COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

Comments on specific questions (Biology)

Question 1

Most candidates were able to identify the nucleus (as the part that contains DNA) in the diagram.

Question 4

Some candidates believed that photosynthesis occurs in the epidermis. However, the diagram shows that there are no chloroplasts in that layer.

Question 6

Candidates should take particular care when the word **not** appears in the question when selecting the most appropriate answer.

Question 9

Candidates need to consider all parts of the question before selecting their answer. Seeing the heartbeat rise at **A** in the lower graph led some to believe that this was when adrenaline was secreted. A closer look at the upper graph would have shown them that, not until **C** does the level of glucose in the blood also rises – the result of adrenaline secretion.

Question 12

Some of the less able candidates believe that 'a plant respires by photosynthesis'. This may have led some to indicate that plant respiration is a process that takes carbon dioxide out of the air.

Question 13

Candidates are aware that deforestation can lead to global warming or species extinction. With the majority of candidates opting for both, there is a sound understanding of the effects of this activity.

Comments on specific questions (Chemistry)

Question 16 proved straightforward with the majority of candidates selecting the correct option.

Question 17 was withdrawn.

Question 20 was difficult with only some of the candidates selecting the correct option.

Question 23 Many candidates incorrectly chose option **A**. The melting point of a metal may have a minor role but candidates who read the whole question realised that option **C** was correct.

Question 24 was difficult with only some of the candidates selecting the correct option.

Question 25 Candidates who incorrectly chose option **B** may have thought that the fourth diagram was water. It actually represents CO_2 with water being represented by the third diagram.

Comments on specific questions (Physics)

Question 28

The popularity of option **C** in this question indicated that a very large number of candidates had not realised that the diagram was a distance / time graph, not a speed / time graph.

Question 29

A large number of candidates incorrectly chose option **D**; this was a result of not taking into account that there were *two* pieces of cheese on the scales.

Question 31

Evaporation and its cooling effect were not well known by many candidates, with more choosing option **D** (evaporation causing a temperature rise) than the correct answer.

Question 32

A popular incorrect choice in this question on heat transfer was option **A**. These candidates did not realise that a lid of any type will reduce heat loss mainly by convection; the fact that the lid was plastic was irrelevant.

Question 35

Candidates incorrectly chose option **A** most often, this showing the ray being refracted in the wrong direction at both interfaces.

Question 36

Many candidates appeared to guess here, with a large proportion believing that visible light had the lowest frequency of any electromagnetic waves.

Question 37

This question concerned the relationship between frequency and pitch for a sound wave. Option **D** was very popular, this showing a small amplitude combined with the smallest period. Only a small number of candidates correctly chose the correct option **B**.

Question 38

Fewer than half the candidates could answer this question on current, voltage and resistance correctly, with all distractors working well.

Question 39

The situation was very similar here; there was much uncertainty about the choice and position of a fuse in a circuit.

Question 40

This question was very poorly answered by candidates, with only a few candidates correctly selecting option **A**. Candidates should be aware of the effect of connecting a switch in a position which would short-circuit a component when closed.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

Comments on specific questions (Biology)

Question 1

Most candidates were able to identify the nucleus (as the part that contains DNA) in the diagram.

Question 6

This question partly examined if plants respire only at night. Over a quarter of candidates answered this incorrectly.

Question 8

Although this proved an easy question for the majority of candidates, some answered that water vapour not only left, but entered a plant through the stomata.

Question 9

Candidates need to consider all parts of the question before selecting their answer. Seeing the heartbeat rise at **A** in the lower graph led them to believe that this was when adrenaline was secreted. A closer look at the upper graph would have shown them that, not until **C** does the level of glucose in the blood also rises – the result of adrenaline secretion.

Question 13

Candidates are aware that deforestation can lead to global warming or species extinction. With the majority of candidates opting for both, there is a sound understanding of the effects of this activity.

Comments on specific questions (Chemistry)

Question 14 proved straightforward with most candidates selecting the correct option.

Question 15 A significant number of candidates incorrectly chose option **C**. Candidates should be reminded to read all of the options before making their choice.

Question 18 proved straightforward with most candidates selecting the correct option.

Question 19 A number of candidates incorrectly chose option **B**. They may have mistaken the '2' in the second blank as a pH value and so said the substance was an acid.

Question 21 Candidates who incorrectly chose option **C** knew the two trends were opposites but chose the wrong alternative.

Question 23 Many candidates incorrectly chose option **A**. The melting point of a metal may have a minor role but candidates who read the whole question realised that option **C** was correct.

Question 24 was difficult with only some of the candidates selecting the correct option.

Question 25 Candidates who incorrectly chose option **B** may have thought that the fourth diagram was water. It actually represents CO_2 with water being represented by the third diagram.

Comments on specific questions (Physics)

Question 28

The popularity of option **C** in this question indicated that a very large number of candidates had not realised that the diagram was a distance / time graph, not a speed / time graph.

Question 29

A large number of candidates incorrectly chose option **D**; this was a result of not taking into account that there were *two* pieces of cheese on the scales.

Question 31

The cooling effect of evaporation was unfamiliar to many candidates, leading to the incorrect choice of option **B**.

Question 33

This question concerned wave terminology and a large proportion of candidates believed the crest-to-trough height to be the amplitude, leading to the incorrect choice of option **C**.

Question 35

Candidates incorrectly chose option **A** most often, this showing the ray being refracted in the wrong direction at both interfaces.

Question 36

Many candidates appeared to guess here, with a large proportion believing that visible light had the lowest frequency of any electromagnetic waves.

Question 37

A speed of sound calculation was required here. Almost half of the candidates managed this successfully. Candidates regularly forget that echo calculations involve a 'there-and-back-again'. In this example this necessitated a division of the distance by two; some candidates forgot to do this.

Question 38

Nearly half of candidates were correct in this simple electrical question.

Question 40

Lighting circuits were the topic here. Some candidates incorrectly chose option **B**, showing knowledge of how lamps are usually connected, but not an understanding of why this is the case.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

Comments on specific questions (Biology)

Question 1

Most candidates were able to identify the nucleus (as the part that contains DNA) in the diagram.

Question 6

This question partly examined if plants respire only at night. Over a quarter of candidates answered this incorrectly.

Question 8

Although this proved an easy question for the majority of candidates, some answered that water vapour not only left, but entered a plant through the stomata.

Question 9

Candidates need to consider all parts of the question before selecting their answer. Seeing the heartbeat rise at **A** in the lower graph led them to believe that this was when adrenaline was secreted. A closer look at the upper graph would have shown them that, not until **C** does the level of glucose in the blood also rises – the result of adrenaline secretion.

Question 13

Candidates are aware that deforestation can lead to global warming or species extinction. With the majority of candidates opting for both, there is a sound understanding of the effects of this activity.

Comments on specific questions (Chemistry)

Question 14 proved straightforward with most candidates selecting the correct option.

Question 15 A significant number of candidates incorrectly chose option **C**. Candidates should be reminded to read all of the options before making their choice.

Question 18 proved straightforward with most candidates selecting the correct option.

Question 19 A number of candidates incorrectly chose option **B**. They may have mistaken the '2' in the second blank as a pH value and so said the substance was an acid.

Question 21 Candidates who incorrectly chose option **C** knew the two trends were opposites but chose the wrong alternative.

Question 23 Many candidates incorrectly chose option **A**. The melting point of a metal may have a minor role but candidates who read the whole question realised that option **C** was correct.

Question 24 was difficult with only some of the candidates selecting the correct option.

Question 25 Candidates who incorrectly chose option **B** may have thought that the fourth diagram was water. It actually represents CO_2 with water being represented by the third diagram.

Comments on specific questions (Physics)

Question 28

The popularity of option **C** in this question indicated that a very large number of candidates had not realised that the diagram was a distance / time graph, not a speed / time graph.

Question 29

A large number of candidates incorrectly chose option **D**; this was a result of not taking into account that there were *two* pieces of cheese on the scales.

Question 31

The cooling effect of evaporation was unfamiliar to many candidates, leading to the incorrect choice of option **B**.

Question 33

This question concerned wave terminology and a large proportion of candidates believed the crest-to-trough height to be the amplitude, leading to the incorrect choice of option **C**.

Question 35

Candidates incorrectly chose option **A** most often, this showing the ray being refracted in the wrong direction at both interfaces.

Question 36

Many candidates appeared to guess here, with a large proportion believing that visible light had the lowest frequency of any electromagnetic waves.

Question 37

A speed of sound calculation was required here. Almost half of the candidates managed this successfully. Candidates regularly forget that echo calculations involve a 'there-and-back-again'. In this example this necessitated a division of the distance by two; some candidates forgot to do this.

Question 38

Nearly half of candidates were correct in this simple electrical question.

Question 40

Lighting circuits were the topic here. Some candidates incorrectly chose option **B**, showing knowledge of how lamps are usually connected, but not an understanding of why this is the case.

COMBINED SCIENCE

Paper 0653/21

Core Theory

Key message

Candidates are reminded to read the stem of the questions carefully and adjust their answers so that they are answering the question asked, making note of any exclusions and ensuring that they mention both items in questions which require a comparison between two things.

General comments

Some very good scripts were seen from candidates who had gained mastery of large areas of the syllabus and of examination techniques.

In the Physics calculations where a formula was requested, the majority of candidates attempted to do so and used appropriate words or symbols. Very few used the triangular memory aids, which are not accepted for credit.

Candidates should be advised to read the questions carefully and take note of phrases explaining which answers should NOT be given. **Questions 1(d)** and **2(b)(i)** included such phrases and any answers which infringed these instructions were not awarded credit.

In questions asking for a comparison between two things such as elements and compounds, candidates should take care to include information about both items in their answers. **Questions 2(b)(ii)**, **4(c)(i)** and **8(b)(i)** are examples of this situation.

It is recommended that this report and the published mark scheme are read together.

Comments on specific questions

Question 1

(a) This question was well answered across the whole ability range, with the majority working through to the correct answer. A few candidates inverted the formula, dividing time by distance.

(b) (i) This was a challenging question for many. In this type of question the response *potential energy* is not accepted because candidates needed to specify the form of potential energy in the context. The most common other error was to say that *heat energy* is stored in oil.

(ii) One of the more common reasons for not gaining credit was that candidates tended to describe to where the energy was transferred, such as 'into the air' without giving the form of energy involved.

(c) Mainly candidates correctly related this question to the expansion of metal with increasing temperatures. Other common non-science based answers were related to the ease of replacement of damaged tracks, or bends in the tracks.

(d) This was well answered by the best candidates. Some answers referred to 'pollution', 'less toxic gas', 'environmentally friendly' and other ideas which were not specific enough to be given credit. Many suggested that ethanol is a lower cost fuel but this was not accepted.

(e) (i) This question was very well answered. Very few candidates quoted 3 or lower.

(ii) This question was also very well answered, with most candidates scoring credit.

(iii) This question prompted a wide variety of answers. The best answers referred to the reliability of the wind. Answers that were based on subjective factors, such as the appearance of wind turbines, did not gain credit. References to the small amount of electricity generated also did not score credit, as no minimum requirement was stated.

Question 2

(a) (i) This was well answered question. The distinction in spelling between neutrons, nucleons and the correct answer, nucleus, was unclear in some scripts.

(ii) The majority stated the correct number of neutrons in the first part. Candidates needed to describe carefully how they obtained their answer in order to score full credit. The terms *nucleon number* and *proton number* were used correctly by many candidates.

(iii) This was quite well answered. The best answers gave the full name of the element; the question asked for the name, and so those answers simply giving the chemical symbol H did not score any credit.

(b) (i) The best answers referred to the properties of metals and non metals; many candidates demonstrated that they understood that in the Periodic Table, metals and non-metals are on opposite sides. However, the question asked for properties and the terms *metal* and *non-metal* are classifications rather than properties. Consequently statements that **X** is a metal and **Y** is a non-metal could not score any credit.

(ii) The best answers referred to the chemical properties of both **Y** and **Z**. Many candidates showed good knowledge of Group 0 elements, by stating that **Z** was a noble gas but made no similar reference to the properties of **Y**. The question asked for a difference, so the answer should have included reference to the reactivity of **Y**. Centres may wish to emphasise this point with candidates since questions requiring comparison are commonly set.

(c) (i) Many candidates answered this question very well by referring to a *reaction* or *bonding* between carbon and oxygen. The presence of calcium carbonate in the kiln proved to be a distraction for some other candidates, who tried to bring it into their answer.

(ii) This part of the syllabus seemed reasonably well known by many candidates. Answers such as 'helping the crops grow' were awarded credit if linked to an explanation of how this would have been achieved, for example, by reducing the soil's acidity. 'Increasing the fertility of the soil' was accepted, but not that the compounds are fertilisers.

Question 3

(a) A majority of candidates gained partial credit for *plant eater* in this question. However to gain full credit, the answer had to be more precisely defined as eating *only* plants, or *eating no meat*. This was not often seen.

(b) Very many candidates showed understanding of the need of marmots to eat a lot. However many limited the increase in food intake to the eating of fats. Candidates need to be aware that the eating to excess of most of the main food groups can lead to increased fat stores.

