They should however be encouraged to avoid leaving unintended gaps in the circuit through careless drawing.

(c) Many candidates drew clear diagrams to help explain their answers and this often secured credit. The main difficulty that candidates found was to express the idea that **when standing on** end **A**, the centre of mass would be lower. Hence many stated that 'the centre of mass is closer to **A**' which, on its own, cannot be awarded credit.

Question 3

(a) A significant number of candidates had learned that as an alkali metal, lithium is very reactive, and gained credit for stating this. Further credit was available for recognising that the hydrocarbon oil prevented reaction with substances in the air. Many candidates suggested that lithium was stored in the way shown because it did not react with the oil. Although this is the case it is not the answer to the question and so did not gain credit.

(b)

(i) Most candidates gained some credit by stating that the reactants, lithium carbonate and dilute hydrochloric acid, must be mixed in the beaker. More candidates may have gained further credit if they had realised the importance of the phrase *neutral solution of lithium chloride* in the question stem. Further credit was available for the precaution of adding excess lithium carbonate and for making it clear that the required solution would be the filtrate after any lithium carbonate residue had been removed.

(ii) Since most of the substances involved in the reaction could be obtained from **(i)**, credit for this word equation was for knowing that carbon dioxide and water are the other products. In general this had not been learned very well. Candidates are advised to avoid writing a <u>symbol</u> equation where the question asks for a <u>word</u> equation.

(c) Electrolysis seems to remain a particularly difficult part of the Chemistry syllabus. Questions on electrolysis are usually only answered very well by more able candidates.

(i) Candidates needed to refer to the need for ionic mobility which is possible only in a liquid medium. A mistake which is very commonly made in this type of question is to discuss conduction through the electrolyte in terms of free electrons.

(ii) Some candidates suggested that positive ions were converted into negative ions at the cathode while others described the reverse process of ionisation of a lithium atom.

Question 4

(a) A good proportion of candidates did well with this question and successfully applied their knowledge of beta and gamma radiation into the smoke alarm context. Credit was awarded for explaining that the high penetration of beta and gamma meant that they would not be stopped by smoke particles. Candidates could also refer to the low ionising ability of these types of radiation which would mean that no current would ever pass between the electrodes. Further credit was available if candidates described the potential health hazard of radiation leakage from the detector.

(b)

(i) In general, candidates understood the concept of half-life and used the graph, or presented written working to show the correct half-life.

(ii) It was expected that candidates would simply state that americium-241 had a very long half-life. Credit was awarded for any implication that the source would radiate for a very long time.

Question 5

(a) Many candidates were awarded credit for referring to the long timescale required for the formation of fossil fuel. For further credit candidates could have discussed the need for heat and / or pressure or the action of microorganisms. Many candidates suggested that fuels are described as fossil fuels because they are found underground, this answer does not answer the question, and is not always the case.

(b) Candidates generally did very well with this question and the majority scored credit. The most frequently seen mistake was to suggest that the working should be (6 x 14) followed by +2.

(c)

(i) A significant number of candidates understood what was required in this question. It was expected that candidates would locate their crosses neatly on one of the single bonds within the methane molecule, but credit was awarded for a cross anywhere close by.

(ii) Credit was available for stating that the term ‘exothermic’ referred to the release of heat (energy) from a reaction. Further credit was awarded for stating that in an exothermic reaction the net energy released by bond formation was greater than that absorbed by bond breaking. A small number of the most able candidates did extremely well and were awarded full credit.

(d)

(i) This question was generally answered well, with candidates using a variety of ways to describe incomplete combustion as the cause of carbon monoxide.

(ii) Most candidates gained credit because they understood that air is taken into the engine and that the air contains nitrogen. Further credit was for a reference to the inert nature of nitrogen. The most common mistakes were to suggest that nitrogen is formed in the combustion reaction or that nitrogen enters the engine with the hydrocarbon fuel.

Question 6

(a) The great majority of candidates gained credit for identifying ‘sperm’ as an example of a cell. A minority were awarded further credit for knowing that the remaining structures were all organs. Candidates should be advised that in questions like this one it may not be necessary for all columns to be used.

