COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Question 1** and **Question 3**.

Questions 6, **Question 18** and **Question 29** proved most difficult for the candidates.

Comments on specific questions

Question 1

This question was answered very well by candidates of all abilities.

Question 3

This question was answered very well by candidates of all abilities. High performing candidates may have found this question very easy.

Question 4

Most candidates did not know the correct answer **C**. There was a relatively even spread of the incorrect answers suggesting that many candidates were guessing.

Question 6

Candidates found this question difficult to answer. Whilst candidates are expected to identify the component included in the question and describe their functions, most candidates did not identify the liver as the site of bile production and the gall bladder as bile storage.

Question 7

Many candidates were distracted by response **A**.

Question 8

Most candidates did get the correct answer, however there were some weaker students that chose option **B**. These candidates may have confused respiration with photosynthesis.

Question 10

Many candidates were distracted by response **D**. It may have been that they did not see the 'not' in the question.

Question 11

Overall this question caused candidates some difficulty. Weaker students were distracted by response **B**. It may be that the candidates that chose **B** did so as this had the number 14 in the response. Most high ability students got the correct answer, but the relative evenness of the spread of the incorrect answers suggested that many candidates were guessing.

Question 12

Many students incorrectly chose **D** or **A** as their preferred options. These candidates may have misread the diagram.

Question 18

Candidates, including the more able, chose the incorrect **A** and **C** more often than the correct answer, **D**. They did not appreciate that the temperature rise in the reaction indicates an exothermic reaction, and that the subsequent temperature decrease occurs through cooling, rather than as a result of an endothermic chemical reaction.

Question 19

More able candidates tended not to choose the correct answer, **D**. They needed to appreciate why apparatus shown in **A**, **B** and **C** are inappropriately set up.

Question 24

Candidates chose the incorrect **D** more often than the correct answer, **B**. They are expected to be able to describe the use of carbon in the extraction of copper from copper oxide.

Question 25

Candidates chose the incorrect **A** more often than the correct answer, **C**. They are expected to know a chemical test for water, and that the boiling point of a liquid is a property linked to a physical change rather than a chemical change.

Question 26

Candidates chose the incorrect **C** and **D** more often than the correct answer, **A**. They are expected to know the uses of three fractions obtained from petroleum, including gasoline, and that combustion of fuels is an exothermic process.

Question 27

More able candidates tended not to choose the correct answer, **D**. They may have confused the structures of methane and ethane. They are expected to be able to identify the structures of methane, ethane, ethene and ethanol.

Question 28

A large proportion of candidates of all abilities opted for **D** in this question on speed-time and distance-time graphs, presumably misreading the *y*-axis of the distance-time graph. Care should be taken over this.

Question 29

This question was very badly answered, showing widespread confusion. Many candidates chose options **C** or **D**, either not realising that density is a property of the material and not dependent on its dimensions, or failing to appreciate that doubling the side length would cause an eightfold increase in volume and therefore mass.

Question 30

A common error here was to believe that the ball had less kinetic energy at Y than at X, whereas it would have none at either point, being at rest in both cases.

Question 37

This question concerned sound waves and, despite this being a frequent topic in previous papers, more than half of the candidates failed to choose the correct option **B**. Although **C** was the closest match to this, the most common mistake was to choose **D**, probably as a result of confusing the amplitude of the wave with pitch.

Question 38

Although a large majority of candidates knew that current in a metal is caused by a flow of electrons, more thought that the flow would be from the positive to the negative terminal rather than the other way round.

Question 39

In this question on e.m.f., resistance and current, option **A** was a popular choice. This represented the smallest e.m.f. but also the least resistance. Once Ohm's law was applied, it became clear that option **D** was correct, despite including a larger value of e.m.f.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments

Question 11 and Question 28 proved straightforward for candidates.

Questions 23, **27**, **29** and **30** proved most difficult for the candidates.

Comments on specific questions

Question 3

On average candidates answered this question well. This question was answered very well by higher ability candidates. Weaker candidates were distracted by response **D**.

Question 4

This question was answered very well by candidates of all abilities. Weaker candidates were distracted by response **C**. Whilst the small intestine does have a role in carbohydrate digestion, it does not have a role in egestion.

Question 6

Candidates found this question difficult to answer. Most chose option **A** even though this is not biologically correct. Plasma is used to transport antibodies, not to produce them. White blood cells are where antibodies are formed.

Question 7

Most candidates did get the correct answer, however many students of a lower ability chose option **B**. These candidates may have confused respiration with photosynthesis.

Question 10

This question was answered well by high ability students but many other candidates dismissed the correct answer in favour of the three other incorrect responses.

Question 12

Many lower ability students chose the incorrect **D** as their preferred option. These candidates may have misread the diagram.

Question 15

More able candidates tended not to choose the correct answer, **A**. They are expected to be able to describe paper chromatography, as well as to interpret simple chromatograms.

Question 16

More able candidates chose the incorrect **A** rather than the correct answer, **C**. They confused the number of neutrons with the mass (nucleon) number. Weaker candidates thought that protons orbit the nucleus.

Question 20

More able candidates chose the incorrect **A** rather than the correct answer, **D**. Weaker candidates chose the incorrect **C**. They are expected to be able to know that a catalyst is an agent which increases the rate of a chemical reaction and that it remains unchanged at the end of the reaction.

Question 21

There was evidence that many candidates guessed at the answer to this question. They should be able to identify oxidation and reduction reactions from word equations.

Question 23

More able candidates chose the incorrect **C** rather than the correct answer, **B**. Weaker candidates chose the incorrect **D**. They are expected to know the physical state of bromine, and that this element must have a lower melting point than potassium and iron. They are also expected to the trend in the melting points of Group I metals, and that potassium has a relatively low melting point.

Question 24

More able candidates tended not to choose the correct answer, **A**. They are expected to be able to identify the position of the transition elements, and to know the properties of these elements.

Question 26

More able candidates chose the incorrect **B** rather than the correct answer, **A**. They did not realise that water turns white copper sulfate crystals to blue.

Question 27

More able candidates chose the incorrect **C** rather than the correct answer, **A**. Weaker candidates chose the incorrect **B**. They are expected to know the uses of several fractions obtained from petroleum, including gasoline, and that combustion of fuels is an exothermic process.

Question 29

Almost half the candidates believed that the unit of mass is the newton and that the mass of an object would be different on another planet.

Question 29

This question was very badly answered, showing widespread confusion. Many candidates chose options **C** or **D**, either not realising that density is a property of the material and not dependent on its dimensions, or failing to appreciate that doubling the side length would cause an eightfold increase in volume and therefore mass.

Question 31

Here one in three thought that option **B** was correct. This was a situation in which the man's legs are working rather than his arms, and these candidates may have thought this not to be working.

Question 32

In this question on evaporation a third of candidates, although aware that it is the more energetic molecules leaving the surface, believed that the temperature of the remaining liquid rises.

Question 34

There appeared to be much guessing in this question on critical angle, with option **A** being more popular than the correct **C**.

Question 35

A widespread belief here was that satellites transmit television signals by radio waves rather than microwaves, although a large majority knew that infra-red is used for television remote controllers.

Question 36

This question concerned sound waves and, despite this being a frequent topic in previous papers, a large number of candidates failed to choose the correct option **B**. Although **C** was the closest match to this, the most common mistake was to choose **D**, probably as a result of confusing the amplitude of the wave with pitch.

Question 37

Almost twice as many here chose the list of conductors instead of the list of insulators, as required.

Question 40

Guessing was evident again here, showing uncertainty over the topic of currents in parallel circuits.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Question 20** and **Question 28**.

Questions 3, **11**, **12**, **27**, **33** and **39** proved most difficult for the candidates.

Comments on specific questions

Question 3

To access this question, candidates had to realise that incubating an enzyme at a temperature of 90 °C for 30 minutes would denature the enzyme. This would mean that the conversion of starch to simple sugars would not have happened and therefore no sugar would have been produced. It may be that many students thought that the enzyme would only be denatured whilst at 90 °C and hence why they chose **A**. Students need to be reminded that denaturing is permanent for most enzymes.