(c) (i) Almost all candidates correctly gave the main idea that increased body mass improved the chance of surviving the winter. Full credit was gained by discussing the graph shape in detail. The best answers referred to numerical data points taken from the graph; the very best answers referred to the levelling off of the line. An error made by some of the higher scoring candidates was to discuss conclusions about feeding, body fat and insulation and how these would benefit the marmots in cold weather. These would have been good answers but to different questions.

(ii) The best answers demonstrated an understanding of the insulating nature of the layer of fat. Many referred to the layer of fat as preventing the entry of cold (air), rather than stopping heat energy being conducted away from the body/organs. It was important that candidates used phrases very similar to "good insulator" or "poor conductor".

(d) A variety of correct answers was seen from candidates across the ability range. The expected responses of carbon dioxide, methane and water (vapour) occurred frequently.

(e) (i) Some answers did not gain credit because candidates did not appreciate that they needed to ignore the fine structure in the graph. Any answer that suggested that the general trend was an increase gained credit. Centres may wish to emphasise to candidates that credit allocation is a good clue to the detail expected in an answer.

(ii) The best answers explained the trend in terms of a shorter period in which marmots would lose weight, or a longer period in which they could eat and increase their weight. This was a challenging question for most candidates.

Question 4

(a) Candidates who realised that the question was asking for practical details correctly gave the two ideas of mixing the reactants and positioning the bung. The explanation of what measurements should be taken proved a problem for all but the high scoring candidates. Any sensible suggestion concerning what measurements to make was given credit.

(b) (i) This was quite well answered, although the name magnesium was not always qualified by the name of the property, size or mass, to be kept constant.

(ii) This was less well answered. The best answers referred to how the results would have changed and gave an explanation of the change, with a clear reference to increased reaction rate.

(c) (i) Centres are referred to the comments for **Question 2(b)(ii)** above. This question required a comparison; both the atom and the ion should have had a description. Many answers described either only the atom or the ion in sufficient detail.

(ii) Many candidates correctly used the information in the question to state the chemical formula of magnesium chloride. Candidates need to be reminded that questions like this are marked strictly, requiring that formulae be reproduced exactly. Thus, answers such as MGcl_2 will not gain credit.. The most commonly seen errors included MgCl, Mg2Cl and MgCl^2.

(iii) This was quite well answered; to get full credit, candidates needed to give the name, rather than the chemical symbol. A commonly-seen error was *water*.

Question 5

(a) (i) Generally only the high scoring candidates gave an acceptable answer. Many seemed unfamiliar with this aspect of Physics and did not attempt an answer. Many candidates who did, gave a single frequency, rather than a range.

(ii) In defining both frequency and wavelength, it was clear that some candidates had learned formal definitions. The best explanations of frequency correctly referred to the number of waves either generated or passing a point and also specified the time period (one second). A common error, shown on a wave diagram, was to explain amplitude rather than frequency. In defining wavelength many candidates drew an appropriately labelled diagram, to be awarded credit. Common errors included stating that wavelength is the 'length of a wave', being unclear that peak to peak (or trough to trough) distances must refer to consecutive waves, showing only a half-wavelength on a diagram, and confusing wavelength and amplitude.

(b) (i) Many candidates understood the need for a medium

(ii) Many answers described how well or how clearly the girl would hear the second sound, rather than the change in the sound heard. The required answer needed to refer to the volume of the sound.

(iii) In general, candidates appeared to be unfamiliar with the fact that mobile phones communicate via microwaves. Commonly-seen incorrect answers included infrared and radio waves.

(c) Candidates need to be aware that the incident and refracted angles are measured between the ray and the normal. Many candidates ignored the normals and selected the angles between the edges of the glass and the rays for their answer.

Question 6

(a) Most of those who attempted this question correctly labelled a root hair cell.

(b) Most candidates gained partial credit with the answer *water*. Many candidates gave the answer *nutrients* which was not specific enough, and which general description includes substances that root hair cells would not absorb. A number of answers gave a variety of named ions, which were accepted. *Minerals* was the most common answer in addition to *water* that gained further credit.

(c) (i) The better candidates correctly gave the answer *xylem*.

(ii) Candidates needed to indicate the central area of the figure clearly, to gain credit.

(d) (i) This question was answered very well across the ability range. Candidates had the most problems with differentiating between cell walls and membranes. A few candidates lost credit by not following instructions; they chose to leave some of the boxes empty rather than write a cross as the question specified.

(ii) This question discriminated well. The best answers referred to the location of a plant cell.

Question 7

(a) (i) Many candidates made a good effort to draw clear, well-constructed circuits. Candidates should realise that in a question like this, all of the circuit symbols should be included.

(ii) Correct answers referred to changing the current through the lamp and, rarely, to the voltage across the lamp. A commonly-seen incorrect answer was the idea that the variable resistor would be used to measure either current or voltage. Answers suggesting ‘so that the investigation can be done’ were not specific enough to be awarded credit.

(b) (i) This was quite well answered. The most commonly-seen errors were the suggestions of *anode* and *cathode* as the names of the types of charge, or answers giving the names of charged particles.

(ii) The best candidates realised that the charged particles transferred between the rod and cloth are the electrons found on the outside of atoms.

(iii) While this question was very well answered across the ability range, the most common error was to give the name of a fabric such as wool. Candidates need to realise that, in the scientific context, the word *material* is a mass noun which denotes a physical substance, and thus has a wider meaning than that of simply a cloth of woven fabric. The question asked for the name of a conductor and so the chemical symbol of a metal was not given credit.

Question 8

(a) (i) Candidates need to be aware of the percentage composition of clean air.

(ii) This was quite well answered. A wide range of answers gained credit, including any of the noble/rare gases. Candidates wisely avoided suggesting pollutant gases. A frequently-seen answer which could not be awarded credit was hydrogen.

(b) (i) Candidates need to be able to describe the difference between elements and compounds. Many candidates found this question challenging. In common with answers seen to other questions, candidates may have given a good explanation for either the elements or the compounds, but then did not go on to give a full explanation of the other one of the pair.

(ii) Many named the bond type correctly and scored partial credit. Higher scoring candidates then went on to give an acceptable explanation.

(iii) The best answers compared the pH values in the table, related these to the change of acidity in the answers, and then explained the change in acidity to the presence of nitrogen oxide in the sample of rainwater collected in a thunderstorm. Many candidates could generally score at least partial credit for their answers.

Question 9

(a) This was a well answered question. The majority of candidates showed good knowledge of the characteristics. One of the more frequent errors was to list the senses. Candidates should take note that *breathing* is not an alternative answer for *respiration*, nor is *eating* an alternative for *nutrition.*

(b) (i) Those who answered this question generally gave the correct answer.

(ii) The best answers gave information relating to the heart beating faster or the blood flowing faster to the muscles. This proved to be a challenging question for many candidates. Common errors included references to sweating and the causes of increased adrenaline secretion.

(c) This was well answered. It showed that the majority had a good understanding of blood as a carrier around the body.

COMBINED SCIENCE

Paper 0653/22

Core Theory

Key message

Candidates are reminded to read the stem of the questions carefully and adjust their answers so that they are answering the question asked, making note of any exclusions and ensuring that they mention both items in questions which require a comparison between two things.

General comments

The examination produced a wide range of awarded credit. Some very good scripts were seen from candidates who had mastered many of the aspects of the syllabus and examination techniques.

There was no evidence that candidates had difficulty in completion of the paper in the available time. In only a few cases, was there evidence of candidates wasting time on unnecessarily extended writing. In the Physics questions, it was good to see that almost all candidates who used a formula for calculations wrote the formula down first.

It is recommended that this report and the published Mark Scheme are read together.

Comments on specific questions

Question 1

(a) (i) The best candidates gained credit by giving both galena and argentite as examples of binary compounds; many candidates correctly gave at least one correct ore.

(ii) Candidates found this question more challenging. Candidates should be familiar with the periodic table and able to use it to look up the details of an unfamiliar element such as Tungsten.

(b) This question was well answered, with a few candidates incorrectly using the terms nucleus or nucleon in place of neutron.

(c) (i) Most candidates gained credit for stating that there would be a temperature rise and/or fizzing. The question asked for observations and so hydrogen on its own did not gain credit. Candidates who referred to the appearance of hydrogen gas did gain credit.

(ii) Many candidates stated that potassium is more reactive, and they would have gained credit if they had suggested an observation which shows this. The occurrence of a lilac flame was rarely given.

(iii) The best answers to this question gave the names of the products of the reaction, rather than chemical symbols representing the products. Centres should emphasise to candidates that word equations must be completed using the names of substances. A common error was to suggest that potassium oxide would be produced.

Question 2

(a) This was very well answered; almost all candidates achieved credit. The lines were well drawn, using rulers. In most cases, suitable scales were chosen such that the speed/time graph covered the whole of the grid. Candidates failed to gain credit if one or both of their scales occupied less than 50% of the available grid space.

(b) (i) This proved a challenging question, but the context is familiar and the majority of candidates made sensible attempts to explain what happened. Many used the term *evaporation* in their answers; an explanation of evaporation gained partial credit. Some answers referred to heat from the Sun causing the evaporation. In the context of this question, this could not be awarded credit.

(ii) Many candidates gained partial credit for temperature, although some suggested *weather*, which was too imprecise. Very few gave humidity.

Question 3

(a) The best answers correctly described respiration in terms of energy release from nutrients. A very common mistake, often seen when questions about respiration are asked, is that candidates describe the process of breathing. It was important that candidates did **not** write that energy was created or produced by respiration.

(b) This was quite well answered and most gained at least minimal credit, usually for nitrogen.

(c) Many candidates gave details of how the oxygen arrived into the blood. Of those who referred to red blood cells, a minority went further to discuss the involvement of haemoglobin. Credit was not given simply for reference to blood cells.

(d) (i) Many referred to the causes of adrenaline secretion, which was required in answer to the following part. Where candidates had made this error, there was no evidence that they had thought to return from answering part **(ii)**, to reconsider their answer. Centres may wish to ensure that candidates know that this is allowed.

(ii) There was a wide variety of acceptable answers.

(iii) This was quite well answered across the whole ability range. The most common error was kidney.

Question 4

(a) The best answers referred to both sound and radio waves, or made a comparison such as 'radio waves travel faster'. Many candidates gave partial or incomplete answers.

(b) This was very well answered. A few incorrect answers referred to microwaves and infra-red.

(c) (i) This was very well answered. The relationship between speed, distance and time had been very well learned and a majority of candidates worked through to the correct answer.

(ii) This was not well answered. Of those who showed some familiarity with the audible range, many suggested 2000 Hz for the upper limit.

(iii) Many candidates scored credit, working through to the correct answer. The use of the term *weight* was penalised if used in the formula.

Question 5

(a) There was a variety of acceptable answers to this question. Far more candidates than in previous years correctly referred to harmful bacteria or microorganisms rather than germs.

(b) Candidates need to be able to discuss the difference between a compound and a mixture. Some candidates gave answers containing excellent descriptions of a compound, but were too brief or confused when trying to contrast this with a mixture. A common difficulty that candidates have in dealing with this question is shown in answers such as 'in compounds the elements are bonded but in a mixture they are not bonded'. Some candidates suggested differences in physical state even though the question showed that this would not gain any credit.

(c) (i) Candidates who made a simple reference to heating and evaporation to leave crystals scored full credit. Other candidates struggled to construct an answer more complex than required by the question.

(ii) This question proved to be very challenging for the whole ability range. Many who had worked out that hexane is a liquid did not then continue to describe how it would behave in a filter paper. Others gave the insolubility of hexane as the reason why hexane could be separated from water by filtration.

(d) (i) Only higher scoring candidates gained credit. Many others referred to magnesium atoms in their answers. A few compared the number of electrons in an atom and an ion and this generalised answer was not sufficient.

(ii) Candidates needed to deduce that the magnesium oxide must have reacted with the water, to produce an alkaline solution. Many candidates found this challenging. Of those who deduced that the magnesium oxide must have reacted with the water, some mentioned that the pH was affected but did not refer clearly to the alkalinity of the resulting solution.

Question 6

(a) (i) Most candidates were awarded some credit here. In many cases, candidates gave 'increasing speed' and 'decreasing speed' as two effects of a force. Responses like this were awarded partial credit. Another common error was the description of a force, e.g. push, rather than the effect of the force.

(ii) This was a well answered question across the ability range. Candidates needed to state the word newton. The symbol N alone did not score. The most common mistake was the answer Joules or J.

(b) Approximately half of the entry correctly stated **B** was the greater force and many went on to gain credit by giving a relevant reference to the deceleration of the car. A common misconception was that force **F** must be greater because the car is still travelling in a forward direction.

(c) This was extremely well answered by the great majority of candidates. The greatest confusion was between the words *boiled* and *burned*. Many candidates incorrectly gave *nuclear* in the 4th position (after 'wasted as'). This may be because candidates associate the word *nuclear* with the word *waste*. Candidates should be reminded to look carefully at context.

(d) This proved to be a challenging question for most candidates. Those who gained full credit were able to discuss the presence of the two gases in terms of the complete combustion of the hydrocarbon fuel.