(b) It was essential that candidates realised that this question concerned enzymes and the fact that it is enzyme activity that depends on temperature. Credit was awarded for a sensible reference to enzymes and further credit was available for explaining the effects of either too low or too high a temperature on enzyme activity.

(c)

(i) Candidates needed to limit their answers to a description of the relationship between age and mineral content as revealed by the graph. Candidates across the ability range included valid but irrelevant detail about the reasons for the relationship. The graph is not quite a straight line but candidates were allowed to describe it as linear or proportional, although the term 'directly proportional' was penalised, since it is expected that candidates at this level know that a graph of a directly proportional relationship would pass through the origin. Other descriptions such as 'steady increase' were allowed. Further credit was available for a supporting reference to the numerical data.

(ii) Most candidates recognised dairy products as a source of calcium and gained at least partial credit. Further credit was less commonly awarded and was for a reference to the increasing requirement for calcium in bone development in teenagers.

(iii) Most candidates gained credit for their answers. A wide variety of sources of vitamin C were suggested and accepted.

Question 7

(a)

(i) Gravity or weight was correctly suggested by the majority of candidates. The term 'downward force' was sometimes transferred from the question stem but this was not accepted.

(ii) Many candidates were awarded credit for a reference to an increase in the upward force when the parachute opens. Several acceptable ways of referring to the upward force such as 'air resistance', 'drag' or 'friction' were seen but statements referring only to an increase in surface area did not gain credit. Further credit was for recognising that the upward force must have become larger than the downward force and for stating that this would produce deceleration.

(b)

(i) Candidates usually placed the letter **Z** very clearly at the correct point on the graph. To be extra clear some candidates drew a labelling line.

(ii) The letter **S** needed to be positioned very clearly on the horizontal section of the graph well away from the corner near 50 seconds. Most candidates were awarded credit for this.

(iii) The great majority of candidates successfully obtained the correct answer.

Question 8

(a)

(i) It was expected that candidates would suggest the importance of controlling the temperature of the water or the surface area of the metals and further credit was gained by many candidates for stating that these variables influence the rate of reaction. A more detailed discussion of the effect on rate in terms of molecular motion or a more general statement referring to the idea that variable control ensures validity would have gained further credit. Many candidates were distracted by similar reactions involving dilute acid and suggested concentration as a variable which needed control. Others suggested that the volume of water needed to be controlled. This was accepted but only for partial credit. Other incorrect suggestions for the variable to be controlled included the terms 'mass of metal' and 'amount of metal'.

(ii) The most able candidates recognised the ion as hydroxide and could explain that the presence of this ion confers alkalinity or basicity on the solution. The most common incorrect suggestions of ions were calcium and hydrogen.

(iii) Candidates who were familiar with metal displacement reactions had no difficulty in knowing how to answer this question and usually wrote very clear, correct answers. Candidates need to gain experience of these types of displacement reactions.

(b) Only a minority of candidates could write a correct symbol equation for the oxidation of hydrogen. Many were distracted by the context in which the hydrogen was produced and attempted an equation for the reaction between calcium and water. Another incorrect suggestion seen was '$H_2 + O_2 \rightarrow H_2O_2$'.

Question 9

(a) Candidates had generally learned the parts of the flowering plant very well and most gained full credit.

(i) Most candidates identified 'petals' or 'nectar'.

(ii) Most candidates identified 'anthers' or 'stamen'. The most common incorrect response was stigma.

(b) Very few candidates were familiar with phrases to describe the shape of stigmas in insect or wind-pollinated flowers. Suitable descriptors for insect-pollinated stigmas included smooth, flat, rounded or disc shaped. Wind pollinated stigmas are best described as feathery. Candidates were much more successful in describing the position of stigmas and credit was frequently awarded. Some candidates simply wrote the two unqualified words 'inside' and 'outside' rather than 'inside *the petals*' or 'hanging outside *the flower*'.