Question 4

On average candidates answered this question well. This question was answered very well by higher ability candidates. Other candidates were distracted by response **B**.

Question 5

This question was answered very well by higher ability candidates. Weaker candidates were distracted by response **C**. It may be that there is confusion here with the role of the cuticle (*preventing* water loss).

Question 7

There were some higher ability students that chose option **B**. These candidates may have confused respiration with photosynthesis.

Question 9

Most candidates performed poorly with this question. Most went for **C** as the answer. This could be that many candidates thought that germination requires photosynthesis rather than respiration. This may be why they chose the option with light and no oxygen.

Question 10

This question was answered better by the weaker candidates. It appears that the stronger candidates may have 'over-thought' the question. The most likely place for fertilisation to occur in humans is the oviducts.

Question 11

This question was not answered well. Many candidates of all abilities wrongly included the sun in the food chain.

Question 12

This question performed well at discriminating between low and high ability students. Most high ability students got the correct response. Lower ability students chose **D** and then **A** as their preferred options. These candidates may have misread the diagram.

Question 13

Most low performing candidates were distracted by option **C**. Stronger candidates did identify **A** as the correct answer. Candidates need to make the link between photosynthesis and the capture of carbon dioxide as a way of reducing global warming.

Question 14

More able candidates chose the incorrect **D** more often than the correct answer, **B**. They had confused the terms *atom* and *molecule*, which they are expected to understand.

Question 16

More able candidates chose the incorrect **B** more often than the correct answer, **D**. They are expected to understand simple diagrammatic representations of mixtures and compounds.

Question 17

The incorrect **D** was chosen more often than the correct answer, **B**. Whilst reduction is involved in the breakdown of lead bromide, understanding of this during electrolysis is not a requirement.

Question 19

The incorrect **D** was chosen more often than the correct answer, **C**. Although candidates did identify the greatest temperature changes, they confused the terms *endothermic* and *exothermic*.

Question 20

Candidates were clearly familiar with the term *catalyst* and they understood what this term means.

Question 21

Many able candidates chose the incorrect **C** rather than the correct answer, **A**. They chose a description of the reduction of iron, which does occur, rather than a statement that was **not** correct.

Question 23

Some more able candidates chose the incorrect **C** rather than the correct answer, **B**. They had, perhaps, mistaken Kr, the symbol for the noble gas krypton, as the symbol for the reactive metal potassium.

Question 25

Candidates chose the incorrect **D** more often than the correct answer, **B**. They are expected to know that carbon, and not sodium, is used in the extraction of copper from copper oxide.

Question 27

More able candidates chose the incorrect **C** more often than the correct answer, **A**. Other candidates chose the incorrect **B** and **D** more often than the correct answer. They are expected to know the uses of three fractions obtained from petroleum, including gasoline.

Question 29

Here many candidates chose option **D**, failing to realise that doubling the side length would cause an eightfold increase in volume and therefore mass.

Question 30

It seems likely that the third of candidates who chose the incandescent lamp as being the most efficient failed to notice that the useful energy in this case was light, not heat.

Question 33

There seems to have been widespread guessing of the answer to this question on convection, with the incorrect options **A** and **C** being popular choices.

Question 35

Although most knew in which direction the light would be refracted, a sizeable proportion chose option **D**, with the angles measured to the interface rather than to the normal.

Question 39

This question simply involved the choice of a fuse symbol for the circuit shown, but was nevertheless very badly answered. This suggests that either many candidates did not know the purpose of a fuse, or could not identify its circuit symbol. Many chose the variable resistor, and even more opted for the switch, despite that fact that it was required to operate automatically if there was too much current.

Question 40

Many less able candidates believed that the parallel combination of resistors would have a combined resistance greater than 10 Ω.

COMBINED SCIENCE

Paper 0653/21
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 2**, **3**, **17** and **34**.

Questions 6, **25**, **29**, **35** and **40** proved most difficult for the candidates.

Comments on specific questions

Question 3

This question was answered very well by candidates of all abilities.

Question 5

This question was answered very well by candidates of all abilities. High performing candidates found this question easy suggesting candidates are familiar with the context.

Question 6

Candidates found this question difficult to answer. Whilst candidates are expected to identify the component include in the question and describe their functions, most lower ability candidates did not identify the liver as the site of bile production and the gall bladder as bile storage.

Question 7

Most candidates identified the correct diagram although option **A** was a popular distractor for lower ability candidates.

Question 10

This question was answered very well by higher ability candidates. Weaker candidates were distracted by response **D**. It may have been that they did not see the 'not' in the question.

Question 12

Most candidates were familiar with the definition of a trophic level.

Question 16

Less able candidates chose the incorrect **A** more often than the correct answer, **D**. They confused the dot-and-cross diagram for ethane with that of ethene.

Question 17

It is very clear that candidates are able to link the names and formulae of different acids.

Question 22

Some of the more able candidates chose the incorrect **A** rather than the correct answer, **B**. They had thought that reactive metals form *anions*, whereas they actually form *cations*. Both of these terms are used in the syllabus.

Question 24

Some of the less able candidates chose the incorrect **C** rather than the correct answer, **A**. They are expected to know the uses of two noble gases, including argon.

Question 25

More able candidates chose the incorrect **D** as often as the correct answer, **B**. Less able candidates chose the incorrect **C** more often than the correct answer. These candidates chose correct statements rather than the statement about metals that is **not** correct.

Question 26

Candidates chose the incorrect **C** more often than the correct answer, **A**. They are expected to know the uses of three fractions obtained from petroleum, including gasoline, and that combustion of fuels is an exothermic process.

Question 29

This question was badly answered, showing widespread confusion. Many candidates chose options **C** or **D**, either not realising that density is a property of the material and not dependent on its dimensions, or failing to appreciate that doubling the side length would cause an eightfold increase in volume and therefore mass.

Question 33

In this question on evaporation a quarter of candidates, although aware that it is the more energetic molecules leaving the surface, believed that the temperature of the remaining liquid rises.

Question 35

The topic of this question was waves and a large proportion of candidates incorrectly chose option **D**. They seem to have used the correct wave equation and rearranged it correctly to make frequency the subject, but unfortunately failed to double the distance given in order to find the wavelength.

Question 37

In this question on sound waves almost three quarters failed to choose the correct option **B**. Although **C** was the closest match to this, by far the most common mistake was to choose **D**, probably as a result of confusing the amplitude of the wave with pitch.

Question 39

Guessing was apparent here, with only one in three candidates being able to place the resistances of the wires in order.

Question 40

A very common mistake in this question on electrical energy was a failure to convert the time given to seconds, resulting in the choice of option **D**. Candidates should be warned to be very careful when the unit used for time is not the second.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments

Questions 11, **13** and **32** gave candidates little difficulty.

Candidates found **Questions 7**, **8**, **26**, **30**, **35** and **39** much more difficult.

Comments on specific questions

Question 1

Most candidates recognised the definition of the cell membrane and were able to identify it on the diagram.

Question 4

Some candidates were distracted by response **A**. Candidates may have identified calcium as one of the nutrients, and then been left with a 50:50 choice between iron and vitamin D.

Question 5

This question was answered very well by candidates of all abilities. Nearly all candidates knew where chlorophyll was present in the leaf but some were less confident about the presence of starch and the test result.

Question 6

This question was answered very well by higher ability candidates, many may have found this question very easy. Weaker candidates were distracted by response **A** and **C**. Candidates need to remember that plants generate their own glucose via photosynthesis.

Question 7

This question was answered very well by higher ability candidates. Weaker candidates were distracted by all other responses, indicating a fair degree of guessing.

Question 8

This question was answered well by higher ability candidates. Weaker candidates did not do so well being distracted by responses **B** and **C**. This may be because they incorrectly read the question which states that six molecules of glucose are respired. This was also a mistake by several higher ability candidates.

Question 15

Some of the more able candidates chose the incorrect **C** rather than the correct answer, **A**. They are expected to be able to describe the process of paper chromatography, as well as to interpret simple chromatograms.