Question 7

(a) This was quite well answered. Most candidates realised that the presence of the trees reduced the sand temperature; the best answers specified that the trees offer shade to the sand. A few very good candidates gave evidence of the temperature difference from the data.

(b) This was quite well answered. The best answers explained both sets of data rather than just one. Candidates needed to refer to temperature in order to account for the differences between the numbers of male and female offspring. Many candidates simply restated the data shown in the table; candidates need to add something to the data given in questions such as these to be awarded credit.

(c) Candidates needed to make the connection between higher sand temperatures caused by deforestation and the consequent imbalance between males and females. Credit was also available for any sensible suggestion of the negative impact of the male/female imbalance on future breeding. This question proved more challenging than **(b)**.

(d) This was a generally well answered question and many excellent discussions were given which showed candidates' knowledge of environmental issues. Some candidates discussed extinction of species, even though the question showed that no credit was available for this.

Question 8

(a) (i) A minority of candidates recognised potassium hydroxide as an alkali. Many suggested Experiment 1, possibly assuming that if a substance reacts with an acid it must therefore be an alkali. Candidates need to be aware of the characteristic reactions of acids.

(ii) The best candidates were familiar with the term endothermic. Of those who identified the correct reaction, many gave reasons such as 'lower temperature' or 'temperature is only 16' without specifying which temperatures were being referred to. The very best answers referred to a 'decrease in temperature'.

(iii) This was quite well answered; candidates needed to refer to the lack of any reaction or discuss the relative reactivities of copper and magnesium.

(b) Candidates were generally able to apply their knowledge of factors affecting reaction rate to this context. Many gained partial credit for referring to the higher surface area of powdered zinc and remaining credit for stating that the rate of reaction would therefore be higher. Although an answer based on collision theory is not expected from core candidates, any correct discussions of this type were credited.

Question 9

(a) This was generally well answered; those who gained only partial credit correctly introduced the term *catalyst*, but then went on to describe the effect of a catalyst, rather than describing the protein nature and the biological action of an enzyme.

(b) Many candidates were challenged by the interpretation of the graph. Many referred to the increase/decrease in activity as a result of pH change, with no reference to the complete inactivity of the enzyme below pH 4 or above pH 9. Candidates needed to identify the pH of maximum activity as 6.5, although those who specified maximum activity 'in the range 6 to 7' were credited.

(c) (i) Some candidates did not attempt this question. It was important that the line started and finished at zero activity and rose to a maximum at pH 4 or below.

(ii) Many candidates found this question challenging. Partial credit was awarded for a reference to the alkalinity or basicity of sodium hydrogencarbonate or its neutralising effect in pancreatic juice. The remaining credit was for a sensible statement involving the idea that the new pH would not now allow the enzyme to function.

(d) Only higher scoring candidates related digestion to absorption in the gut. Although the question encouraged candidates to think in terms of what happens to molecules, many answers referred to the breaking down of food particles for easier swallowing.

COMBINED SCIENCE

Paper 0653/23

Core Theory

Key message

Candidates are reminded to read the stem of the questions carefully and adjust their answers so that they are answering the question asked, making note of any exclusions and ensuring that they mention both items in questions which require a comparison between two things.

General comments

Some very good scripts were seen from candidates who had gained mastery of large areas of the syllabus and of examination techniques.

In the Physics calculations where a formula was requested, the majority of candidates attempted to do so and used appropriate words or symbols. Very few used the triangular memory aids, which are not accepted for credit.

Candidates should be advised to read the questions carefully and take note of phrases explaining which answers should NOT be given. **Questions 1(d)** and **2(b)(i)** included such phrases and any answers which infringed these instructions were not awarded credit.

In questions asking for a comparison between two things such as elements and compounds, candidates should take care to include information about both items in their answers. **Questions 2(b)(ii)**, **4(c)(i)** and **8(b)(i)** are examples of this situation.

It is recommended that this report and the published mark scheme are read together.

Comments on specific questions

Question 1

(a) This question was well answered across the whole ability range, with the majority working through to the correct answer. A few candidates inverted the formula, dividing time by distance.

(b) (i) This was a challenging question for many. In this type of question the response *potential energy* is not accepted because candidates needed to specify the form of potential energy in the context. The most common other error was to say that *heat energy* is stored in oil.

(ii) One of the more common reasons for not gaining credit was that candidates tended to describe to where the energy was transferred, such as 'into the air' without giving the form of energy involved.

(c) Mainly candidates correctly related this question to the expansion of metal with increasing temperatures. Other common non-science based answers were related to the ease of replacement of damaged tracks, or bends in the tracks.

(d) This was well answered by the best candidates. Some answers referred to 'pollution', 'less toxic gas', 'environmentally friendly' and other ideas which were not specific enough to be given credit. Many suggested that ethanol is a lower cost fuel but this was not accepted.

(e) (i) This question was very well answered. Very few candidates quoted 3 or lower.

(ii) This question was also very well answered, with most candidates scoring credit.

(iii) This question prompted a wide variety of answers. The best answers referred to the reliability of the wind. Answers that were based on subjective factors, such as the appearance of wind turbines, did not gain credit. References to the small amount of electricity generated also did not score credit, as no minimum requirement was stated.

Question 2

(a) (i) This was well answered question. The distinction in spelling between neutrons, nucleons and the correct answer, nucleus, was unclear in some scripts.

(ii) The majority stated the correct number of neutrons in the first part. Candidates needed to describe carefully how they obtained their answer in order to score full credit. The terms *nucleon number* and *proton number* were used correctly by many candidates.

(iii) This was quite well answered. The best answers gave the full name of the element; the question asked for the name, and so those answers simply giving the chemical symbol H did not score any credit.

(b) (i) The best answers referred to the properties of metals and non metals; many candidates demonstrated that they understood that in the Periodic Table, metals and non-metals are on opposite sides. However, the question asked for properties and the terms *metal* and *non-metal* are classifications rather than properties. Consequently statements that **X** is a metal and **Y** is a non-metal could not score any credit.

(ii) The best answers referred to the chemical properties of both **Y** and **Z**. Many candidates showed good knowledge of Group 0 elements, by stating that **Z** was a noble gas but made no similar reference to the properties of **Y**. The question asked for a difference, so the answer should have included reference to the reactivity of **Y**. Centres may wish to emphasise this point with candidates since questions requiring comparison are commonly set.

(c) (i) Many candidates answered this question very well by referring to a *reaction* or *bonding* between carbon and oxygen. The presence of calcium carbonate in the kiln proved to be a distraction for some other candidates, who tried to bring it into their answer.

(ii) This part of the syllabus seemed reasonably well known by many candidates. Answers such as 'helping the crops grow' were awarded credit if linked to an explanation of how this would have been achieved, for example, by reducing the soil's acidity. 'Increasing the fertility of the soil' was accepted, but not that the compounds are fertilisers.

Question 3

(a) A majority of candidates gained partial credit for *plant eater* in this question. However to gain full credit, the answer had to be more precisely defined as eating *only* plants, or *eating no meat*. This was not often seen.

(b) Very many candidates showed understanding of the need of marmots to eat a lot. However many limited the increase in food intake to the eating of fats. Candidates need to be aware that the eating to excess of most of the main food groups can lead to increased fat stores.

(c) (i) Almost all candidates correctly gave the main idea that increased body mass improved the chance of surviving the winter. Full credit was gained by discussing the graph shape in detail. The best answers referred to numerical data points taken from the graph; the very best answers referred to the levelling off of the line. An error made by some of the higher scoring candidates was to discuss conclusions about feeding, body fat and insulation and how these would benefit the marmots in cold weather. These would have been good answers but to different questions.

(ii) The best answers demonstrated an understanding of the insulating nature of the layer of fat. Many referred to the layer of fat as preventing the entry of cold (air), rather than stopping heat energy being conducted away from the body/organs. It was important that candidates used phrases very similar to "good insulator" or "poor conductor".

(d) A variety of correct answers was seen from candidates across the ability range. The expected responses of carbon dioxide, methane and water (vapour) occurred frequently.

(e) (i) Some answers did not gain credit because candidates did not appreciate that they needed to ignore the fine structure in the graph. Any answer that suggested that the general trend was an increase gained credit. Centres may wish to emphasise to candidates that credit allocation is a good clue to the detail expected in an answer.

(ii) The best answers explained the trend in terms of a shorter period in which marmots would lose weight, or a longer period in which they could eat and increase their weight. This was a challenging question for most candidates.

Question 4

(a) Candidates who realised that the question was asking for practical details correctly gave the two ideas of mixing the reactants and positioning the bung. The explanation of what measurements should be taken proved a problem for all but the high scoring candidates. Any sensible suggestion concerning what measurements to make was given credit.

(b) (i) This was quite well answered, although the name magnesium was not always qualified by the name of the property, size or mass, to be kept constant.

(ii) This was less well answered. The best answers referred to how the results would have changed and gave an explanation of the change, with a clear reference to increased reaction rate.

(c) (i) Centres are referred to the comments for **Question 2(b)(ii)** above. This question required a comparison; both the atom and the ion should have had a description. Many answers described either only the atom or the ion in sufficient detail.

(ii) Many candidates correctly used the information in the question to state the chemical formula of magnesium chloride. Candidates need to be reminded that questions like this are marked strictly, requiring that formulae be reproduced exactly. Thus, answers such as MGcl_2 will not gain credit.. The most commonly seen errors included MgCl, Mg2Cl and MgCl^2.

(iii) This was quite well answered; to get full credit, candidates needed to give the name, rather than the chemical symbol. A commonly-seen error was *water*.

Question 5

(a) (i) Generally only the high scoring candidates gave an acceptable answer. Many seemed unfamiliar with this aspect of Physics and did not attempt an answer. Many candidates who did, gave a single frequency, rather than a range.

(ii) In defining both frequency and wavelength, it was clear that some candidates had learned formal definitions. The best explanations of frequency correctly referred to the number of waves either generated or passing a point and also specified the time period (one second). A common error, shown on a wave diagram, was to explain amplitude rather than frequency. In defining wavelength many candidates drew an appropriately labelled diagram, to be awarded credit. Common errors included stating that wavelength is the 'length of a wave', being unclear that peak to peak (or trough to trough) distances must refer to consecutive waves, showing only a half-wavelength on a diagram, and confusing wavelength and amplitude.

(b) (i) Many candidates understood the need for a medium

(ii) Many answers described how well or how clearly the girl would hear the second sound, rather than the change in the sound heard. The required answer needed to refer to the volume of the sound.

(iii) In general, candidates appeared to be unfamiliar with the fact that mobile phones communicate via microwaves. Commonly-seen incorrect answers included infrared and radio waves.

(c) Candidates need to be aware that the incident and refracted angles are measured between the ray and the normal. Many candidates ignored the normals and selected the angles between the edges of the glass and the rays for their answer.

Question 6

(a) Most of those who attempted this question correctly labelled a root hair cell.

(b) Most candidates gained partial credit with the answer *water*. Many candidates gave the answer *nutrients* which was not specific enough, and which general description includes substances that root hair cells would not absorb. A number of answers gave a variety of named ions, which were accepted. *Minerals* was the most common answer in addition to *water* that gained further credit.

(c) (i) The better candidates correctly gave the answer *xylem*.

(ii) Candidates needed to indicate the central area of the figure clearly, to gain credit.

(d) (i) This question was answered very well across the ability range. Candidates had the most problems with differentiating between cell walls and membranes. A few candidates lost credit by not following instructions; they chose to leave some of the boxes empty rather than write a cross as the question specified.

(ii) This question discriminated well. The best answers referred to the location of a plant cell.

Question 7

(a) (i) Many candidates made a good effort to draw clear, well-constructed circuits. Candidates should realise that in a question like this, all of the circuit symbols should be included.

(ii) Correct answers referred to changing the current through the lamp and, rarely, to the voltage across the lamp. A commonly-seen incorrect answer was the idea that the variable resistor would be used to measure either current or voltage. Answers suggesting ‘so that the investigation can be done’ were not specific enough to be awarded credit.

(b) (i) This was quite well answered. The most commonly-seen errors were the suggestions of *anode* and *cathode* as the names of the types of charge, or answers giving the names of charged particles.

(ii) The best candidates realised that the charged particles transferred between the rod and cloth are the electrons found on the outside of atoms.

(iii) While this question was very well answered across the ability range, the most common error was to give the name of a fabric such as wool. Candidates need to realise that, in the scientific context, the word *material* is a mass noun which denotes a physical substance, and thus has a wider meaning than that of simply a cloth of woven fabric. The question asked for the name of a conductor and so the chemical symbol of a metal was not given credit.

Question 8

(a) (i) Candidates need to be aware of the percentage composition of clean air.

(ii) This was quite well answered. A wide range of answers gained credit, including any of the noble/rare gases. Candidates wisely avoided suggesting pollutant gases. A frequently-seen answer which could not be awarded credit was hydrogen.

(b) (i) Candidates need to be able to describe the difference between elements and compounds. Many candidates found this question challenging. In common with answers seen to other questions, candidates may have given a good explanation for either the elements or the compounds, but then did not go on to give a full explanation of the other one of the pair.

(ii) Many named the bond type correctly and scored partial credit. Higher scoring candidates then went on to give an acceptable explanation.