(c)

(i) Candidates needed to show that they understood how sugars would be produced in parts of the plant where photosynthesis occurred and then transported in phloem to the flower. Many did know the role of phloem in transporting sugars but were the suggestion 'that sugars were transported in phloem from the root system'. Credit was gained if candidates remembered that the sugar is transported as sucrose. The question referred to sugars and other nutrients and so credit could be obtained for discussion of the transport of minerals via xylem.

(ii) In general candidates did well in this question. Any relevant energy-requiring process was acceptable here and correct responses included reference to 'respiration, for energy, to make nectar' and most biosynthetic processes.

Question 10

(a)

(i) Candidates had difficulty in showing the convection currents and several incorrect versions were seen. A very common incorrect response was to show warm air rising from one vertical edge of the heater and circling back down into the opposite vertical edge.

(ii) This part was answered far better than either **(i)** or **(b)**. Many candidates identified point **C** as the warmest and **A** as the coolest parts of the room, and were awarded credit. Further credit was for stating that warm air would rise and cool air would sink. The term 'heat rises' does not gain credit. For explaining the movement of air in terms of density differences candidates were awarded further credit. A significant number of candidates gained full credit.

(b) This question proved quite difficult for most candidates although many gained credit for describing concrete as an insulator. Candidates who did best with this question recognised that they needed to discuss the restriction of heat loss in terms of conduction, convection and radiation. They described concrete, and / or polystyrene and / or trapped gas as poor conductors (insulators), how the polystyrene restricted the free movement of trapped gas limiting heat loss by convection, and how aluminium would reflect radiant heat back into the house.

COMBINED SCIENCE

Paper 0653/04

Coursework

Key message

- Centres continue to show a good understanding of the skills required when undertaking coursework and have chosen tasks which allow candidates to demonstrate their ability.

(a) Nature of tasks set by Centres.

Of the Centres who submitted coursework for the June examination, most had provided coursework in previous years. All the tasks 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.

In all Centres the assessment criteria were understood and applied well for all of their activities. All produced Marking Schemes specific to the task given.

No Centre tried to assess both skill C1 and C4 in the same investigation.

(c) 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.

Tick lists remain popular, particularly with skill C1.

(d) Good practice.

Some Centres make very useful comments about individual candidate's performance on a summary sheet.

COMBINED SCIENCE

Paper 0653/51

Practical Test

Key message

- to ensure that candidates are awarded appropiately, the Supervisors results need to be as full and accurate as possible.

General comments

Candidates did not appear to run out of time to complete this paper and all parts of the three questions proved to be accessible. The inclusion of the Supervisor's results for all three questions helped with the marking and it was clear that the apparatus and chemicals for the examination had been well prepared in most Centres. It is worth noting that, as well as providing readings and observations, Supervisors are invited to plot any graphs and carry out any calculations using readings from the graph because there may be credit available for accuracy relating to the Supervisor's final answer; this was not the case in this paper.

Comments on specific questions

Question 1

Generally the question was well answered with most candidates performing well on **(a)**, **(b)**, **(c)(i)** and **(c)(ii)**. A number of candidates had clearly confused inhaled air and exhaled air in their answers. In **(c)(ii)** there were references to carbon dioxide instead of oxygen; these were simply ignored. Although there were several options for the award of credit in **(c)(iii)** very few candidates referred to respiration or to humans breathing out carbon dioxide.

Question 2

The Examiners relied on information provided by Supervisors, as the *length* of the elastic band was often given in **(a)** although the *width* had been asked for. Generally the experiment was carried out well and sensible results were obtained. The most common error in **(b)** was the increase in the length since the previous reading being calculated instead of the *total* increase in length. Graphs were well plotted with very few plotting errors. There were, however, several instances of non-linear scales and candidates using less than half of the graph paper area provided. Many candidates drew a line through their points before answering **(d)** and then used the shape of their line to answer **(d)**. Candidates were expected to state that the line should go through the origin because there is no increase in length when the mass is zero. If candidates wrongly predicted that the graph should not go through the origin, they were then given credit for drawing a line which did not go through the origin. Part **(f)** was well answered.