Question 26

Candidates chose the incorrect **C** more often than the correct answer, **A**. They are expected to know the uses of three fractions obtained from petroleum, including gasoline, and that combustion of fuels is an exothermic process.

Question 27

The distractor **A** and correct answer **D** were similarly popular among lower ability candidates suggesting that there was some guesswork involved after eliminating **B** and **C** as possible answers.

Question 30

This question was not well answered, showing confusion with the topic. Many candidates chose option **D**, failing to appreciate that doubling the side length would cause an eightfold increase in volume and therefore mass.

Question 33

Many candidates, although aware that it is the more energetic molecules leaving the surface, believed that the temperature of the remaining liquid rises.

Question 35

A widespread belief here was that satellites transmit television signals by radio waves rather than microwaves, although a very large majority knew that infra-red is used for television remote controllers.

Question 36

Here many candidates failed to appreciate that the image would be 'approaching' the mirror at the same speed as the girl, giving a combined speed of 2.0 m / s.

Question 39

Option **D** was chosen here by candidates who failed to read the question carefully and opted for the value of the total power rather than the power produced by each lamp. Others chose option **A**, possibly having divided the power supply voltage by the total current.

COMBINED SCIENCE

Paper 0653/23
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 1**, **5**, **16**, and **20**.

Candidates found **Questions 3**, **25**, **30** and **40** difficult.

Comments on specific questions

Question 1

This question was answered very well by candidates of all abilities, many may have found this question very easy.

Question 3

Most higher ability candidates were able to access this mark. However, many lower ability candidates were distracted by **B**. This is a typical graph showing the effect of heat on enzyme activity. Students need to be reminded to read the question and to look at the context of the question.

Question 7

This question was answered very well by candidates of all abilities. High performing candidates may have found this question very easy. Where weaker candidates did not know the correct answer there was a relatively even spread of the incorrect answers suggesting that these candidates were guessing.

Question 8

Some lower ability candidates were distracted by response **A**. Candidates need to have the role of the cilia reinforced or need to identify cilia in the diagram.

Question 10

This question performed well. Most high and low performing candidates identified the correct response. Where candidates did not know the correct answer there was a relatively even spread between **A**, **B** and **C** indicating that **D** was easily dismissed but that the candidates were guessing between the remaining options. This may have been be caused by confusing the need for photosynthesis and respiration in germinating seeds. Candidates should be reminded that most seeds germinate in the dark and therefore photosynthesis cannot happen until the shoot reaches light.

Question 11

This question was answered very well by higher ability candidates. Other candidates were distracted by response **D**. They may think that because blood travels in two directions down the umbilical cord this is the site of exchange.

Question 14

Candidates knew well that covalent molecules are close together and vibrate about a fixed point.

Question 15

Candidates were easily able to identify the correct use of apparatus used to separate the different colours in an ink by chromatography.

Question 16

Candidates had no difficulty in identifying the electronic structure of a noble gas as one that had the full outer shell of electrons.

Question 20

Candidates were very clearly familiar with the term *catalyst* and they understood well what this term means.

Question 23

Candidates were easily to be able to identify the position of the transition elements in the Periodic Table, and they knew well properties of these elements.

Question 24

Candidates clearly knew the use of helium to fill weather balloons.

Question 29

Although this question on density was generally well answered, slightly more than one in four candidates chose option **D**, failing to appreciate that doubling the side length would cause an eightfold increase in volume and therefore mass.

Question 30

The topic here was the limit of proportionality of a wire, and there appears to have been some guessing between options **A**, **B** and the correct **C**. **A** was particularly popular for more able candidates, being a reflection of the correct response, and **B** was a common choice for the less able, showing a point of maximum extension on the same reflection.

Question 34

A large majority were aware of the longitudinal nature of sound waves, but a quarter of weaker candidates seemed to have divided the frequency by the speed, rather than the other way round, therefore arriving at option **A**.

Question 35

In this question about the image formed by a plane mirror the most common mistake was a failure to realise that the girl's image would also become 2.0 m closer to the mirror, giving a combined distance change of 4.0 m.

Question 37

Here several weaker candidates found difficulty in placing the resistances of the wires in order.

Question 39

This question simply involved the choice of a fuse symbol for the circuit shown, and was well answered by the majority. However several weaker candidates had difficulty, suggesting that either they did not know the purpose of a fuse, or could not identify its circuit symbol; most chose the variable resistor or the switch.

Question 40

This was by far the worst answered of the physics questions on the paper. The correct response, **A**, was the least popular, with options **B** and **C** being chosen by many more candidates. These involved either an incorrect ammeter reading or an incorrect voltmeter reading, and suggest widespread confusion over current and voltage rules in a series circuit.

COMBINED SCIENCE

Paper 0653/31
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and use all the information to ensure they answer exactly the question that is being asked. Detail that is provided in a question points candidates towards the specific information that is required for an accurate answer.

Where there are multiple marks for an answer, care should be taken to include sufficient detail; for example, if a question is worth two or three marks, multiple points will usually need to be made.

In questions involving calculations candidates are advised to show all their working. Partial credit can be gained where candidates recall the correct formula even if the numerical answer is incorrect.

General comments

Some good responses were seen in this paper, with a number of candidates showing a sound understanding of the Core syllabus.

Many candidates find it difficult to provide a clear explanation of terms given in the syllabus. Being able to provide a clear statement of the meaning of scientific terms is an important part of this course.

Comments on specific questions

Question 1

(a) Many candidates correctly identified breathing and digestion as the processes which were not characteristics of all living things from the list, suggesting a good understanding of this part of the syllabus.

(b) (i) The question asked for one structure to be labelled and candidates should be careful to follow this instruction so that they gain full credit for a correct structure. Either the cell wall or vacuole correctly labelled gained credit here, but a few candidates added additional incorrect labels, such as cell membrane or nucleus and so could not be given full credit. Cell wall was the most common correct label seen.

(ii) With three marks available candidates needed to provide some detail for full credit. Many responses gained some credit for identifying water taken in by root hair cells and then transported either through the stem or in the xylem. A common misunderstanding seemed to be that both the xylem and phloem were involved in transporting the water to the palisade cells. The strongest responses also included detail about osmosis.

(c) (i) Candidates struggled to recall the term phototropism here, and quite a few candidates incorrectly described the response as photosynthesis.

(ii) A good number of candidates realised that the separation of the leaves allowed more light to be received by the plant. However, to gain full credit for this two-mark question, the advantage of this feature needed to be linked to photosynthesis and only the strongest candidates gave a detailed enough answer for full credit.

Question 2

(a) Here candidates were expected to select the correct terms from a given list and almost all candidates completed every section. Identifying atoms and ions was done well by many candidates. In part **(ii)** a number of candidates did not read the question carefully enough to see that *compounds* did not correctly describe all atoms joined by sharing electrons, since there are ionic compounds. In part **(iv)** weaker responses sometimes confused mixtures and compounds, placing the two terms in the wrong gaps.

(b) (i) About half the candidates gained full credit here, with some weaker responses stating the names of the two electrodes but placing them in the wrong boxes.

(ii) A good number of candidates correctly identified that copper is the solid produced. Answers for the gas were more varied with a few candidates perhaps recognising that the gas would be chlorine but writing the incorrect 'chloride' in the space. However, a wide range of answers were seen for the gas, including bromine, which suggested that candidates had not read the question carefully.

Question 3

(a) (i) Most candidates correctly named force Z as the gravitational force or weight of the train.

(ii) To gain credit here, candidates needed to state both that the forces were equal and that this is because the train is travelling with a constant speed. Some candidates needed to read the question more carefully which stated that the arrows did not indicate the size of the forces.

(b) (i) Candidates showed secure understanding of how changing speed is indicated on a speed-time graph. A few candidates labelled particular points on the graph where a transition from changing speed to constant speed took place, which suggested they were less confident in interpreting a speed-time graph.