(iii) The best answers compared the pH values in the table, related these to the change of acidity in the answers, and then explained the change in acidity to the presence of nitrogen oxide in the sample of rainwater collected in a thunderstorm. Many candidates could generally score at least partial credit for their answers.

Question 9

(a) This was a well answered question. The majority of candidates showed good knowledge of the characteristics. One of the more frequent errors was to list the senses. Candidates should take note that *breathing* is not an alternative answer for *respiration*, nor is *eating* an alternative for *nutrition.*

(b) (i) Those who answered this question generally gave the correct answer.

(ii) The best answers gave information relating to the heart beating faster or the blood flowing faster to the muscles. This proved to be a challenging question for many candidates. Common errors included references to sweating and the causes of increased adrenaline secretion.

(c) This was well answered. It showed that the majority had a good understanding of blood as a carrier around the body.

COMBINED SCIENCE

Paper 0653/31

Extended Theory

Key Messages

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 usually wrote answers of appropriate length although Centres should continue to stress to candidates that they should take note of the amount of credit and the space allocated for answers as a guide to length and detail required.

Many candidates included good diagrams to support their written answers. This can very often increase a candidate's score, and is to be encouraged.

General comments

Candidates' responses generally showed the correct units for physics calculations. Care should be taken to use the correct symbols in formulae of physics calculations.

A few candidates wrote a balanced symbol equation. Even if this is perfectly correct it does not usually gain full credit when a word equation has been requested. Centres may wish to emphasise this aspect of examination technique with candidates.

When answering questions requiring use of information from a graph, candidates should be reminded that credit is given when using the numbers or numerical deductions correctly.

Candidates should avoid using unscientific phrases.

Comments on specific questions

Question 1

(a) (i) Candidates usually realised that the combined mass of the train and its load had to be calculated first. Many candidates then went on successfully to work through to the answer. Even among the higher scoring candidates it was often the case that a correct formula would be followed by arithmetical errors. Although a variety of incorrect responses were seen, a common one was to calculate the product of mass and speed.

(ii) Most candidates recalled the correct formula. Many of these candidates then were able to work through to the answer. Of those candidates who were familiar with this type of calculation, by far the most common mistake they made was to express the distance travelled in kilometres rather than metres.

(iii) Candidates generally were less familiar with the formula relating power to work and time. Of those candidates who did recall the correct formula, the most common mistake was to express the time in minutes rather than seconds.

(b) This piece of applied Physics was familiar to candidates across the ability range. Some candidates suggested reasons for the gaps between rails that were not related to temperature increases. Other candidates made imprecise comments such as 'the length can change if the temperature changes'; this was not creditworthy as the answers needed to discuss expansion at higher temperatures. Some candidates spent some time producing excellent particle explanations of expansion without including any reference to the advantage of leaving the gaps between the rails.

Question 2

(a) This was familiar to large numbers of candidates from across the ability range. Candidates had to write the full name, hydrogen, and most did. Those who gave only the chemical symbol, H, did not gain credit.

(b) (i) Many candidates answered this question very well, and were able to relate the number of outer shell electrons in an atom to the group number of the element. Candidates should be advised to refer to Group 0 rather than Group 8. A minority of candidates gave the names of the elements rather than group number and were unable to gain credit.

(ii) This was answered very well by many candidates. The characteristics of Group 0 elements were very familiar, and a variety of appropriate explanations were seen and were creditworthy.

(iii) This was well answered, and most candidates recognised element **P** and stated that it was a metal. A minority of candidates seemed to be attempting to describe metallic bonding which is not required by this syllabus; unless this was described correctly, credit could not be given.

(c)(i) Some candidates were unfamiliar with the addition of limestone (calcium carbonate) to the blast furnace to remove impurities. A very wide variety of substances and reasons for their addition were suggested.

(ii) In comparison with part **(i)**, candidates seemed more familiar with the redox equation to extract iron from iron oxide, but the award of full credit for both reactants and products, was rarely given. Large numbers stated that the reactants would be 'iron oxide and carbon oxide', which was not accepted. Many gained partial credit for correct products. A minority missed the reference in the question to 'a gaseous oxide of carbon', and wrote 'carbon' as one of the reactants. A few candidates attempted to write a balanced symbol equation. Even if this is perfectly correct it does not usually gain full credit when a **word** equation has been requested.

(d)(i) The guidance given in the question helped many candidates to answer this question properly, and many gained some credit for stating the correct relative reactivities of aluminium and carbon. Further credit was often gained by a suitable reference to the reaction which cannot therefore take place.

(ii) Large numbers of candidates from across the ability range could recall that aluminium is extracted using electrolysis. The question requests a process rather than a type of reaction, and so answers referring to redox were not accepted in this case.

Question 3

(a) There were a number of points that candidates could make in answering this question. Most candidates gained credit for the idea that the marmots needed to eat a lot of food. Many candidates thought that the consumption of exclusively fats was required but were not penalised provided they had specified that a large quantity of food had to be consumed. Further credit was awarded if it was clear that the marmots needed to take in more energy (in the form of nutrition) than they used. The idea that any food type in excess would be converted to fat, was rarely seen.

(b)(i) Partial credit was gained for describing the graph. Only a few candidates gained further credit by extracting at least two data points from the graph to support the general description that survival chances increased with body mass, or giving a discussion of the curved shape of the graph.

(ii) To gain credit, candidates had to discuss the fat layer either as a poor conductor (of heat) or as a good insulator. As is often seen in answers to questions on this general topic, many candidates wrote that the fat layer 'prevents the entry of the cold from the environment or that the fat traps heat' which were not creditworthy. The suggestion that the marmot would metabolise the fat and release heat energy, was also not creditworthy.

(c) Candidates generally showed good awareness of factors thought to be contributing to global warming, and large numbers gained most of the available credit. Very many discussed deforestation and the increase in carbon dioxide levels due to reduced photosynthesis. Candidates wisely answered this question in terms of *carbon dioxide* and not *carbon*. A minority of candidates also referred to methane and its sources.

(d) (i) Most candidates understood the term *general trend* and were not distracted by the fine structure in the graph.

(ii) Credit was usually awarded for this part. Most candidates realised that the shorter period of hibernation would leave the marmots with excess fat.

Question 4

(a) Candidates tended either to be very familiar with what this question was testing or completely unfamiliar with it. This question was challenging in that two relevant variables were required in order to gain credit. Temperature and surface area of magnesium were the two variables that were expected. As the diagram clearly showed magnesium in ribbon form, mass, length and size of magnesium were also accepted; the terms *amount* or *quantity* of magnesium was not.

(b) (i) Most candidates gained credit by stating that graph **B** represented a faster reaction or by discussing the evidence from the graph for the greater reaction rate.

(ii) Most candidates made good progress through this calculation and many gained full credit. Some calculated the average rate for reaction **B** rather than **A**, but were awarded partial if all else was correct. Candidates could either calculate the rate in cm^3 / minute or cm^3 / second.

(c) (i) Candidates generally recalled that the state symbol (aq) refers to an aqueous solution. Candidates who correctly described an aqueous solution without stating the word *aqueous* could gain credit. Answers such as 'it means aqueous in other words a liquid or aqueous (liquid)' were not creditworthy.

(ii) Many candidates gained partial credit for this question. The key ideas were that the same amount of magnesium (mass, size, length were accepted) was used in both trials and that magnesium is the limiting reagent. Higher scoring candidates were able to express this idea and gained full credit.

Question 5

(a) (i) A large number of candidates had learned the human audible frequency range. Many candidates did not seem familiar with the concept of a range of frequencies and gave a single value. Some of the suggested answers showed that many candidates were completely unfamiliar with this part of the Physics syllabus.

(ii) Higher-scoring candidates did very well with this question and many produced perfectly correct answers with very well drawn supporting diagrams. Carelessly drawn diagrams which did not support clear written descriptions of frequency and / or wavelength were unable to gain credit. A common misunderstanding was to confuse either frequency or wavelength with amplitude.

(iii) Usually it was only the higher scoring candidates that were familiar with the relationship between wave speed, frequency and wavelength. Although many of these candidates could state the formula only a small number of them went on to work through to the final answer. A common error was to forget to convert frequency from kilohertz to hertz. Others wrote incorrect units such as *Hz*/*m*. Some candidates incorrectly suggested the formula *speed* = *distance* ÷ *time*.

(iv) Candidates need to be able to clearly explain how sound travels through the air using the concepts of compression and rarefaction; many found this difficult.

(b) (i) Candidates generally got these two wave types the correct way round, but many from across the ability range reversed them.

(ii) Most candidates did not know that mobile phones use microwaves. The most common mistake was to suggest radio waves.

Question 6

(a) Very few candidates had any difficulty in labelling a root hair cell.

(b) (i) In order to gain credit, candidates needed to refer to the absorption of either *minerals, salts* or *ions*. Some repeated the question and stated *water absorption*, and others discussed the role of roots rather than root hair cells and were unable to be awarded credit.

(ii) Candidates generally were able to state that the root hair cells had a large surface area and scored partial credit. Many could also go on to explain the benefits of this in terms of more efficient absorption. A common suggestion was that the root hairs were very long and thin and so could easily penetrate the soil.

(c) (i) Most candidates correctly identified xylem.

(ii) Candidates needed to be very careful to ensure that the letter **A** (or a labelling line from it) was fully enclosed within the endodermis.

(iii) This proved a challenging question for candidates across the ability range. The most commonly awarded credit was for recognising that only water evaporates but the red dye does not. The remaining credit could have been gained for suggesting a sensible difference in the behaviour of water and dye molecules or for the simple idea that the water and dye formed a mixture rather than a compound.

Question 7

(a) (i) Many candidates scored partial credit for their drawn circuits. The most commonly omitted feature was the means to vary the potential difference across the lamp. This could have been by including a variable resistor in series with the lamp or by use of a variable voltage power supply. Most candidates drew their circuit diagrams carefully without having large careless breaks in the circuit.

(ii) The form and use of Ohm's law had been very well learned and many candidates worked through to the answer. Only a few candidates incorrectly used the symbols A or C for current in their formula.

(b) (i) A majority of candidates had learned the relationship between resistance and length of wire. A few candidates gave neither **B** nor **D** as their selection, suggesting they did not perhaps read the question carefully.

(ii) The relationship between cross-sectional area and resistance was not quite as well known as the relationship in **(i)**. There was much evidence that many candidates had learned the concept in reverse, and thought that the thicker wire, **E**, would present *more wire for electrons to pass through*. This might be showing that they had carried this idea over from the effect of length on resistance. Similarly to part **(i)**, a few candidates gave neither **A** nor **E** as their selection.

(c) (i) Most candidates realised that the simple pair of answers *positive* and *negative* were all that was required. Common errors usually included responses which were positive and negative such as *anode, cathode, proton* and *electron.*

(ii) A majority of candidates gave the correct answer, *electrons*. The common error here was to give the word *negative*.

Question 8

(a) (i) Candidates generally are very familiar with drawing covalent bonding diagrams and most gained full credit. The most common mistake was the addition of extra electrons to the outer shells of either the carbon or hydrogen atoms.

(ii) Many candidates gained full credit. A common incorrect response was to draw a methane molecule for both. It was noticeable that double bonds tended to appear only in candidates' attempts to draw ethene.

(b) Credit was awarded for giving both reactants and products. Some candidates were distracted by the compounds in the question and many suggested equations containing *gasoline* and *methane* on both reactant and product sides. As in **Question 2c (ii)**, some candidates attempted to write a symbol equation.

Question 9

(a) Several candidates had learned textbook definitions of the term *hormone* and gained full credit. Large numbers of candidates wrote lengthy answers focussing on emotional and developmental issues which could not be rewarded.

(b) Candidates needed to discuss the role of adrenaline in the context of how it helps in the physical action of running. Many quite good, but too general, answers were seen which tended to miss the key link to how leg muscles would be able to work harder. Many candidates scored at least partial credit for describing how increased heart rate would deliver oxygenated blood faster. If candidates did not mention muscles at all then they could not gain full credit on this question. The term *respiration* was not essential but credit was available if candidates referred to a *higher rate of respiration in muscles*.

(c) (i) The only accepted alternative to *phototropism* was *phototrophic response.* Higher scoring candidates tended to be familiar with the term.

(ii) This proved a challenging question and full credit was very rarely awarded. Many candidates attempted to answer without any reference to auxin, and such answers were often accompanied by elaborate diagrams of an experiment to demonstrate phototropism. Some candidates gained credit from the detailed diagrams they had drawn to show the role of auxin. A common incorrect response seen was 'auxin concentrates on the illuminated side of the stem and that its extra weight causes the stem to bend towards the light'.

COMBINED SCIENCE

Paper 0653/32

Extended Theory

Key Messages

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 usually wrote answers of appropriate length although Centres should continue to stress to candidates that they should take note of the amount of credit and the space allocated for answers as a guide to length and detail required.

Many candidates included good diagrams to support their written answers. This can very often increase a candidate's score, and is to be encouraged.

General comments

Candidates' responses generally showed the correct units for physics calculations. Care should be taken to use the correct symbols in formulae of physics calculations.

A few candidates wrote a balanced symbol equation when asked for a word equation. Even if this is perfectly correct full credit can not be awarded. Centres may wish to emphasise this aspect of examination technique with candidates.