Question 3

Supervisors must take care to read the instructions carefully and provide the chemicals specified. The appearance of iron(III) ammonium sulfate changes if the crystals are crushed and this was allowed for when the Supervisor recorded the appearance of the crystals. Where iron(II) ammonium sulfate was provided instead of iron(III) ammonium sulfate, the Examiners were able to make an allowance, but this may not always be the case. Part **(b)(i)** was a 'dissolving test' and it is important for such tests that a small amount of material is tested to ensure that candidates do not move on to unnecessary solvents. The rest of the practical was quite well done and did not cause difficulties with observations.

Centres are reminded that candidates are expected to be made familiar with the practical tests leading to the identification of ions and gases as specified in the curriculum and the *Notes for Use in Qualitative Analysis* provided in each practical paper. This also provides information to help candidates spell the names of ions and write formulae correctly. For example, ammonia was not accepted as an alternative to ammonium.

COMBINED SCIENCE

Paper 0653/52

Practical Test

Key message

- to ensure that candidates are awarded appropiately, the Supervisors results need to be as full and accurate as possible.

General comments

Centres are to be congratulated on the setting up of the practical exercises in this paper. Supervisors' results, which are essential to ensure fair marking, were mostly helpful; they are reminded to plot any graphs and carry out any calculations using readings from the graph because credit may be available for accuracy relating to their final answer although this was not the case in this paper. Very good answers were seen and there were relatively few very weak answers. All three questions were accessible and there did not appear to be any time issues regarding the completion of the paper.

Comments on specific questions

Question 1

Parts **(a)(i)** and **(a)(ii)** were very well done with very few instances of inappropriate recording of results. A small number of candidates gave the energy content of the bread to more than three decimal places. Candidates seemed relatively unaware of the likely sources of error in this experiment although loss of heat and incomplete combustion were seen in answers. There was little confidence seen in the answers to **(a)(iv)**. The food test in **(b)** was well done. Descriptions of colours of solutions, not mixtures, were asked for, so *white* was not an acceptable part of any answer.

Question 2

Despite the complexity of the apparatus, candidates were able to produce very good sets of results. Some candidates did not follow the instructions which stated clearly that the 500 g mass should be moved 50 mm each time. A few candidates recorded the force as values which must have been mass rather than force. Graphs were well plotted with very few plotting errors. However there were a number of cases of non-linear axes and use of less than half of the graph paper area provided. Candidates were told to draw a straight line which would not pass through the origin. Despite this a significant number of candidates incorrectly drew curves or lines which passed through the origin. Extended lines which cut axes extended beyond the grid were accepted but values read in such circumstances were not accepted. Some candidates were able to work through the calculations in **(d)** a significant number of candidates could not calculate the mass correctly.

Question 3

The mixture of copper carbonate and aluminium sulfate gave obvious results for most of the tests. For the colours of the solid **X** and the residue in **(b)**, additional colour references were ignored. Consequently the colour of the solid **X** was very well answered but only about half of the candidates obtained a white residue; this may have been due to insufficient shaking. In **(c)**, the expected precipitates were usually seen but candidates did not always record this in an appropriate manner nor did they document the solubility of these precipitates. It is clear that the terms *soluble in excess* and *insoluble in excess* are not fully understood. Also it is important to add reagents slowly in order to observe precipitation before any precipitate dissolves. The naming of the two ions in the filtrate was done well. A significant number of candidates used chemical symbols when (chemical) names had been asked for. This practice should be discouraged as symbols can so easily be incorrect.

Centres are reminded that candidates are expected to be made familiar with the practical tests leading to the identification of ions and gases as specified in the curriculum and the *Notes for Use in Qualitative Analysis*

provided in each practical paper. This also provides information to help candidates spell the names of ions and write formulae correctly. For example, ammonia was not accepted as an alternative to ammonium.

COMBINED SCIENCE

Paper 0653/61

Alternative to Practical

Key message

Candidates who have carried out experiments themselves will have a greater understanding of the principals and practice of practical work in science. Ensuring that candidates have practical experience is therefore the key to improving the performance of candidates on this paper.