(ii) Many candidates correctly converted 12.8 km to 12 800 m. The most common incorrect response seen was 1280, suggesting candidates had either made a slip in the calculation or believed there are 100 m in each km, rather than 1 000 m.

(iii) To gain full credit here, candidates had to recall the formula average speed = average distance/total time and then to identify the time taken for the journey from the speed-time graph. Candidates should always write down their working as they can sometimes gain partial credit for an answer even if the numerical final answer is not correct. Correct recall of the formula or identification of the correct time from the graph could gain one of the marks. Here the final answer was 19.7 m/s.

(c) Many candidates correctly identified that the moving train has kinetic energy. Fewer candidates were able to state that this comes from chemical energy in the coal.

(d) A few candidates recognised that coal was a fossil fuel but were unable to state that the original source of its energy is the Sun. Many simply stated a type of energy, such as thermal or chemical energy. Candidates should be encouraged to take careful note of words in bold in a question which offer clues to the answer required.

Question 4

(a) Many candidates correctly identified seaweed as the producer and selected a correct consumer from the food web. The term herbivore was less well understood. A few candidates identified starfish as the herbivore which may have indicated a misreading of information in the question. Candidates do need to take care to record information accurately.

(b) The answers here suggested a good understanding of food chains. Where candidates did not gain full credit, it was often for providing incomplete food chains, selecting only some of the chain from the web given in the question. A few weaker responses did not include arrows in the chains and occasionally candidates made food chains of their own including plants and animals not given in the question.

(c) A good number of candidates identified that the octopus would have less food. Only the strongest candidates recognised that the sealion, having also lost a food source, would now eat more octopus.

Question 5

(a) (i) To gain credit here, candidates needed to realise that for a sulfate to be formed sulfuric acid is needed. The answer needed to be precise and a reference to 'sulfur' or 'sulfate' was insufficient to identify sulfuric acid.

(ii) While stronger candidates stated clearly that pH increases, many answers were about colour changes or the mixture becoming an alkali. Candidates need to read the question carefully and answer exactly the question that is being asked.

(iii) Candidates are expected to know the characteristic reactions between acids and bases or carbonates. Very few correct answers were seen here suggesting that this is poorly understood by candidates or that they were not able to apply their knowledge to the specific situation in the question.

(iv) About half the candidates could explain the term exothermic as being a reaction in which temperature increases or thermal energy is released. A few candidates were unclear about whether thermal energy was being taken in or given out in the reaction, suggesting a lack of clear understanding of the terms exothermic and endothermic.

(b) Filtering was correctly identified as the method by a good many candidates. Where full credit was not gained, it was often for an explanation of filtering that lacked the necessary clarity. The important point is that the solid does not pass through the filter paper whereas the liquid does.

(c) (i) Candidates are expected to be able to say that metals are found on the left of a period in the Periodic Table and use this knowledge to identify calcium as having the properties of a metal; being a good electrical conductor and having a high melting point. Very few candidates showed a good understanding of this.

(ii) Stronger candidates were able to recall the correct order of reactivity for the three metals in the question; sodium, calcium and magnesium.

Question 6

(a) To gain credit here candidates needed to have a good understanding of the term 'property'. Answers, which often named liquids used in thermometers, suggested that many candidates did not fully understand the question.

(b) (i) Some candidates were able to identify ethanol as the suitable substance from the table, gaining some credit here. Explanations often involved simply quoting the melting and boiling points rather than explaining why the particular melting (and boiling) point of ethanol made it suitable. Candidates were not able to apply their knowledge to realise that the liquid in the thermometer must be a liquid over the entire range of measurement required.

(ii) Only the very strongest candidates realised that the key to this question was linking the melting point of gallium to room temperature and realising that Gallium would be a solid at room temperature.

(c) (i) Just over half of candidates correctly identified that there were four complete wavelengths in the diagram. The most common incorrect answers seen were three, which suggested that candidates had not considered the diagram carefully enough to note four full wavelengths, and eight, which suggested candidates were incorrectly counting from one peak to the next trough as a whole wavelength.

(ii) In this question candidates are being asked to apply their knowledge of the main features of the electromagnetic spectrum. They are given information about how the wavelength of the emitted radiation varies with temperature. They know that within the electromagnetic spectrum, as wavelength decreases the frequency increases and should use this to say that frequency will increase as the temperature of the hot body increases. Only the strongest candidates were able to

explain this clearly although more candidates did predict that frequency would increase and so gained some credit.

(iii) When asked to complete a ray diagram, candidates should always use a ruler and a sharp pencil to draw thin, neat lines. A number of candidates brought their rays to a focus in front of the detector and some candidates did not have a clear intersection of the three rays on their diagram at all.

Question 7

(a) This question was attempted by almost all candidates with most gaining at least some credit. Knowing that arteries carried blood away from the heart and that capillaries are one cell thick were the best understood features. A few candidates thought that both arteries and veins carried blood away from the heart.

(b) (i) Many candidates identified increased heart/pulse rate as an effect of adrenaline on the body. Increase in blood glucose concentration and increase in breathing rate were seen in some answers. Candidates need to describe an effect, such as an increase in the rate of respiration, rather than just give a vague answer such as 'more energy is released' to gain credit. They should also realise that 'increased heart rate' and 'increased pulse rate' are two ways of expressing the same effect.

(ii) **C**andidates gained credit here for stating that adrenaline is destroyed in the liver.

(c) (i) Candidates demonstrated a good knowledge of foods which are a good source of calcium. The most popular answer seen was milk, with other dairy foods and fish seen occasionally.

(ii) Many correct answers were given to this question. The importance of calcium is in the growth of strong bones/teeth and so a reference to 'development of bones/teeth' was insufficient to gain credit here.

(iii) A good number of candidates gave appropriate symptoms for iron deficiency. Some weaker responses seemed to continue from part **(ii)** and give answers about weaker bones suggesting that candidates had not read the question carefully enough and realised that this part was about iron deficiency and not calcium deficiency.

Question 8

(a) (i) Strong candidates gained credit here for fractional distillation. A number of weaker candidates offered no answer to this question, and the incomplete answer 'distillation' was very rarely seen, suggesting that candidates either recalled this process confidently or did not.

(ii) The syllabus requires candidates to learn uses of three different fractions of petroleum, including gas oil. The incorrect answers 'cooking' and 'heating' were often seen here, suggesting that candidates were not secure in understanding which use applies to which fraction. It was important to state that the use of gas oil is as a fuel, rather than just giving a vague answer about 'used in vehicles'.

(b) A good number of candidates gained at least some credit here for identifying oxygen and carbon dioxide gases, with the best responses stating the changes in the amount of each in air. A number of weaker responses identified carbon monoxide, a product of incomplete combustion. It is important that candidates read the question carefully as here they were told that this question was about the complete combustion of gasoline.

(c) About half of candidates correctly recalled the structure of a molecule of ethanol. A number only gained partial credit by missing out the single bond between the O-H. Again, it was necessary to read the question carefully as all bonds between atoms were explicitly requested.

Question 9

(a) (i) This question required candidates to read carefully all the information about the circuit components and use it to complete the circuit diagram. Credit was gained for knowing the correct symbol for a switch and for placing the heater and motor in parallel. Candidates gained full credit for placing the switch in the main part of the circuit where it would turn both the motor and heater on and off. A number of candidates did not include a switch in their circuit and weaker responses often put the motor and heater in series with each other.

(ii) The fuse symbol was recognised by fewer than half of candidates with many believing it was the symbol for a resistor. Even the strongest candidates, having identified the fuse, found it difficult to give the reason for including a fuse as the protection of components/wiring from excess current. A vague answer about 'controlling the current' was insufficient as this is the function of a variable resistor, rather than a fuse.

(b) (i) Candidates were provided with the formula $R = V/I$ and expected to rearrange it so that they could calculate the current, I. They also needed to find the value for V from Fig. 9.2 and give the correct unit for current with their final answer. Candidates should always show their working in questions involving calculations as some credit can often be awarded even if the correct answer is not obtained. Candidates demonstrated good ability at rearranging the formula. Some candidates were not able to find the voltage value to use in the formula. Credit for knowing that the unit of current is A/amps was awarded even if the numerical answer was incorrect. A number of candidates did not include the unit in their answer. The correct numerical answer was 10 A.