When answering questions requiring use of information from a graph, candidates should be reminded that credit is given when using the numbers or numerical deductions correctly.

Candidates should avoid using unscientific phrases.

Comments on specific questions

Question 1

(a) (i) Most candidates answered this question well. Both names and formulae of the binary compounds were accepted.

(ii) Generally well answered. Candidates correctly sought the compound with the symbol W for tungsten.

(b) (i) Many candidates correctly identified the element as silicon. A few candidates, identified the element by being in both Group IV and the third period gaining credit. Most candidates correctly stated that silicon has 14 electrons, however to gain full credit they had to identify the element by its atomic number.

(ii) Many candidates gained full credit on this question. Two electrons were correctly drawn in each bonding area.

(iii) Many responses were completely correct. It was acceptable if Si was used in the equation instead of **Q**. Also, if the element was incorrectly identified in **(b)(i),** an error carried forward was allowed.

Question 2

(a) Many candidates gained full credit on this question, showing a good understanding of the information and ability to translate this information into a graph. The most common area for credit not to be awarded was for candidates missing units or not labelling axes. Candidates should remember that scales should be chosen to use as much of the given graph paper as possible.

(b) (i) Very well answered by the majority of candidates.

(ii) This question was answered well by many candidates. The most common error in this question was the use of the incorrect equation. A minority changed their mass to grams leading to an incorrect answer, though starting off with the right equation.

(c) (i) In this question the focus was on the movement of water molecules and many candidates ignored the reference to molecules, obtaining little or no credit. The best responses focused on the range of kinetic energy possessed by the water molecules in sweat and the ability of the more energetic molecules to escape, causing the kinetic energy of the remaining water molecules to decrease.

(ii) 'Increased temperature' or 'increased surface area' gained credit; it was not sufficient just to state 'temperature' or 'surface area'. '

Question 3

(a) This was generally answered well by the higher scoring candidates. Mention, or strong implication, of respiration being a chemical reaction was required, but burning was not accepted. Glucose or nutrients were acceptable as substrates. Candidates should remember that energy is released, not produced or created. The most common misconceptions were that respiration was breathing, or that respiration was gaseous exchange.

(b) This straightforward question was answered well by most candidates. Candidates should take care to write the symbol equation, not the word equation, when requested.

(c) The best candidates responded correctly by describing the role of haemoglobin in combining with oxygen in the red blood cells. Candidates who only described the loading and unloading of oxygen, omitting the transport of oxygen through the body were only able to gain partial credit.

Question 4

(a) Many candidates gained full credit. Candidates are reminded that when describing the differences between the waves they should include both types of waves. For example 'Radio waves do not need a medium to travel' is not sufficient. 'Radio waves do not need a medium to travel but sound waves do need a medium' gained credit.

(b) Generally well answered. Candidates showed a good knowledge of the different types of radiation. The most frequent incorrect answer was the confusion of the uses of gamma radiation and microwaves.

(c) The higher scoring candidates gained full credit in this question, showing thorough learning. Candidates should remember that the correct units for speed are m/s. Some incorrect units given were Hz/m, or Hz/s. Other incorrect answers used an incorrect formula, e.g. $v = \frac{f}{\lambda}$.

(d) This was a straightforward account of density measurement and most candidates described it well. Since it was a description of a practical procedure the correct apparatus was needed for full credit. Failure to mention a balance for finding the mass was the most frequent omission.

Question 5

(a) There were several possible correct responses to this question providing most candidates the opportunity of gaining credit. By far the most popular correct response was the use of chlorine. Chloride ions and heating were not allowed, unless it was specified the heating was to a high temperature.

(b) There were several ways in which candidates could gain full credit. The best candidates when describing the compound stated 'that there was bonding between the two different elements', not just writing covalent bonding. This is because covalent bonding exists between the atoms of hydrogen and oxygen elements in the mixture.

A completely different approach which was credited was the statement that water can put out a flame but a mixture of hydrogen and oxygen will burn.

(c) (i) Many candidates correctly identified the correct answer as silicon dioxide.

(ii) The unsuitability of filtration as a separation technique was well explained by many candidates. Both the solubility of sodium chloride and the liquid state of hexane had to be discussed separately to obtain full credit. A minority of candidates did not discuss each substance separately, therefore were not awarded credit.

(d) (i) This was the description of a practical procedure, and those candidates who were familiar with it scored well. The zinc carbonate had to be added to the sulfuric acid, though credit was given for mixing both reactants together.

(ii) There were many correct responses showing sound learning of the reaction between a dilute acid and a metal carbonate. Credit was needlessly lost by candidates, across the ability range, by writing the symbol equation rather than the word equation.

Question 6

(a) Most candidates successfully answered that the air molecules move faster. A small number of candidates incorrectly described convection currents.

(b) A minority of candidates obtained full credit on this question. Many described the ability to change the speed of an object. Full credit would have been achieved if the ability to change the shape of an object and its direction of movement were additional effects of a force on a body.

(c) This question was generally well answered by candidates of all abilities. A good knowledge of electrical symbols and parallel circuits was demonstrated. Some candidates wrongly placed the switch in one or both of the branches of the parallel circuit. They should realise that the switch should control both lamps so should be in the unbranched part of the circuit.

Question 7

(a) The majority of candidates stated that the presence of trees reduced the temperature. Candidates are reminded that the question asked for reference to Fig. 7.1 in their response. Numerical information taken from the graph, or a calculation using data from the graph would have enabled more candidates to gain full credit.

(b) (i) Some candidates correctly identified the edge of forest as the place where most eggs were laid.

(ii) The vast majority of candidates correctly stated that more females than males hatched in hotter areas, or more males than females hatched in cooler areas. They would have obtained full credit if they had made reference to the general observation that a temperature over 29 °C would favour females, or less than 29 °C would favour males.

(c) This question was well answered by the many candidates who correctly linked the increase in temperature of the sand with the hatching of more female turtles, and then described the consequences of the gender imbalance.

(d) Many candidates scored well in this question. Good answers required two descriptions of an effect of deforestation, and its possible consequence. There were good explanations about the increase of carbon dioxide in the air and its effect on global warming. Although many responded that the level of oxygen would decrease, this was rarely followed up by a consequence for respiration. Soil erosion was widely described. Candidates should ensure that they emphasise the role of tree roots in stabilising the soil.

Question 8

(a) This was well answered by candidates who correctly identified potassium hydroxide as an alkali as in experiment **2**.

(b) Many candidates correctly identified experiment **1** as the endothermic one, stating that the temperature had decreased.

(c) Many candidates correctly described the appearance of a precipitate of copper, or the change of colour of the solution from blue to colourless. Credit was not given for imprecise statements such as 'changed colour' or 'a precipitate formed'; candidates should be reminded that such statements need to be qualified or described correctly.

(d) The majority of candidates correctly stated that the reaction occurred because magnesium is more reactive than copper.

(e) Most candidates correctly responded that there was no reaction because copper is less reactive than magnesium.

Question 9

(a) (i) Many candidates correctly identified the optimum pH to be 6.5. An optimum between pH 6 and 7 was also allowed. Fewer candidates described the lack of enzyme activity below pH 4 and above pH 9. A common misconception was that candidates interpreted this graph to be a change in reactivity of a single test as pH was increased. As a result, they did not appreciate that the enzyme was denatured in the acidic environment as well as when the pH became more alkaline.

(ii) Many candidates referred to denaturation of the enzyme. Credit was given if it was clear that denaturation occurred in both acidic and alkaline pH. Very few candidates referred to the enzyme and its active site changing shape, preventing the substrate from binding.

(iii) Only a few candidates correctly provided a similar curve in the acidic area.

(iv) Most candidates correctly identified the sodium hydrogencarbonate in the pancreatic juice to be an alkali which can react with the hydrochloric acid. Fewer developed the point to describe the pH being increased above the optimum for the stomach enzyme.

(b) There were some very good responses to this question with many candidates gaing full credit. The description had to include the breaking down of large molecules into small molecules that could be absorbed into the blood. If 'food particles' were described rather than molecules no credit was given as there was no indication of how small the particles were.

COMBINED SCIENCE

Paper 0653/33
Extended Theory

Key Messages

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 usually wrote answers of appropriate length although Centres should continue to stress to candidates that they should take note of the amount of credit and the space allocated for answers as a guide to length and detail required.

Many candidates included good diagrams to support their written answers. This can very often increase a candidate's score, and is to be encouraged.

General comments

Candidates' responses generally showed the correct units for physics calculations. Care should be taken to use the correct symbols in formulae of physics calculations.

A few candidates wrote a balanced symbol equation. Even if this is perfectly correct it does not usually gain full credit when a word equation has been requested. Centres may wish to emphasise this aspect of examination technique with candidates.

When answering questions requiring use of information from a graph, candidates should be reminded that credit is given when using the numbers or numerical deductions correctly.

Candidates should avoid using unscientific phrases.

Comments on specific questions

Question 1

(a) (i) Candidates usually realised that the combined mass of the train and its load had to be calculated first. Many candidates then went on successfully to work through to the answer. Even among the higher scoring candidates it was often the case that a correct formula would be followed by arithmetical errors. Although a variety of incorrect responses were seen, a common one was to calculate the product of mass and speed.

(ii) Most candidates recalled the correct formula. Many of these candidates then were able to work through to the answer. Of those candidates who were familiar with this type of calculation, by far the most common mistake they made was to express the distance travelled in kilometres rather than metres.

(iii) Candidates generally were less familiar with the formula relating power to work and time. Of those candidates who did recall the correct formula, the most common mistake was to express the time in minutes rather than seconds.

(b) This piece of applied Physics was familiar to candidates across the ability range. Some candidates suggested reasons for the gaps between rails that were not related to temperature increases. Other candidates made imprecise comments such as 'the length can change if the temperature changes'; this was not creditworthy as the answers needed to discuss expansion at higher

temperatures. Some candidates spent some time producing excellent particle explanations of expansion without including any reference to the advantage of leaving the gaps between the rails.

Question 2

(a) This was familiar to large numbers of candidates from across the ability range. Candidates had to write the full name, hydrogen, and most did. Those who gave only the chemical symbol, H, did not gain credit.

(b) (i) Many candidates answered this question very well, and were able to relate the number of outer shell electrons in an atom to the group number of the element. Candidates should be advised to refer to Group 0 rather than Group 8. A minority of candidates gave the names of the elements rather than group number and were unable to gain credit.

(ii) This was answered very well by many candidates. The characteristics of Group 0 elements were very familiar, and a variety of appropriate explanations were seen and were creditworthy.

(iii) This was well answered, and most candidates recognised element **P** and stated that it was a metal. A minority of candidates seemed to be attempting to describe metallic bonding which is not required by this syllabus; unless this was described correctly, credit could not be given.

(c)(i) Some candidates were unfamiliar with the addition of limestone (calcium carbonate) to the blast furnace to remove impurities. A very wide variety of substances and reasons for their addition were suggested.

(ii) In comparison with part **(i)**, candidates seemed more familiar with the redox equation to extract iron from iron oxide, but the award of full credit for both reactants and products, was rarely given. Large numbers stated that the reactants would be 'iron oxide and carbon oxide', which was not accepted. Many gained partial credit for correct products. A minority missed the reference in the question to 'a gaseous oxide of carbon', and wrote 'carbon' as one of the reactants. A few candidates attempted to write a balanced symbol equation. Even if this is perfectly correct it does not usually gain full credit when a **word** equation has been requested.

(d)(i) The guidance given in the question helped many candidates to answer this question properly, and many gained some credit for stating the correct relative reactivities of aluminium and carbon. Further credit was often gained by a suitable reference to the reaction which cannot therefore take place.

(ii) Large numbers of candidates from across the ability range could recall that aluminium is extracted using electrolysis. The question requests a process rather than a type of reaction, and so answers referring to redox were not accepted in this case.

Question 3

(a) There were a number of points that candidates could make in answering this question. Most candidates gained credit for the idea that the marmots needed to eat a lot of food. Many candidates thought that the consumption of exclusively fats was required but were not penalised provided they had specified that a large quantity of food had to be consumed. Further credit was awarded if it was clear that the marmots needed to take in more energy (in the form of nutrition) than they used. The idea that any food type in excess would be converted to fat, was rarely seen.

(b)(i) Partial credit was gained for describing the graph. Only a few candidates gained further credit by extracting at least two data points from the graph to support the general description that survival chances increased with body mass, or giving a discussion of the curved shape of the graph.

(ii) To gain credit, candidates had to discuss the fat layer either as a poor conductor (of heat) or as a good insulator. As is often seen in answers to questions on this general topic, many candidates wrote that the fat layer 'prevents the entry of the cold from the environment or that the fat traps heat' which were not creditworthy. The suggestion that the marmot would metabolise the fat and release heat energy, was also not creditworthy.

(c) Candidates generally showed good awareness of factors thought to be contributing to global warming, and large numbers gained most of the available credit. Very many discussed

deforestation and the increase in carbon dioxide levels due to reduced photosynthesis. Candidates wisely answered this question in terms of *carbon dioxide* and not *carbon*. A minority of candidates also referred to methane and its sources.