General comments

Questions 1, 2 and **3** are based on the corresponding experiments in the Practical examination paper 51, so that this paper is firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated their practical knowledge. Nevertheless, others showed poor appreciation of the principles and practice of science, especially in the chemistry questions. There were a number of completely blank spaces where candidates did not attempt the question.

Candidates appeared to have few problems in reading dials and scales and there was significant improvement in the drawing of graphs.

Candidates would benefit from experience in the correct use of decimal places. In the main, answers should be at least to the same number of decimal places as on the question paper, remembering there is a difference between 2 and 2.0. When truncating a long string of numbers after the decimal point correct rounding is expected, 2.47 should be correctly given as 2.5 to one decimal place and not 2.4.

Comments on specific questions

Question 1

(a) Despite being asked, in **(i),** to record the times in seconds a number of candidates did not do this and answered in minutes and seconds. In **(ii)** it was left to the candidates' judgement to say yes or no, providing they gave a suitable explanation. A good proportion of candidates gave a suitable comment in **(iv)** to explain the oxygen content of inhaled and exhaled air and the subsequent effect on the time the candle flame stayed alight.

(b) The vast majority realised that carbon dioxide was responsible for the difference in appearance and the more able candidates realised that respiration was responsible.

Question 2

(a) Most candidates were able to complete the table successfully, converting the mass to force and calculating the total increase in length. Although many candidates drew very good graphs, there were some missing or inaccurate labels. Some candidates did not use a ruler to draw the straight line and so could not receive credit for this. Candidates were asked, in **(iv)** to describe and explain the relationship between the applied force and the total increase in length. The values are proportional (one marking point) because it is a straight line graph (second marking point). Very few gained full credit here. Most were able to use the graph to predict the required value and most showed clearly how they did it. Examiners were expecting lines drawn on the graph from the *x*-axis to the line and then to the *y*-axis. Little dots on the axes or line were insufficient.

(b) Only the most able candidates correctly answered this part. A line vertical from the end of the graph to the *x*-axis was expected as the increase in length would be zero if the band broke. Many candidates showed the graph tailing off slowly to the *x*-axis, others started off vertically but then turned 90° and finished off parallel to but well above the axis.

Question 3

This question, again based upon the corresponding practical paper, was a collection of standard chemical analysis questions concerning an unknown solid containing a mixture of two cations and an anion. The Examiners noted that many candidates left parts of this question completely blank, and as chemical analysis questions often appear, it was unclear whether this was because candidates ran out of time or were unfamiliar with this type of experiment. A number of candidates who had learned these tests scored very highly.

(a) Litmus turning blue was known by many, but disappointingly was often the only credit scored in the entire question. Many gave the ion responsible for the gas as ammo**nia** rather than ammo**nium**.

(b)

(i) The answer, iron(III), was not well known.

(ii) A number of candidates appeared to be giving a test for chlorine gas. The negative test result was also required. Acidified silver nitrate solution that gave a white precipitate if chloride was present, and no change or no precipitate if not present, would have gained full credit.

(iii) The standard test for a sulfate was not well known.

(iv) Only a few candidates gave a valid reason for the addition of hydrochloric acid.

(c) A candidate that successfully answered all previous parts would identify the unknown as iron(III) ammonium sulfate.

Question 4

(a) Although the instructions clearly stated that the reading had to be taken from where the dough touched the side of the measuring cylinder, many candidates disregarded this and gave incorrect readings.

A number of candidates were unable to fill the table in correctly, sometimes giving negative increases in the volume of dough. This shows a lack of understanding of the question. This is an example of where candidates should check their answers to ensure that they are logical and 'make sense' given the context of the question.

(b) This should have been 40 °C, but error carried forward was applied and therefore partial credit could be gained.

(c) Many candidates gave the correct answer as a 'water-bath', although a large number gave 'thermometer' as their answer (probably misreading the question).