(ii) Candidates are expected to know that the combined resistance of two resistors in parallel is less than that of either resistor by itself. This knowledge would lead them to choose 3.4Ω. The vast majority of candidates simply added the two resistances and chose the answer 28Ω. The few candidates who chose 3.4Ω were generally able to give the correct reason and gain credit here.

COMBINED SCIENCE

Paper 0653/32
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and use all the information to ensure they answer exactly the question that is being asked.

Where there are multiple marks for an answer, care should be taken to include sufficient detail; for example, if a question is worth two or three marks, multiple points will usually need to be made. Candidates should avoid simply repeating words and phrases given in the stem of the question.

General comments

Some good responses were seen in this paper, with a number of candidates showing a sound understanding of the Core syllabus.

Many candidates find it difficult to provide a clear explanation of terms given in the syllabus. Being able to provide a clear statement of the meaning of scientific terms is an important part of this course.

Comments on specific questions

Question 1

(a) Many candidates were able to link both function and name of cell to the correct diagram and gain full credit in this question. The most common error seen was confusing the diagrams of the white and red blood cells. Only a few weaker candidates were not able to match the name of a cell with its function.

(b) To gain full credit here, candidates needed to take a careful measurement of the diameter of the cell in the diagram and then recall and use the formula to calculate the magnification of the diagram. There were a couple of common errors in measurement; either measuring in centimetres and not converting to millimetres or wrongly converting from centimetres to millimetres. A good number of candidates were able to recall and use the formula to calculate magnification correctly.

(c) Almost all candidates were able to select three substances from the given list. Only the strongest candidates gained full credit for their choices. Of those candidates who correctly identified two substances transported by blood plasma, carbon dioxide and platelets were most commonly chosen.

(d) (i) In this question candidates were expected to identify that chemical digestion is important for producing small, soluble molecules that can be absorbed. With three marks available, candidates needed to realise that a good level of detail was required. Weaker responses were more likely to feature ‘pieces’ of food rather than ‘molecules’ and so did not gain full credit. The most common way of gaining full credit was to write about large molecules being broken down into small molecules. Very few candidates included the detail that this happened to enable absorption of the soluble molecules.

(ii) Many suitable answers were seen, the most common being the stomach. The answer ‘mouth’ was not given credit since it is the salivary glands that are the organ that produces the enzymes that work in the mouth.

Question 2

(a) (i) Many candidates gained full credit here. Filtering was the more common answer seen where partial credit was gained. Weaker candidates were more likely to simply identify process B as 'heating' or 'boiling'.

(ii) Candidates needed to realise that a single piece of metal carbonate would have a much smaller surface area in contact with the acid than the same mass of powdered metal carbonate and so would produce a slower rate of reaction. This did not seem to be well understood by candidates and many stated that the reaction rate would increase with the single piece of metal carbonate.

(iii) Many more candidates knew that a more concentrated acid would increase the rate of the reaction and gained credit here.

(iv) A good number of candidates correctly recalled that exothermic reactions cause temperature to increase. The most common incorrect response here was endothermic, suggesting weaker candidates had not confidently grasped the difference between these two types of reaction.

(b) (i) Here candidates were provided with the names of both reactants and one of the products in a chemical reaction. Given the information that a colourless gas and a colourless liquid are also formed they were asked to complete the word equation for the reaction. Most candidates were able to gain a mark for correctly placing the named reactant and product in the word equation. Only the best responses identified both the colourless gas and liquid for full credit.

(ii) Only the strongest candidates were able to identify both the test for aqueous copper (II) ions and the observations for a positive result. Candidates needed to state clearly that a blue precipitate would be formed with sodium hydroxide, not just a blue colour seen.

(iii) A careful reading of this question allowed strong candidates to identify a property specific to transition metals, and not just a property of metals more generally, and gain credit here. Some weaker responses named a metal, suggesting it was not understood that a property was being asked for.

Question 3

(a) (i) Almost all candidates showed a secure understanding that the gravitational force acting on the trailer was downwards.

(ii) To gain full credit here candidates needed to identify that Force Y must be the same as Force W and explain that the reason for this is that the tractor and trailer are moving at a constant speed. Some candidates were able to state that Force Y = 2000 N even though they could not explain clearly why.

(b) (i) To gain credit here, candidates needed to identify a point on the speed-time graph which showed changing speed. Some candidates seemed less confident in interpreting the graph and placed the letter C very close to the region of constant speed.

(ii) To gain full credit here, candidates had to recall the formula average speed = average distance/total time and then to identify the time taken for the journey from the speed-time graph. Candidates should always write down their working as they can sometimes gain partial credit for an answer even if the numerical final answer is not correct. Correct recall of the formula or identification of the correct time from the graph could gain one of the marks. Here the final answer was 3.3 m/s.

(c) (i) Candidates needed to identify two types of energy here, the chemical energy stored in the diesel oil and the kinetic energy of the moving tractor. A good number of candidates gained full credit. Weaker candidates sometimes referred to thermal energy, rather than the chemical energy in the diesel oil and the weakest candidates were not able to identify types of energy here at all.

(ii) A number of candidates recognised that diesel oil was a fossil fuel but were unable to state that therefore the original source of its energy is the Sun. Candidates should be encouraged to take careful note of words in bold which offer clues to the answer required in a question.

(iii) This question required candidates to use their qualitative understanding of efficiency to realise that most of the wasted energy would be converted to thermal energy. This did not seem to be well understood by the majority of candidates. A reference to sound energy was insufficient to gain credit here, since the question specifically asked about most of the wasted energy.

Question 4

(a) Only the strongest candidates were able to gain full credit here by realising that boiling the potato has prevented the enzyme activity. This could be expressed in several ways such as destroying or deactivating, but not by killing the enzyme.

(b) (i) A lot of candidates repeated information from the question stem in their answer. Some gained partial credit for recognising that sewage contains bacteria and the strongest candidates were able to suggest that this puts humans at risk of disease.

(ii) To answer this question well, candidates needed to read the question carefully. Many were still answering the previous question about the effect of the sewage spill, whereas here candidates were being asked specifically about the effect of a drop in oxygen levels on animals living in the river. While some candidates recognised that animals might die only the strongest were able to explain why this would happen and gain full credit.

Question 5

(a) (i) Candidates are expected to know that coal, gas and petroleum are all fossil fuels. A good number of candidates recalled petroleum here. Candidates need to be careful to name the fuel itself rather than one of the products derived from fractional distillation of petroleum.

(ii) Stronger candidates correctly recalled methane as the main constituent of natural gas.

(b) (i) Candidates could gain credit here either by recalling that alkanes are generally unreactive or by describing that the exception to this is that they burn well. This proved to be a very difficult question for many candidates who often mentioned single bonds or the fact that alkanes are carbohydrates rather than describing their chemical properties.

(ii) More than half of candidates were able to draw the molecular structure of ethane correctly and gain full credit here. A few candidates incorrectly drew a methane molecule and a few of the weakest candidates made no attempt at this question.

(c) (i) Defining the atomic number as the number of protons in an atom proved difficult for many candidates. There seemed to be a lot of confusion about terms with many writing that it is the number of atoms in an element.

(ii) This question required candidates to recall the differences in properties of protons, electrons and neutrons. Most candidates were able to gain some credit with just the very strongest candidates gaining full credit. A common misunderstanding seen was the relative mass of an electron given as 1.

Question 6

(a) (i) (ii) These two questions together were testing candidates' ability to identify properties that could be used to distinguish between a liquid and a solid and then describe the difference in terms of the arrangement of molecules. A number of candidates were able to distinguish a liquid by the fact that it takes the shape of its container. Candidates often found it easier to explain this in terms of solids not being able to flow because the molecules are fixed in a regular arrangement. Some candidates confused the arrangement of molecules in liquids with that of gases, talking about molecules being far apart and moving freely which limited the credit they gained here.