(d) (i) Most candidates understood the term *general trend* and were not distracted by the fine structure in the graph.

(ii) Credit was usually awarded for this part. Most candidates realised that the shorter period of hibernation would leave the marmots with excess fat.

Question 4

(a) Candidates tended either to be very familiar with what this question was testing or completely unfamiliar with it. This question was challenging in that two relevant variables were required in order to gain credit. Temperature and surface area of magnesium were the two variables that were expected. As the diagram clearly showed magnesium in ribbon form, mass, length and size of magnesium were also accepted; the terms *amount* or *quantity* of magnesium was not.

(b) (i) Most candidates gained credit by stating that graph **B** represented a faster reaction or by discussing the evidence from the graph for the greater reaction rate.

(ii) Most candidates made good progress through this calculation and many gained full credit. Some calculated the average rate for reaction **B** rather than **A**, but were awarded partial if all else was correct. Candidates could either calculate the rate in cm^3 / minute or cm^3 / second.

(c) (i) Candidates generally recalled that the state symbol (aq) refers to an aqueous solution. Candidates who correctly described an aqueous solution without stating the word *aqueous* could gain credit. Answers such as 'it means aqueous in other words a liquid or aqueous (liquid)' were not creditworthy.

(ii) Many candidates gained partial credit for this question. The key ideas were that the same amount of magnesium (mass, size, length were accepted) was used in both trials and that magnesium is the limiting reagent. Higher scoring candidates were able to express this idea and gained full credit.

Question 5

(a) (i) A large number of candidates had learned the human audible frequency range. Many candidates did not seem familiar with the concept of a range of frequencies and gave a single value. Some of the suggested answers showed that many candidates were completely unfamiliar with this part of the Physics syllabus.

(ii) Higher-scoring candidates did very well with this question and many produced perfectly correct answers with very well drawn supporting diagrams. Carelessly drawn diagrams which did not support clear written descriptions of frequency and / or wavelength were unable to gain credit. A common misunderstanding was to confuse either frequency or wavelength with amplitude.

(iii) Usually it was only the higher scoring candidates that were familiar with the relationship between wave speed, frequency and wavelength. Although many of these candidates could state the formula only a small number of them went on to work through to the final answer. A common error was to forget to convert frequency from kilohertz to hertz. Others wrote incorrect units such as *Hz / m*. Some candidates incorrectly suggested the formula *speed = distance ÷ time*.

(iv) Candidates need to be able to clearly explain how sound travels through the air using the concepts of compression and rarefaction; many found this difficult.

(b) (i) Candidates generally got these two wave types the correct way round, but many from across the ability range reversed them.

(ii) Most candidates did not know that mobile phones use microwaves. The most common mistake was to suggest radio waves.

Question 6

(a) Very few candidates had any difficulty in labelling a root hair cell.

(b) (i) In order to gain credit, candidates needed to refer to the absorption of either *minerals, salts* or *ions*. Some repeated the question and stated *water absorption*, and others discussed the role of roots rather than root hair cells and were unable to be awarded credit.

(ii) Candidates generally were able to state that the root hair cells had a large surface area and scored partial credit. Many could also go on to explain the benefits of this in terms of more efficient absorption. A common suggestion was that the root hairs were very long and thin and so could easily penetrate the soil.

(c) (i) Most candidates correctly identified xylem.

(ii) Candidates needed to be very careful to ensure that the letter **A** (or a labelling line from it) was fully enclosed within the endodermis.

(iii) This proved a challenging question for candidates across the ability range. The most commonly awarded credit was for recognising that only water evaporates but the red dye does not. The remaining credit could have been gained for suggesting a sensible difference in the behaviour of water and dye molecules or for the simple idea that the water and dye formed a mixture rather than a compound.

Question 7

(a) (i) Many candidates scored partial credit for their drawn circuits. The most commonly omitted feature was the means to vary the potential difference across the lamp. This could have been by including a variable resistor in series with the lamp or by use of a variable voltage power supply. Most candidates drew their circuit diagrams carefully without having large careless breaks in the circuit.

(ii) The form and use of Ohm's law had been very well learned and many candidates worked through to the answer. Only a few candidates incorrectly used the symbols A or C for current in their formula.

(b) (i) A majority of candidates had learned the relationship between resistance and length of wire. A few candidates gave neither **B** nor **D** as their selection, suggesting they did not perhaps read the question carefully.

(ii) The relationship between cross-sectional area and resistance was not quite as well known as the relationship in **(i)**. There was much evidence that many candidates had learned the concept in reverse, and thought that the thicker wire, **E**, would present *more wire for electrons to pass through*. This might be showing that they had carried this idea over from the effect of length on resistance. Similarly to part **(i)**, a few candidates gave neither **A** nor **E** as their selection.

(c) (i) Most candidates realised that the simple pair of answers *positive* and *negative* were all that was required. Common errors usually included responses which were positive and negative such as *anode, cathode, proton* and *electron.*

(ii) A majority of candidates gave the correct answer, *electrons*. The common error here was to give the word *negative*.

Question 8

(a) (i) Candidates generally are very familiar with drawing covalent bonding diagrams and most gained full credit. The most common mistake was the addition of extra electrons to the outer shells of either the carbon or hydrogen atoms.

(ii) Many candidates gained full credit. A common incorrect response was to draw a methane molecule for both. It was noticeable that double bonds tended to appear only in candidates' attempts to draw ethene.

(b) Credit was awarded for giving both reactants and products. Some candidates were distracted by the compounds in the question and many suggested equations containing *gasoline* and *methane* on both reactant and product sides. As in **Question 2c (ii)**, some candidates attempted to write a symbol equation.

Question 9

(a) Several candidates had learned textbook definitions of the term *hormone* and gained full credit. Large numbers of candidates wrote lengthy answers focussing on emotional and developmental issues which could not be rewarded.

(b) Candidates needed to discuss the role of adrenaline in the context of how it helps in the physical action of running. Many quite good, but too general, answers were seen which tended to miss the key link to how leg muscles would be able to work harder. Many candidates scored at least partial credit for describing how increased heart rate would deliver oxygenated blood faster. If candidates did not mention muscles at all then they could not gain full credit on this question. The term *respiration* was not essential but credit was available if candidates referred to a *higher rate of respiration in muscles*.

(c) (i) The only accepted alternative to *phototropism* was *phototrophic response.* Higher scoring candidates tended to be familiar with the term.

(ii) This proved a challenging question and full credit was very rarely awarded. Many candidates attempted to answer without any reference to auxin, and such answers were often accompanied by elaborate diagrams of an experiment to demonstrate phototropism. Some candidates gained credit from the detailed diagrams they had drawn to show the role of auxin. A common incorrect response seen was 'auxin concentrates on the illuminated side of the stem and that its extra weight causes the stem to bend towards the light'.

COMBINED SCIENCE

Paper 0653/04

Coursework

(a) Nature of the tasks set by Centres.

The entry for this component was low, although considerably higher than in previous sessions. 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 to previous years, with candidates achieving the full range of available credit.

(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 Mark Schemes specific to the tasks given.

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

(c) Recording of credit 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 to justify credit awarded.

Tick lists remain popular, particularly with skill C1.

(d) Good practice.

Some Centres made very useful comments about individual candidate's performance on a summary sheet. Some produced a booklet of assessment tasks.

COMBINED SCIENCE

Paper 0653/51

Practical Test

Key Message

Candidates need to pay close attention to instructions regarding the accuracy of readings, calculations and should use the same number of decimal places for each set of readings.

General comments

Supervisors are reminded of the importance of their role in providing a good set of results and observations as well as reporting difficulties with apparatus and chemicals.

Comments on specific questions

Question 1

Most candidates started strongly by gaining most of the credit in part **(a)**; a range of colours was allowed in part **(a)(ii)**. In part **(b)**, around half of the candidates could give a reason why the leaves were placed in boiling water and why the Bunsen burner must be turned off; the danger of the alcohol igniting was considered to be a better answer than the alcohol evaporating. In part **(b)(iii)**, the most common omission was 'photosynthesis' and the most common error was to repeat the conclusions from Table 1.1 rather than to state that 'starch had been produced' as a result of photosynthesis. There were a significant number of unclear discussions made.

Question 2

Generally candidates did well with reading I and V and calculating R. Some candidates need practice in reading meters since they wrote down some impossibly high and low values. Some used different numbers of decimal places within a column. If 2 decimal places have been chosen then 0.2 should be written as 0.20 although this was not necessarily penalised in this paper.

For the graph, most candidates plotted points accurately and included the origin on the line. There were a small number of candidates who did not draw a line of best fit. Most candidates were familiar with gradients and most showed their working. Too many candidates worked from a very small triangle and they should be made aware that errors in reading the scales will have a smaller effect on the value of the gradient if a large triangle is used. The cross-sectional area was usually calculated correctly.

Question 3

Most candidates observed and recorded a green residue. Some candidates still describe a colourless solution as clear which cannot be accepted, as a coloured solution will probably be clear (transparent) also. For part **(a)(ii)**, most candidates described seeing bubbles and correctly concluded the presence of the carbonate ion. The copper hydroxide precipitate in part **(a)(iii)** was usually observed and identified; many did not use the word 'precipitate' so could only access the partial credit.

In part **(b)(i)**, the responses 'milky' and 'cloudy white' were not accepted as alternatives for 'precipitate'; nevertheless many candidates scored full credit. The last part had a negative result which many candidates were not expecting and consequently gave a positive observation (white precipitate) when this was not the case. A significant number of candidates did recognise that there was no sulfate present.

COMBINED SCIENCE

Paper 0653/52

Practical Test

Key Message

Candidates need to pay close attention to instructions regarding the accuracy of readings, calculations and should use the same number of decimal places for each set of readings.

General comments

Judging from some results, it may be that a small number of Centres had difficulty in preparing the solutions. Supervisors are reminded of the importance of their role in providing a good set of results and observations as well as reporting difficulties with apparatus and chemicals. Information provided from Centres concerning any difficulties is helpful to the Examiners.

Comments on specific questions

Question 1

For part **(a)** many candidates did not record the times in seconds as instructed.

In part **(b)**, many candidates gained full credit and most appreciated that as the pH fell below 8 the colour changes.

A significant number knew that boiling lipase denatures the enzyme in part **(c)**. In part **(d)**, the majority referred to temperature as a source of error but did not qualify this.

The large majority were familiar with the test in part **(e)** and it was not unusual for full credit to be awarded.

Question 2

This question was executed competently by most candidates. A significant number of candidates did not record their results to the number of decimal places specified or to the appropriate accuracy. However, calculations were carried out very well. Although the credit in parts **(b)(i)**, **(ii)** and **(iii)** could be easily obtained, often the volumes were read poorly; candidates who took care over readings often went on to gain credit in part **(b)(iv)**.

Question 3

The majority of candidates appeared to have no difficulty in performing this experiment although a few seemed to find that the temperatures just reduced. A small number had strange starting temperatures, e.g. zero, and many did not enter the readings to the nearest half a degree as instructed (meaning that temperature readings should end with .0 or .5). In part **(a)(iii)**, most candidates gained at least partial credit as a relatively large range of colours was accepted.

Graph plotting was generally very good; however the phrase ‘smooth curve through the points’ was often overlooked or misinterpreted. It was expected that a best fit smooth curve with one maximum would be drawn, not necessarily passing though every point.

Parts **(b)(ii)** and **(iii)** were well answered although some candidates used Table 3.1 rather than the graph to find the maximum temperature rise.

COMBINED SCIENCE

Paper 0653/53

Practical Test

Key Message

Candidates need to pay close attention to instructions regarding the accuracy of readings, calculations and should use the same number of decimal places for each set of readings.

General comments

Supervisors are reminded of the importance of their role in providing a good set of results and observations as well as reporting difficulties with apparatus and chemicals.

Comments on specific questions

Question 1

Most candidates started strongly by gaining most of the credit in part **(a)**; a range of colours was allowed in part **(a)(ii)**. In part **(b)**, around half of the candidates could give a reason why the leaves were placed in boiling water and why the Bunsen burner must be turned off; the danger of the alcohol igniting was considered to be a better answer than the alcohol evaporating. In part **(b)(iii)**, the most common omission was 'photosynthesis' and the most common error was to repeat the conclusions from Table 1.1 rather than to state that 'starch had been produced' as a result of photosynthesis. There were a significant number of unclear discussions made.

Question 2

Generally candidates did well with reading I and V and calculating R. Some candidates need practice in reading meters since they wrote down some impossibly high and low values. Some used different numbers of decimal places within a column. If 2 decimal places have been chosen then 0.2 should be written as 0.20 although this was not necessarily penalised in this paper.

For the graph, most candidates plotted points accurately and included the origin on the line. There were a small number of candidates who did not draw a line of best fit. Most candidates were familiar with gradients and most showed their working. Too many candidates worked from a very small triangle and they should be made aware that errors in reading the scales will have a smaller effect on the value of the gradient if a large triangle is used. The cross-sectional area was usually calculated correctly.