(d) The final part of this question was very poorly answered. The rate of reaction (of the enzyme) increased as the temperature increased from 20 °C to 30 °C, and activity (of the enzyme) decreased above 40 °C as the enzyme was denatured.

Question 5

(a)(b) The vast majority gained full credit here, although a few candidates misread the scales.

(c) Candidates were given the equation to calculate the density, but some used incorrect values from their tables. The main reason for credit not being awarded however was incorrect rounding of answers. Candidates using calculators often find themselves with a string of numbers after the decimal point, some then incorrectly forget to round up or down as necessary. For instance, a value of 8.87 expressed to one decimal place should be 8.9 rather than 8.8, and a value of 11.33 should not be given as 11.4.

(d) The table of densities given should have led candidates to the metals lead, gold and copper. Weaker candidates seemed to manipulate their answers in **(c)** to exactly match values in the table.

Question 6

(a) A number of candidates were confused by the upside-down nature of the readings. However the graph was often very well plotted. There were instances of not labelling the lines or of joining the points with very thick lines. A single, carefully drawn curve passing through as many points as possible gained credit. Manganese(IV) oxide was often identified as the best catalyst, and most noted that the graph showed more gas being given off or that the line was steeper. A number of candidates gave copper(II) oxide as the best catalyst for the opposite reason.

(b) Candidates had difficulty in finding a credible source of error in the experiment. The expected answer of spatula measurements being inaccurate was given by the more able candidates. Many vague answers such as 'timing errors', 'temperature variations' or 'being unable to read inverted cylinders' did not gain credit.

(c) Candidates had already been told that a catalyst is not used up in the reaction, so when asked how they could prove that the oxide is a catalyst some detail was required. A simple statement saying none was used up or it could be used again did not gain credit. The expected answer that 'The catalyst had to be retrieved, filtered, decanted etc. then washed and dried so that the mass could now be compared with the starting mass' gained credit. However valid alternatives of stated were given full credit.

COMBINED SCIENCE

Paper 0653/62

Alternative to Practical

Key message

Candidates who have carried out experiments themselves will have a greater understanding of the principals and practice of practical work in science. Ensuring that candidates have practical experience is therefore the key to improving the performance of candidates on this paper.

General comments

Questions 1, 3 and **6** are based on the corresponding experiments in the Practical examination, paper 52, so that this paper is firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated their practical knowledge. Nevertheless, others showed poor appreciation of the principles and practice of science, especially in the chemistry questions. There were a number of completely blank spaces where candidates did not attempt the question.

Candidates appeared to have few problems in reading dials and scales and there was significant improvement in the drawing of graphs.

Candidates would benefit from experience in the correct use of decimal places. In the main, answers should be at least to the same number of decimal places as on the question paper, remembering there is a difference between 2 and 2.0. When truncating a long string of numbers after the decimal point correct rounding is expected, 2.47 should be correctly given as 2.5 to one decimal place and not 2.4.

Some candidates seemed to be unaware of the difference between accuracy and reliability. Any number of repeats (and taking the average) will not improve the accuracy if there is an underlying fault in the procedure.

Comments on specific questions

Question 1

(a) The vast majority of candidates read the thermometers accurately. Given other necessary information candidates had to calculate the energy content of the bread and the majority were able to gain full credit.

(b) Only the more able candidates understood the principles behind the experiment, many thinking it was because only a small piece of bread was burned and not the whole slice or loaf. Another common misunderstanding was that the bread lost energy because it was burned. The expected answer that energy was lost to the air or to the glass of the test-tube was seen along with other valid comments that were creditworthy such as a long delay in placing the lit bread under the test-tube. Suggestions were then sought to increase the accuracy of the experiment, the expected answer was to apply some sort of wind-proof insulation so that most of the heat was directed at the test-tube and there were many ways of expressing this.

(c) About half the candidates thought the butter would reduce the total energy released, either because it insulated the bread and stopped it burning or because it absorbed the energy as it melted. The more able candidates stated that the energy output would be higher as fat contains more energy than carbohydrate.