(b) Some candidates correctly identified a thermometer as making use of thermal expansion, although many candidates seemed to misunderstand the question and name a measuring cylinder which would be used to measure the volume of the liquid. Presumably they thought they were being asked to measure the expansion rather than make use of it.

(c) This question was answered well by a good number of candidates with many realising that the drink did not lose thermal energy by radiation. Some candidates did not understand that the drink would lose thermal energy by conduction through the sides and base of the cup.

(d) (i) The key idea in this question is that conduction and convection both require a medium to travel through whereas radiation does not. Candidates found it hard to express this clearly and only the strongest gained credit here.

(ii) Over half of the candidates placed gamma radiation in the box at the left of the electromagnetic spectrum showing a good recall of the place of gamma radiation in the electromagnetic spectrum. Each of the possible incorrect placements was seen in approximately equal numbers.

(iii) When asked to complete a ray diagram, candidates should always use a ruler and a sharp pencil to draw thin, neat lines. A number of candidates brought their rays to a focus before the screen and some candidates did not have a clear intersection of the three rays on their diagram at all.

(iv) A number of candidates did not attempt this question. In the answers seen there was evidence that candidates did not have a clear understanding of the term focal length, so that even candidates who had gained credit in part **(iii)** were not able to mark the focal length correctly on their diagram.

Question 7

(a) (i) most candidates were able to recognise diagram A as the root and stronger candidates gained partial credit by noticing the root hairs in diagram A. Very few candidates were able to gain full credit here, which required them to describe the different arrangement of vascular tissue in the two root diagram.

(ii) This question was not attempted at all by a large number of candidates. A good number correctly identified the xylem. Candidates must be careful to follow instructions carefully as a few candidates shaded parts of diagram A in error.

(b) Selecting answers from the list allowed all candidates to attempt this question, with the strongest candidates able to gain full credit. Common misunderstandings seen were the idea that water vapour dissolves out of the leaves or the idea that the tiny holes are called the cuticle.

(c) Many candidates were able to recall the word equation for photosynthesis. Where full credit was not gained it was often for answer that had the correct chemical names wrongly placed in the equation.

Question 8

(a) Candidates could gain credit here either by predicting that electrolysis would not happen and explaining that the lead bromide was a solid or that it needed to be a liquid. Weaker candidates who identified that there was no electrolysis often suggested that a high voltage power supply was needed, suggesting a lack of understanding of electrolysis.

(b) Very few candidates gained full credit here although a good number identified chlorine as the gas produced. Some candidates incorrectly identified the gas as chloride and only the strongest candidates were able to state that chlorine will bleach litmus paper.

(c) This question tested candidates' ability to recall that oxidation involves the addition of oxygen and reduction the removal of oxygen. Some candidates were confused about which substance is oxidised and which is reduced and a number of candidates gained only the credit for carbon being oxidised as they stated that copper is reduced, rather than correctly noting it is the copper oxide that is reduced.

(d) (i) A careful reading of the question was required here to identify a gas found in small quantities in clean air. Candidates identifying oxygen or nitrogen did not gain credit since these gases are found in large quantities in the air. The correct answers seen were most often a named noble gas, such as argon.

(ii) Most candidates knew that oxygen is needed for rusting. To gain credit here, though, they also needed to identify the need for water vapour, which could be expressed as moisture. A number of

candidates incorrectly stated that carbon dioxide is needed for rusting, perhaps lifting that name from the stem of the question.

Question 9

(a) Some candidates correctly identified the variable resistor symbol. Candidates needed to be precise as the more general answer, resistor, was seen often and was not creditworthy.

(b) (i) Many candidates correctly recalled and used the formula for working out the missing resistor, gaining full credit here. The final answer was 7.5 Ω.

(ii) This question asked candidates to suggest what happens to the lamp as the experiments are performed. With both the voltage and current readings decreasing from experiments 1 to 4 they could have suggested the lamp gets less bright. Credit was also given for those that noted that the resistance of the lamp decreased.

(c) (i) Many candidates were able to place a second lamp in parallel with the first lamp and gain credit here. To do this it was necessary for candidates to add a new branch to the circuit. Credit was not given to candidates who simply added a lamp in the branch containing the voltmeter.

(ii) To answer this correctly, candidates needed to recall that the combined resistance of two resistors in parallel is less than that of either resistor by itself. Therefore, in this case the current, and so the ammeter reading, will increase because the voltage has remained the same and the overall resistance is less than before. A few candidates did correctly identify that the ammeter reading would increase but only the very strongest candidates were able to explain why.

COMBINED SCIENCE

Paper 0653/33
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and use all the information to ensure they answer exactly the question that is being asked. Where there are multiple marks for an answer, care should be taken to include sufficient detail; for example, if a question is worth two or three marks, multiple points will usually need to be made.

In questions involving calculations candidates are advised to show all their working. Partial credit can be gained where candidates recall the correct formula even if the numerical answer is incorrect.

General comments

Some good responses were seen in this paper, with a number of candidates showing a sound understanding of the Core syllabus.

Many candidates find it difficult to provide a clear explanation of terms given in the syllabus. Being able to provide a clear statement of the meaning of scientific terms is an important part of this course.

Comments on specific questions

Question 1

(a) Credit was gained in this question for each line that clearly linked a function to the correct structure in the plant diagram. Some candidates could improve by ensuring that one clear structure is identified, rather than a line which ends at, for example, the place where leaf and stem join. To gain full credit it was necessary to realise that the leaf is the place where both carbon dioxide is absorbed, and carbohydrate is made.

(b) A good answer here identified evidence for insect pollination that was clearly shown in the flower diagram. This could include noting that the petals are large or that the anther and stigma are located inside the flower. Simply noting the presence of petals or noting features not shown in the diagram (such as brightly coloured petals) was insufficient to gain credit.

(c) There were many good responses to this question, which identified the spikes on the pollen grain and stated that these would make it easy for the pollen to stick to insects' fur or bodies. To answer this question well it was necessary to realise that the pollen grain is shown magnified and so it is tiny in relation to the size of an insect.

(d) (i) Many candidates correctly identified that germination requires oxygen so that the seed can grow. Full credit required candidates to appreciate that oxygen is necessary for respiration, giving the extra detail asked for in the question.

(ii) Many candidates were able to state that germination requires either warmth or water. Candidates need to understand that, during germination, photosynthesis is not taking place and so light and carbon dioxide are not needed.

Question 2

(a) Candidates were being tested here on their ability to recognise terms from their descriptions. The vast majority of candidates correctly identified that elements in the Periodic Table are listed in order of their atomic number. To gain full credit in this question candidates needed to know that the collective name for the gases listed is noble gases, and that the metals exhibiting the particular properties stated are transition metals. Some candidates often simply restated that the last collection were metals.

(b) (i) The syllabus requires candidates to learn about ionic and covalent bonding. For credit in this question candidates needed to recall that for non-metallic elements, identified in the question, covalent bonding occurs. Some candidates seemed not to be able to recall either type of bonding, with some leaving this answer blank and others coming up with their own name for a type of bonding.

(ii) This question required the key idea that electrons are shared in covalent bonding. To gain credit this needed to be expressed clearly in terms of electrons. Answers here which described ionic bonding were seen from a number of candidates, suggesting a weakness in the understanding of bonding.

(c) To gain credit here it was essential that an answer stated what happens to electrons when ions form; this could be either the loss or gain of electrons from an atom. Very few good answers were seen here and most answers suggested a lack of clear understanding about what an ion is.

(d) (i) About half the candidates correctly identified filtration as a suitable separation technique for the insoluble charcoal powder. Candidates should be encouraged to look for clues in the wording of questions, such as the reference to charcoal being insoluble here, so that fewer might leave an answer completely blank.

(ii) This question proved easier than **(d)(i)** with many more candidates correctly identifying the need to heat, evaporate or distil the water in order to separate it from the sodium chloride. To gain credit here candidates did need to recall that sodium chloride is soluble in water.