Question 3

Most candidates observed and recorded a green residue. Some candidates still describe a colourless solution as clear which cannot be accepted, as a coloured solution will probably be clear (transparent) also. For part **(a)(ii)**, most candidates described seeing bubbles and correctly concluded the presence of the carbonate ion. The copper hydroxide precipitate in part **(a)(iii)** was usually observed and identified; many did not use the word 'precipitate' so could only access the partial credit.

In part **(b)(i)**, the responses 'milky' and 'cloudy white' were not accepted as alternatives for 'precipitate'; nevertheless many candidates scored full credit. The last part had a negative result which many candidates were not expecting and consequently gave a positive observation (white precipitate) when this was not the case. A significant number of candidates did recognise that there was no sulfate present.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key Messages

Candidates need to have a good knowledge of chemical analysis and the practical aspects of all three sciences in order to do well in this paper.

Candidates should be reminded to use the same of significant figures as that of the question unless they are instructed otherwise.

General comments

There were many scripts from good candidates who have thoroughly grasped the practical aspects of the three sciences that make up the syllabus. These candidates are a credit to the Centres who entered them for this examination.

Some candidates from some Centres need to demonstrate a better understanding of chemical analysis.

A common problem is the incorrect rounding of numerical answers and answers given to the incorrect number of significant figures. In general, Examiners expect candidates to give answers to the same number of significant figures as appear in the question, rounded correctly if required. A calculator answer of, for example, 2.606 should be written as 2.61 and not 2.60 if three significant figures are required.

An alternative to practical paper will have a number of diagrams with scales on, and candidates who are unable to interpret them correctly are at a disadvantage.

Comments on specific questions

Question 1

This question concerned two leaves, with one de-starched by being stored in the dark for 24 hours.

(a) (i) Most candidates realised the green substance dissolved in the alcohol was chlorophyll.

(ii) Many candidates were unaware of the colours of iodine and others thought that iodine tested for glucose. A number tried to write a sentence in the conclusion box referring to photosynthesis; this was not required as the conclusion required only reference to the test in question, i.e. starch being present or absent.

(b) (i) Almost all candidates were able to read the measuring cylinders correctly, although a few were still reading them in the wrong direction, e.g. 28 cm^3 rather than 12 cm^3.

(ii) Again, almost all candidates identified oxygen as the gas that relit a glowing splint.

(ii) Tube **F** had been kept in the dark for 48 hours, and the gas did not relight a glowing splint. Many candidates realised that the gas must be carbon dioxide, produced by respiration. However a minority thought it was hydrogen, and others thought the process was still photosynthesis.

Question 2

Candidates were expected to find the cross-sectional area of a resistance wire, with a diagram showing how the apparatus was set up.

(a) (i)(ii) Candidates were asked to read voltmeter and ammeter dials and record the values in a table. All other values in the table were given to two decimal places and candidates were expected to follow the example. Some gave the voltmeter reading as 2.225, suggesting accuracy above the tolerance of the meter. Values of 2.22 or 2.23 were expected and credited. Candidates were given the formula to calculate the resistance of the lengths of wires, and again answers to two decimal places, correctly rounded, were credited.

(b) (i) Candidates had to plot a graph of their values for resistance against length of wire. In this case, a grid was provided with the axes already printed. Almost every candidate plotted their points accurately and drew in a line of best fit, although some failed to follow the instruction that the line should pass through the origin, and others failed to use a ruler. Candidates should be reminded to follow the instructions given.

(ii) While many candidates correctly calculated a gradient, a significant number did not indicate on the graph the values they used or how they did this. The clearest way of doing this is with a 'triangle' under the line, but any *clear* and unambiguous method is acceptable and creditworthy.

(iii) The cross-sectional area could be worked out using the formula provided. A value in the region of 0.0004 was expected, depending on the gradient. Some candidates gave an incorrect number of zeroes in their answer.

(iv) Candidates had to predict that the resistance would decrease if the wire had a greater cross-sectional area.

Question 3

The candidates worked through a series of tests in order to identify a mixture containing two cations and two anions.

The question demanded a working knowledge of practical chemistry rather than the reproduction of facts and there were some good answers given by candidates.

Candidates should be reminded that unless the formula is asked for, a name will gain credit; however an incorrect formula, even if the name is correct, will not be credited.

(a) (i) Following the addition of hydrochloric acid, carbon dioxide is evolved. Candidates were asked to give the test and result to prove the gases identity. Many candidates were able to correctly state that limewater turns milky. However, fewer candidates were able to give the anion that must be present. Some, correctly stated carbonate, but were not credited as they had given an incorrect formula, usually CO_3^-.

(ii) Candidates then had to identify the cation responsible for the blue precipitate produced when aqueous sodium hydroxide was added to the residue left from the above test. Only a small minority correctly identified the copper ion, many giving either zinc or iron.

(b) (i) The filtrate from previous tests was now tested, with the candidates being asked for a sulfate test. Few candidates knew the reagent barium chloride (or nitrate) as the test for sulfate ions, and that the result would have been no precipitate formed. Some candidates stated that a white precipitate *would* be produced, indicating that they had not read the question fully.

(ii) A second sample of the filtrate was tested with acidified silver nitrate. A number of candidates correctly identified the chloride ion, but a number suggested it was chlori**ne** or gave an incorrect formula.

(iii) Aqueous sodium hydroxide was added to the final sample of the filtrate produced above, no precipitate was formed. After warming gently, a piece of damp red litmus paper showed no change when held over the mouth of the test-tube. This should have led candidates to the conclusion that the ammonium ion was not present. Common incorrect answers were 'ammonia' and / or an incorrect formula.

(c) Candidates had to suggest a possible second cation using the information above. They should have noted that only ammonium, potassium or sodium ions fail to give a precipitate with aqueous sodium hydroxide. The ammonium ion has already been discounted, so either of the other two was an acceptable answer.

Question 4

Oscilloscope traces were used to investigate how exercise affects breathing rates.

(a) The three sections of this part required candidates to use a diagram of an oscilloscope trace to find out the volume of air inhaled in one breath (0.5 dm^3), the number of breaths in one minute (12) and therefore the total volume inhaled in one minute (6 dm^3). This was successfully achieved by most candidates, but a common answer in part **(a) (i)** was 0.45 dm^3 suggesting that the graph scales had been misinterpreted.

(b) (i) A second trace was provided showing the readings of a candidates breathing pattern after exercise. Candidates were required to describe two differences between this trace and the original. Some candidates, however, only described this second trace without reference to the first trace.

(ii) Most candidates were able to give the volume of the first breath as 1.6 dm^3.

(iii) Candidates were asked to explain why this volume was different to the resting value. Many candidates answered that 'more air' was required; this answer was insufficient as oxygen had to be named. Few candidates mentioned the need to remove the increased volume of carbon dioxide, although a number referred to 'oxygen debt' and gained credit.

(c) Candidates had to give reasons why it would be undesirable to breathe in the exhaled air. Many candidates answered that the exhaled air would *only* contain carbon dioxide and no oxygen; these answers were not creditworthy. Candidates who stated that the exhaled air had 'an increased proportion of carbon dioxide and a reduced amount of oxygen' gained full credit. Candidates who said that there would be 'too much carbon dioxide and not enough oxygen' were given credit.

Question 5

This question was based on the expansions of different metals.

While many candidates scored well on this question, a significant number did not gain credit because they had not read the information carefully enough.

(a) Candidates had three different figures to study and complete a table using them. Almost all candidates correctly completed the first column giving the original lengths of the metals, but there were many errors in the second column, where candidates had to read the increase in length from the scales in the three figures. Some candidates gave the new, expanded length of the metal, but as they were clearly asked for the increase in length, these answers were not awarded credit.

(b)(i) Candidates were given the formula to calculate the coefficient of thermal expansion. Many calculated correctly, but some, having not read all the information provided, failed to use the correct temperature rise of 100 °C.

(ii) Candidates were asked to state the unit for the coefficient ($°C^{-1}$). A significant number of more able candidates were able to work this out.

(iii) Using their calculated values, candidates had to select which of the metals would expand the least. Some candidates misunderstood the number of zeros after the decimal point and gave an incorrect answer.

(c) Candidates were then required to suggest where, in everyday life, expansion of metals is useful and where it is a problem, Examiners were expecting to see real-life cases. The use of expansion in thermostats, fire alarms and thermometers were some of the expected answers for the former and the buckling of railway tracks or the need to leave expansion gaps in bridges for the latter. General responses such as 'railways' were not creditworthy.

Question 6

In this question candidates had to determine which of two household cleaners would be the best for removing fat.

(a) (i) Universal Indicator was used to follow the neutralisation of the alkali and candidates were asked for the colour change. Therefore two colours were required; the colour changes from blue / purple to green. A number of candidates gave a single colour and many gave wrong colours.

(ii) Candidates were supplied with titration figures for the first cleaner and were required to calculate the volume of acid added in two titrations and then the average. Although this caused few problems to the majority of candidates, a significant minority did not correctly complete this section.

(iii) To calculate the concentration of the first cleaner, candidates had to divide their average (whether it was a correct figure or a reasonable answer if an error had been made) by 25. Most were able to do this.

(b) (i)(ii) Candidates had to do a similar exercise with the second cleaner. This gave similar results as in the previous section.

(c) The second cleaner candidates had to consider a dilution factor. Many candidates were able to calculate this using their answer to part **(b) (ii)**. Some however, used an incorrect figure in their calculation (usually 25).

(d) Candidates had to select the cleaner that would be more effective at removing fat and explain why. The best answers selected the first cleaner, stating that 'it was the most concentrated'.

(e) Finally, candidates had to provide a balanced symbol equation for the reaction, having been given a word equation. A large number of candidates gave the symbol for sodium as S and did not correctly write H_2O for water.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key Messages

Candidates need to have a good knowledge of chemical analysis and the practical aspects of all three sciences in order to do well in this paper.

Candidates should be reminded to use the same of significant figures as that of the question unless they are instructed otherwise.

General comments

There were many scripts from good candidates who have thoroughly grasped the practical aspects of the three sciences that make up the syllabus. These candidates are a credit to the Centres who entered them for this examination.

Some candidates from some Centres need to demonstrate a better understanding of chemical analysis.

A common problem is the incorrect rounding of numerical answers and answers given to the incorrect number of significant figures. In general, Examiners expect candidates to give answers to the same number of significant figures as appear in the question, rounded correctly if required. A calculator answer of, for example, 2.606 should be written as 2.61 and not 2.60 if three significant figures are required.

An alternative to practical paper will have a number of diagrams with scales on, and candidates who are unable to interpret them correctly are at a disadvantage.

Comments on specific questions

Question 1

This question concerned the digestion of fat in milk by the enzyme lipase.

(a) (i) Almost all correctly stated 37 °C and most gave the correct reason for this temperature, i.e. body temperature. Other descriptions such as 'optimum temperature' were credited, but not 'normal or room temperature'.

(ii) A number of candidates wrote the times as 3:25, 3:37 and 3:05 rather than 205, 217 and 185. Candidates should be reminded that credit is not awarded for simply copying data from one place to another.

(iii) Almost all candidates were able to calculate a correct average of 202 seconds, even some of those that had incorrectly given the answer in minutes in part **(a) (i)** converted their answer to seconds.

(b) A lot of information was given about what was happening in the reaction. Candidates had to use this information to 'Explain why the mixture in the tubes turned from pink to colourless.' The answer could be extracted from the information given. Some answers suggested that candidates had not read this and did not gain credit.

(c) Some candidates incorrectly stated it was for the lipase to warm up. Answers referring to it being body temperature did not gain credit. Examiners were looking for the need for the contents reaching the temperature (reaching body temperature was credited) or that all the tubes were the same temperature.

(d) Candidates could have approached this in two ways, proving lipase is an enzyme, or proving it breaks down fat. Both approaches however are small refinements on the experiment in the question, for the former, the lipase should be boiled or denatured in some way and the pink colour would not change. For the latter the experiment should be repeated with another type of fat and then the indicator would change as before.

Question 2

Candidates had to find the density of a piece of plastic pipe.

(a) Candidates had to read a balance window and record the mass to the nearest 0.1 g. A number of candidates did not follow instructions and gave an answer of 13.69 g rather than 13.7 g.

(b) (i) The pipe was drawn 'life size' and candidates were instructed to use a ruler to measure and record their values of the length, external diameter and internal diameter. These dimensions were indicated on the diagrams and most candidates were able to do this accurately.

(ii) Candidates had to use their answers above to work out a value for **k**. The formula was given and candidates had to square their values of the external and internal diameters. Most correctly calculated this value gaining credit.

(iii) Another formula was given to candidates to calculate the volume of the pipe, again most candidates were successful.

(c) Candidates were asked to calculate the density of the pipe. They had already read the mass of the pipe in part **(a)** and had just calculated the volume. This time no formula was given and candidates had to show that they correctly used $\frac{\text{mass}}{\text{volume}}$.

Question 3

This question was about the production of heat produced when two chemicals reacted together.

(a) A table of results was provided with three gaps to be filled in by the candidate from three diagrams of thermometers. The first thermometer showed 20 °C exactly and in keeping with every other result in the table should have been shown to one decimal place, i.e. 20.0 °C.