Question 2

(a) This was well answered by the majority of candidates, with only the weakest misreading the scales. Any errors in this part of the question were taken into account in subsequent calculations.

(b) Examiners were expecting answers involving shielding the flame or moving the burner closer to the beaker. Many correct answers were seen. Answers suggesting 'using more fuel', 'burning the fuel for a longer time' and 'using a Bunsen burner', indicates some candidates did not understand the experiment.

(c) This was part well answered, as were most of the calculations on the paper.

(d) Many candidates suggested that it would give off too much heat or was flammable, or other standard properties of a fuel. Examiners were looking for reasons why we would not use it such as, too expensive, gives off too much smoke, too difficult to light etc.

Question 3

(a) Candidates were provided with two newton meters and asked to read the values, most did this correctly. The vast majority of candidates plotted good graphs, with well thought-out linear scales and accurate plotting. Lines of best fit, however, are sometimes drawn without a ruler or join every point in a jagged line which cannot be awarded credit.

(b) The calculations were well done by most candidates.

(c) The more able candidates gave the expected answer, use of a spirit level, or correctly described the process if they were unable to name it. Other candidates suggested measuring the height of each end to make sure the distance from the bench was the same. Weaker candidates suggested levelling it by eye or putting another newton meter at the other end.

Question 4

(a) When asked to measure from the paper candidates should note carefully what they are asked to measure and the units to use. The paper clearly expected answers in mm but a number of candidates gave answers in cm or answers ten times the expected.

(b) Due to incorrect measurements in **(a)**, some candidates had answers showing the actual fruit to be smaller than the photograph. It would be expected that candidates seeing this obvious contradiction should return to and check their previous measurements. It was expected that candidates should have used the equation provided to work out the decimal value of 'fraction of actual size', however many candidates gave an actual fraction (e.g. 55/120). Correct fractions were given full credit.

(c) Many candidates produced a valid working key based initially on the actual size of the fruit (greater or less than 100 mm) and then on the number or position of the seeds. Incorrect keys had information not given such as colour, taste, firmness etc. or used the fractions of actual size, many of these answers gained partial credit.

Question 5

(a) Most candidates were able to do this, although some had difficulty in calculating the total extension. This is an example where candidates should check their work; the extension should increase each time, if it goes up then down then up again candidates should realise that something is amiss.

(b) The graph, if plotted correctly, showed the first seven points in a perfect straight line with the final plot very obviously much higher. The graph clearly showed that it confirmed Hooke's law because it was a straight line between 0 N and 9 N but then the elastic limit had been reached, shown by the last point. However, many candidates were unable to accept this and just gave a statement that it did not follow Hooke's law as the last point was not in line. Candidates should be aware of the mark allocations given for each question, as a simple 'No' is unlikely to gain full credit in a three mark question.

(c) Weaker candidates stated that the spring had been 'stretched'. This was not credit-worthy as the spring had been stretched each time. The important point was that the spring had been stretched too much that it had passed the elastic limit.

Question 6

The final question, based upon the corresponding practical paper, was a collection of standard chemical analysis questions concerning an unknown solid containing a mixture of two compounds. The Examiners noted that many candidates left this question completely blank, and as chemical analysis questions often appear, it was unclear whether this was because candidates ran out of time or were unfamiliar with this type of experiment. A number of candidates who had learned these tests scored very highly.

(a) The best candidates gave the expected answer of a carbonate ion which gives off a gas that turns limewater milky. This type of question is frequently asked and is based on a standard chemical test; candidates should be made familiar with these tests before the examination. Zinc should have been identified as the cation which produces a white precipitate with aqueous sodium hydroxide, dissolving in excess. The range of answers suggests that many candidates need a greater familiarity with these tests as well as the difference between anions and cations.

(b) The effects of aqueous sodium hydroxide and ammonia on copper ions were not well known.

(c) The final chemical test, the barium chloride test to identify a solution containing sulfate ions, was poorly answered. Only a few candidates knew that dilute hydrochloric acid was added to dissolve any carbonate ions present.