(iii) To gain credit here, candidates needed both to recognise that a physical change had taken place and then to explain what characterises a physical change. About half the candidates identified this as a physical change. To gain credit candidates needed to recognise that in a physical change no new substances are made. Many candidates found it difficult to express this clearly.

Question 3

(a) Almost all candidates demonstrated a secure understanding that the gravitational force on the trolley acts downwards and selected the correct letter, Y, to indicate this.

(b) (i) As in part **(a)** candidates here also showed secure understanding of how changing speed is indicated on a speed-time graph. A few weaker candidates labelled particular points on the graph where a transition from changing speed to constant speed took place, which suggested they were less confident in interpreting a speed-time graph.

(ii) To gain full credit here, candidates had to recall the formula average speed = average distance/total time and then to identify the time taken for the journey from the speed-time graph. Candidates should always write down their working as they can sometimes gain partial credit for an answer even if the numerical final answer is not correct. Correct recall of the formula or identification of the correct time from the graph could gain one of the marks. Here the final answer was 0.67 m/s.

(c) (i) Credit was gained here when candidates selected the correct type of energy to fit each gap. Many identified chemical energy in one of the first two gaps, but it was only the strongest candidates that realised it was the correct answer for both of these gaps. Candidates should be encouraged to read the instructions carefully; here they are told each answer may be used once, more than once or not at all. More than half the candidates realised that the trolley gained kinetic energy although a significant number wrongly thought that it gained gravitational energy.

(ii) Candidates were being asked to consider here what happens to the energy used by the man that does not actually keep the trolley moving but is wasted. To gain credit here they needed to apply their qualitative understanding of efficiency and realise that most wasted energy is transferred to the surroundings as thermal energy.

Question 4

(a) (i) This question required simple identification of two structures in the region of the alimentary canal. Almost all candidates gained at least some credit here with a good number gaining full credit.

(ii) To gain credit here, candidates needed to recognise that the duodenum is the first part of the small intestine and is immediately followed by the ileum. A careful reading of the question here provides a clue for candidates, in the use of the word immediately. A number of candidates wrongly identified later parts of the alimentary canal such as the large intestine, rectum or anus.

(iii) Very few candidates associated the gall bladder with bile. Candidates should be encouraged to distinguish between storing bile which is the function of the gall bladder and production of bile, which happens in the liver. Credit here required knowledge that bile is stored in the gall bladder.

(b) Here candidates were expected to apply their science knowledge along with additional data given in the question. Candidates should know that enzymes are catalysts and so they are not used up in reactions. They should also know that pH can affect enzymes' activity. Knowing that enzymes in the mouth begin to digest starch they are being asked to deduce that more enzymes must be secreted in the small intestine because the original enzymes have stopped working. The table shows a big change of pH in the stomach, and so candidates need to realise that the acidic environment of the stomach has stopped the enzymes working. Candidates should be encouraged to use all the information they are given in a question, both the words and information in tables, as well as drawing on their science knowledge to give an answer.

(c) There were a number of different ways of expressing correct answers here. A careful reading of the question should have noted that glucose had already been identified as being transported in blood plasma and two other examples were wanted. Quite a few candidates were distracted by other constituents of blood, such as red or white blood cells rather than substances that are dissolved in plasma.

(d) Most candidates recalled that oxygen is carried by red blood cells. For full credit candidates needed to recall that it is haemoglobin in the red blood cells that transports oxygen around the body.

Question 5

(a) (i) Full credit here required candidates to recognise that the two variables, volume of gas evolved, and the time taken to evolve the gas, were needed in order to calculate the rate of the reaction. Strong candidates generally scored full marks. In particular candidates needed to be careful to clearly identify volume of gas, rather than just state that they would 'measure the gas' which was too vague to gain credit.

(ii) The syllabus requires candidates to place a number of metals in order of their reactivity. Here four of those metals were given and the strongest candidates were able to put them all in the correct order. Candidates need to be secure in this knowledge as with only one mark available the order had to be completely correct.

(iii) With two marks for this question the first was for correctly placing hydrochloric acid as a reactant and hydrogen gas as a product in the reaction. A good number of candidates were able to do this. Full credit then required candidates to realise that if the other reactant is magnesium the salt produced will be magnesium chloride and thus complete the word equation with magnesium chloride. Candidates should know that a word equation requires the names of chemicals and not just the more general term 'salt' given in the question stem.

(iv) Many candidates were able to recall the test for hydrogen gas and gain full credit. Candidates do need to say that the splint or match used is lit for full credit and the key observation is the 'squeaky pop' which indicates the presence of hydrogen.

(b) Candidates were given the word equation for a chemical reaction and asked to identify the substance that is oxidised and explain their answer. With only one mark available it was important both to identify carbon, and also state that it has gained oxygen. Candidates need to ensure that they give clear unambiguous explanations for credit to be awarded.

Question 6

(a) (i) (ii) These two questions together were testing candidates' ability to identify properties that could be used to distinguish between a liquid and a gas and then describe the difference in terms of the arrangement of molecules. Candidates were often able to describe the distinguishing feature of the molecular arrangement; talking about molecules being close together in a liquid and far apart in a gas and so gained some credit. Candidates had great difficulty expressing clearly properties of liquids and gases, with ideas that liquids are more dense than gases or that liquids cannot be compressed rarely mentioned.

(b) A good number of candidates were able to give an example of the use of expansion of gases, with the most popular one being the hot air balloon. To gain credit candidates did need to focus on a specific use of the property rather than just describing what happens to molecules of a gas when they are heated.

(c) (i) Almost all candidates recognised that the drop in mass of water was due to evaporation.

(ii) This question required candidates to apply their knowledge of heat transfer methods to specific parts of the apparatus used in the experiment. Very few candidates realised that this question was about conduction and convection. A few recognised that heat would travel by convection from the outside of the pan to the room. Candidates need to be more confident about when conduction and convection will take place in solids, liquids and gases.

(d) (i) About half the candidates correctly recognised that light changes direction at the surface of the water due to refraction. Half of the remaining candidates thought that it was due to reflection of the light.

(ii) Candidates are expected to be familiar with ray diagrams that show how light is refracted through transparent material with parallel sides. Candidates need to understand that the ray is refracted at the surface of the water and so a straight ray from the actual thermometer bulb meeting the existing ray at the water surface was needed to complete the diagram. Most candidates did not understand that this was required.

Question 7

(a) A full answer here required a reference both to smoke blocking sunlight and the rate of photosynthesis dropping. Candidates sometimes failed to gain credit by not including a reference to how the rate of photosynthesis changed, suggesting that they had not read the question carefully enough. Candidates do need to ensure that they reference light rather than just giving a vague reference to the sun being blocked for credit. A careful reading of the question stating that the wind carried the haze to neighbouring countries would have helped some candidates avoid talking about an increase in carbon dioxide levels which would not be relevant once the smoke has been carried by the wind.

(b) Here it was really important to read the question carefully and realise that candidates were being asked about the loss of soil, not the loss of nutrients from the soil. Most answers focused on the soil being burnt and losing nutrients. Candidates needed to think about why soil is lost when trees are removed; because the roots which hold it in place have been removed, for example. Alternatively, they could have noted that without trees the soil is bare and exposed making it more likely to be blown or washed away.

(c) While many candidates had misunderstood the question in **(b)** this part was well answered by almost all candidates. They demonstrated an excellent knowledge of the way that animals will be affected by the removal of trees through slash and burn and many gained full credit giving two clear effects.

(d) Most candidates gained some credit here by making a reference either to global warming or to the fact that carbon dioxide is a greenhouse gas. For full credit candidates needed to cover either both

those points or include a specific consequence of global warming. A couple of examples, such as melting of polar ice caps were given and candidates generally could have gained more credit by taking the time to give a more detailed answer here.

Question 8

(a) (i) Candidates are expected to know that coal, petroleum and natural gas are fossil fuels. While most recalled coal here very few gained the credit that required recall of both coal and natural gas.