(b) (i) A grid was provided and candidates were asked to plot the values. A total of 15 plots had to made, most of them were only 1 or 1.5 °C less than the one before, therefore any incorrect plots should have stood out and been corrected. Most candidates plotted correctly but failed to label the axes with the variable or the unit. Candidates were instructed to draw a smooth curve between the points. Examiners are aware that this can be challenging, however straight lines or right angle turns were penalised and a maximum between the second and third points was also expected.

(ii) Candidates had to find the maximum temperature rise in the reaction. This was not the highest point of the graph, as the temperature at the start was 20.0 °C. Many candidates missed this. Candidates who failed to show a maximum in part **(i)** were not penalised a second time.

(iii) The energy given out by the reaction could now be calculated using the formula provided. This required candidates reading the information given at the start of the question to find the volume of solution **B**. Those that entered an incorrect volume were awarded no credit.

Question 4

This question was testing the theory that caffeine speeds up heart rate and candidates were given a set of results to evaluate.

(a) (i) Candidates were required to complete the table by converting the figures into beats per minute; that is, multiplying the values by 2.

(ii) A grid was provided for candidates to draw a graph. A maximum should have been drawn here as well, but to ensure that candidates were not penalised twice for the same error, Examiners accepted a curve that did not significantly rise above 90 beats per minute.

(iii) Most candidates were able to give a maximum time, but some gave a range.

(b) (i) Almost all candidates realised that exercise would cause the heart rate to increase and so it should be avoided during this experiment.

(ii) Two quantities that should be kept constant if the experiment is to be reliably repeated are the volume and concentration of coffee. Many gave the inexact term "amount"; this was given partial credit if neither of the expected answers were present.

(iii) Candidates were asked to describe a way in which a more accurate value for the maximum rate of heart beat could be obtained. The available data told the candidates the value was somewhere above 90 beats per minute at sometime between 15 and 20 minutes. Therefore more readings are required between these times, readings being taken every minute or two minutes rather than the present every five minutes. Many candidates thought that using some sort of 'machine' should be used, this may gave a more accurate value for beats per minute, but unless the readings are taken closer together it does not help.

Question 5

This question found the speed of sound, using an echo, and compared an empirical value with the actual value obtained.

(a) (i) Candidates had to use their rulers to measure a distance marked on the paper representing the distance from the girl to a wall, this value was exactly 9 cm.

(ii) Many candidates gave the answer 270 m rather than the expected 540 m as they forgot the return journey.

(iii) A table of five times was shown for five different experiments. The last time was much longer than the others, candidates were asked to suggest a reason for this. Simple answers such as 'timing error' or 'experimental error' were not awarded credit. Examiners were looking for a possible reason such as 'she was not paying attention' or 'she was distracted'.

(iv) A number of candidates used all five values and were not given credit.

(v) An answer of 307 m / s was expected from candidates if their previous calculations were correct.

(vi) Candidates were told that the actual speed of sound in air is 343 m / s and were asked to comment on the accuracy of their value. Simple answers such as 'My answer is not very accurate' with no reason did not gain credit.

(b) Answers referring to molecules or particles being closer together were expected and most candidates realised this.

Question 6

(a) Most candidates correctly gave the test for hydrogen. It pops with a lighted splint. Candidates gained no credit for the use of a glowing splint or an unlit splint.

(b) (i) Many candidates correctly suggested that the hydrogen produced by the reaction floated the magnesium to the surface. Despite being told that magnesium is more dense than the acid, some suggested it wore away and became lighter.

(ii) The answer expected from candidates was that copper was chosen because it does not react with the acid.

(c) Examiners were expecting candidates to note that hydrogen was produced more rapidly in graph **A**. Many candidates were correct, but some stated that more hydrogen was given off, yet the volume of hydrogen given off was the same in both experiments. Many more able candidates were able to suggest that the copper acts as a catalyst for the reaction.

(d) An observation to show that magnesium was in excess would be some solid left in the beaker at the end of the reaction. This is not, however, a precipitate.

(e) Candidates were asked to draw a third line on the graph to show how the reaction between magnesium and ethanoic acid would proceed. A line drawn below the previous curves, but finishing at the same level was expected.

(f) Candidates had to complete a diagram to show a method of collection and measuring the gas evolved that did not involve the displacement of water. A delivery tube to a syringe was expected. Few diagrams given by candidates were air tight and some showed the use of incorrect apparatus.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key Messages

Candidates need to have a good knowledge of chemical analysis and the practical aspects of all three sciences in order to do well in this paper.

Candidates should be reminded to use the same of significant figures as that of the question unless they are instructed otherwise.

General comments

There were many scripts from good candidates who have thoroughly grasped the practical aspects of the three sciences that make up the syllabus. These candidates are a credit to the Centres who entered them for this examination.

Some candidates from some Centres need to demonstrate a better understanding of chemical analysis.

A common problem is the incorrect rounding of numerical answers and answers given to the incorrect number of significant figures. In general, Examiners expect candidates to give answers to the same number of significant figures as appear in the question, rounded correctly if required. A calculator answer of, for example, 2.606 should be written as 2.61 and not 2.60 if three significant figures are required.

An alternative to practical paper will have a number of diagrams with scales on, and candidates who are unable to interpret them correctly are at a disadvantage.

Comments on specific questions

Question 1

This question concerned two leaves, with one de-starched by being stored in the dark for 24 hours.

(a) (i) Most candidates realised the green substance dissolved in the alcohol was chlorophyll.

(ii) Many candidates were unaware of the colours of iodine and others thought that iodine tested for glucose. A number tried to write a sentence in the conclusion box referring to photosynthesis; this was not required as the conclusion required only reference to the test in question, i.e. starch being present or absent.

(b) (i) Almost all candidates were able to read the measuring cylinders correctly, although a few were still reading them in the wrong direction, e.g. 28 cm^3 rather than 12 cm^3.

(ii) Again, almost all candidates identified oxygen as the gas that relit a glowing splint.

(ii) Tube **F** had been kept in the dark for 48 hours, and the gas did not relight a glowing splint. Many candidates realised that the gas must be carbon dioxide, produced by respiration. However a minority thought it was hydrogen, and others thought the process was still photosynthesis.

Question 2

Candidates were expected to find the cross-sectional area of a resistance wire, with a diagram showing how the apparatus was set up.

(a) (i)(ii) Candidates were asked to read voltmeter and ammeter dials and record the values in a table. All other values in the table were given to two decimal places and candidates were expected to follow the example. Some gave the voltmeter reading as 2.225, suggesting accuracy above the tolerance of the meter. Values of 2.22 or 2.23 were expected and credited. Candidates were given the formula to calculate the resistance of the lengths of wires, and again answers to two decimal places, correctly rounded, were credited.

(b) (i) Candidates had to plot a graph of their values for resistance against length of wire. In this case, a grid was provided with the axes already printed. Almost every candidate plotted their points accurately and drew in a line of best fit, although some failed to follow the instruction that the line should pass through the origin, and others failed to use a ruler. Candidates should be reminded to follow the instructions given.

(ii) While many candidates correctly calculated a gradient, a significant number did not indicate on the graph the values they used or how they did this. The clearest way of doing this is with a 'triangle' under the line, but any *clear* and unambiguous method is acceptable and creditworthy.

(iii) The cross-sectional area could be worked out using the formula provided. A value in the region of 0.0004 was expected, depending on the gradient. Some candidates gave an incorrect number of zeroes in their answer.

(iv) Candidates had to predict that the resistance would decrease if the wire had a greater cross-sectional area.

Question 3

The candidates worked through a series of tests in order to identify a mixture containing two cations and two anions.

The question demanded a working knowledge of practical chemistry rather than the reproduction of facts and there were some good answers given by candidates.

Candidates should be reminded that unless the formula is asked for, a name will gain credit; however an incorrect formula, even if the name is correct, will not be credited.

(a) (i) Following the addition of hydrochloric acid, carbon dioxide is evolved. Candidates were asked to give the test and result to prove the gases identity. Many candidates were able to correctly state that limewater turns milky. However, fewer candidates were able to give the anion that must be present. Some, correctly stated carbonate, but were not credited as they had given an incorrect formula, usually CO_3^-.

(ii) Candidates then had to identify the cation responsible for the blue precipitate produced when aqueous sodium hydroxide was added to the residue left from the above test. Only a small minority correctly identified the copper ion, many giving either zinc or iron.

(b) (i) The filtrate from previous tests was now tested, with the candidates being asked for a sulfate test. Few candidates knew the reagent barium chloride (or nitrate) as the test for sulfate ions, and that the result would have been no precipitate formed. Some candidates stated that a white precipitate *would* be produced, indicating that they had not read the question fully.

(ii) A second sample of the filtrate was tested with acidified silver nitrate. A number of candidates correctly identified the chloride ion, but a number suggested it was chlori**ne** or gave an incorrect formula.

(iii) Aqueous sodium hydroxide was added to the final sample of the filtrate produced above, no precipitate was formed. After warming gently, a piece of damp red litmus paper showed no change when held over the mouth of the test-tube. This should have led candidates to the conclusion that

the ammonium ion was not present. Common incorrect answers were 'ammonia' and / or an incorrect formula.

(c) Candidates had to suggest a possible second cation using the information above. They should have noted that only ammonium, potassium or sodium ions fail to give a precipitate with aqueous sodium hydroxide. The ammonium ion has already been discounted, so either of the other two was an acceptable answer.

Question 4

Oscilloscope traces were used to investigate how exercise affects breathing rates.

(a) The three sections of this part required candidates to use a diagram of an oscilloscope trace to find out the volume of air inhaled in one breath (0.5 dm^3), the number of breaths in one minute (12) and therefore the total volume inhaled in one minute (6 dm^3). This was successfully achieved by most candidates, but a common answer in part **(a) (i)** was 0.45 dm^3 suggesting that the graph scales had been misinterpreted.

(b) (i) A second trace was provided showing the readings of a candidates breathing pattern after exercise. Candidates were required to describe two differences between this trace and the original. Some candidates, however, only described this second trace without reference to the first trace.

(ii) Most candidates were able to give the volume of the first breath as 1.6 dm^3.

(iii) Candidates were asked to explain why this volume was different to the resting value. Many candidates answered that 'more air' was required; this answer was insufficient as oxygen had to be named. Few candidates mentioned the need to remove the increased volume of carbon dioxide, although a number referred to 'oxygen debt' and gained credit.

(c) Candidates had to give reasons why it would be undesirable to breathe in the exhaled air. Many candidates answered that the exhaled air would *only* contain carbon dioxide and no oxygen; these answers were not creditworthy. Candidates who stated that the exhaled air had 'an increased proportion of carbon dioxide and a reduced amount of oxygen' gained full credit. Candidates who said that there would be 'too much carbon dioxide and not enough oxygen' were given credit.

Question 5

This question was based on the expansions of different metals.

While many candidates scored well on this question, a significant number did not gain credit because they had not read the information carefully enough.

(a) Candidates had three different figures to study and complete a table using them. Almost all candidates correctly completed the first column giving the original lengths of the metals, but there were many errors in the second column, where candidates had to read the increase in length from the scales in the three figures. Some candidates gave the new, expanded length of the metal, but as they were clearly asked for the increase in length, these answers were not awarded credit.

(b)(i) Candidates were given the formula to calculate the coefficient of thermal expansion. Many calculated correctly, but some, having not read all the information provided, failed to use the correct temperature rise of 100 °C.

(ii) Candidates were asked to state the unit for the coefficient ($°C^{-1}$). A significant number of more able candidates were able to work this out.

(iii) Using their calculated values, candidates had to select which of the metals would expand the least. Some candidates misunderstood the number of zeros after the decimal point and gave an incorrect answer.

(c) Candidates were then required to suggest where, in everyday life, expansion of metals is useful and where it is a problem, Examiners were expecting to see real-life cases. The use of expansion in thermostats, fire alarms and thermometers were some of the expected answers for the former

and the buckling of railway tracks or the need to leave expansion gaps in bridges for the latter. General responses such as 'railways' were not creditworthy.

Question 6

In this question candidates had to determine which of two household cleaners would be the best for removing fat.

(a) (i) Universal Indicator was used to follow the neutralisation of the alkali and candidates were asked for the colour change. Therefore two colours were required; the colour changes from blue / purple to green. A number of candidates gave a single colour and many gave wrong colours.

(ii) Candidates were supplied with titration figures for the first cleaner and were required to calculate the volume of acid added in two titrations and then the average. Although this caused few problems to the majority of candidates, a significant minority did not correctly complete this section.

(iii) To calculate the concentration of the first cleaner, candidates had to divide their average (whether it was a correct figure or a reasonable answer if an error had been made) by 25. Most were able to do this.

(b) (i)(ii) Candidates had to do a similar exercise with the second cleaner. This gave similar results as in the previous section.

(c) The second cleaner candidates had to consider a dilution factor. Many candidates were able to calculate this using their answer to part **(b) (ii)**. Some however, used an incorrect figure in their calculation (usually 25).

(d) Candidates had to select the cleaner that would be more effective at removing fat and explain why. The best answers selected the first cleaner, stating that 'it was the most concentrated'.

(e) Finally, candidates had to provide a balanced symbol equation for the reaction, having been given a word equation. A large number of candidates gave the symbol for sodium as S and did not correctly write H_2O for water.