(ii) Answers here suggested some confusion among candidates about the uses of the different fractions of petroleum. Rarely did a candidate correctly identify the use of all three fractions and more usually it was only refinery gas as heating oil that was recalled.

(iii) Fewer than half of the candidates correctly recalled that exothermic reactions cause a temperature rise. Candidates show some confusion between exothermic and endothermic reactions and a number of candidates did not attempt an answer to this question at all.

(b) (i) Candidates need to be familiar with the names and structures of the four hydrocarbons listed in the syllabus. Very few were able to recognise this as ethene with about half wrongly giving it the name of one of the other hydrocarbons in the syllabus.

(ii) Provided with the formula for ethanol many candidates were able to complete a structure that included the correct number of each type of atom. To gain credit here candidates needed to show that they understood there was a single bond between the two carbon atoms and single bonds connecting hydrogens to the two carbon atoms. For full credit the O-H needed to be correctly bonded with a single bond joining the oxygen atom to a carbon atom and then a single bond between the oxygen and hydrogen atoms.

(c) (i) (ii) Candidates find it difficult to express what is meant by the terms compound and mixture. Guidance is given in the question and candidates would benefit from practising expressing themselves clearly. For the compound it is key that candidates talk about atoms of different elements, not just elements being bonded together. Candidates were encouraged to explain a mixture by talking about separation techniques and the few candidates who gained credit here generally did mention the use of filtering or physical separation techniques generally.

Question 9

(a) (i) To gain full credit here candidates needed to draw accurate and correct circuit symbols, following the instructions in the question carefully and avoiding the addition of any extra components not asked for in the question. Many candidates were able to draw the correct symbol for a lamp. Candidates do need to be careful not to continue a wire through the centre of the lamp as it is not part of the circuit symbol. Some candidates who did not draw the motor and lamp in parallel were then not able to show the switch controlling just the lamp.

(ii) A good number of candidates were able to apply their knowledge of the advantages of lamps being connected in parallel to this slightly different situation. They expressed themselves clearly and gained credit for sensible answers such as the fact that if one component broke the other would keep working.

(iii) This seemed to be an unfamiliar circuit symbol to many candidates. Candidates need to be aware that if they provide multiple answers to a question then a wrong answer will mean they do not gain credit for a correct answer also written down. A few candidates wrote power supply here but then added battery or cell for which this is not the correct symbol.

(iv) To gain credit here, candidates need to state that the use of a fuse is to protect components from a current that is too high. This can be expressed by explaining that it prevents overheating but references to too much power in the circuit did not gain credit.

(b) Many candidates were able to recall the formula for calculating resistance $R = V/I$. To gain full credit they needed to substitute the values of potential difference and current given in the question and recall and state correctly the unit Ω/ohm. The vast majority of candidates gained some credit here and strong candidates gained full credit. The correct answer was 192 Ω.

COMBINED SCIENCE

Paper 0653/41
Extended Theory

Key messages

Those candidates who scored well on this paper ensured that:

- They had read the questions carefully and used the number of marks available for each question as a guide to how much detail to include.
- In Biology they understood the difference between energy use within an organism and energy losses in food chains.
- In questions concerning the environment they gave scientific detail rather than vague everyday answers.
- In Chemistry they had learned the test for unsaturated hydrocarbons.
- In Physics they understood that when balanced forces act on a body it could be moving with constant speed.

General comments

- Some excellent scripts were seen from candidates who had mastered most parts of the syllabus, who were very well-prepared for examinations of this type and who presented answers in a well-organised manner. Some of the candidates who were less successful might have been better suited for entry to the core paper.
- Some questions tested the ability of candidates to apply their knowledge and understanding of Science to describe and explain contexts that may be unfamiliar. Candidates often find these questions challenging and examination practice of this type of question is encouraged.
- Performance across the three Science disciplines was well balanced. There was no evidence that candidates had difficulty in finishing the paper in the time allowed.
- Candidates should write their answers legibly to ensure that Examiners award as many marks as possible. A number of scripts in this examination were very difficult to read either because letters were incorrectly formed or because candidates' handwriting was extremely small.

Comments on specific questions

Question 1

(a) (i) Only a minority of candidates clearly showed the movement of carbon dioxide into the alveolus from the grey shaded part of the diagram representing plasma. Arrows that started on a red blood cell did not gain credit. Many arrows were drawn without any connection to the blood supply and some started on the outside of the capillary wall.

(ii) Most candidates struggled to explain why oxygen diffuses from the alveolus to the blood.

(iii) This question was answered well. Candidates tended to know that the key features of the alveolus structure included thin walls and large surface area. A smaller number of candidates gained credit for referring to the good blood supply. A few candidates gained credit for describing the alveolus as being moist. Common reasons for losing credit were for suggesting the alveolus rather than its wall is one cell thick and for suggesting that the capillary or its wall is thin. Candidates should be discouraged from using the term membrane rather than wall in their answers to this question.

(b) Credit for knowing the importance of the umbilical cord was very frequently gained. The role of the placenta was not so often described. Some candidates did not refer to any of the important organs

but opted for answers that described the general idea that food consumed by the mother would be digested and nutrients passed to the fetus.

(c) (i) The presence of carbon dioxide was identified by the majority of candidates. Carbon monoxide was the most common incorrect suggestion.

(ii) The effects of tar from cigarette smoke was not all that well-known. A wide variety of guesses were seen as were many suggestions that lacked credit-worthy detail, a typical example being *tar contains harmful chemicals which are bad for lungs*.

(iii) Candidates who were well-prepared for the Biology section of the paper correctly described the inability of damaged cilia to remove mucus and so prevent entry of pathogens or other particles to the lungs. Such candidates were in the minority. Large numbers of candidates who had some knowledge of the role of cilia often neglected to mention mucus or suggested that mucus production would be reduced. It seemed that many candidates viewed the cilia as a filter that trapped particles, and so damaged cilia would no longer have this filtering capability. Partial credit was gained for the general idea that damaged cilia would lead to an increase in pathogens entering the lungs and causing infections.

(iv) The tendency of carbon monoxide to attach to red blood cells or haemoglobin was quite well-known and full credit was often awarded. Common guesses included the suggestion that carbon monoxide would cause lung cancer or that carbon monoxide would kill red blood cells.

Question 2

(a) (i) Most candidates gave covalent.

(ii) All that was required was a reference to electrons being shared. Some very well-prepared candidates gave a detailed quantitative description of the covalency in water, often exceeding the generous amount of answer space. Candidates should always be advised to use the number of available marks as a guide to the detail required.

(iii) Many fully correct dot-and-cross diagrams were seen. Incorrect or missing non-bonding electrons on the oxygen atom or extra electrons around hydrogen were often suggested alongside correct representations of the shared pairs.

(b) (i) The names of the electrodes were familiar to large numbers of candidates. Those nearer to the lower end of the mark range sometimes suggested the names of chemicals instead of cathode and anode. Credit was not available for those candidates who gave the answers *negative* and *positive*. Partial credit was awarded to candidates who reversed the names of the electrodes.

(ii) This was marked strictly in that credit was not awarded unless candidates identified the particles as **ions**. Chlorine was not accepted as an alternative for chloride. Only a minority of candidates gained full or partial credit for their answers, although many did match elements and electrodes correctly for example, they might match *chlorine molecules* with anode and *brown solid copper* with cathode.

(c) Many candidates gained credit here. Unlike the requirements for **(b)(ii)** the suggestion that these products would be ions meant that credit would be lost. Partial credit was given for reversing the substances.

Question 3

(a) (i) The identity of force **Z** was well-known. The preferred answer to this question is *weight*. Some suggested *downward force* which is never a credited answer in this context.

(ii) This important concept is often tested and answers can be very revealing. Only the better-prepared candidates understood that the train could still be in motion when forces **W** and **Y** are balanced. Many candidates believed that force **W** had to be greater than force **Y** because the train was in forward motion. Others suggested that **W** and **Y** could not have the same value because the train had constant speed. Others stated that **W** and **Y** must be equal and gave reasoning based on Newton's Third Law.

(b) (i) This was a very challenging question for all except those with a very good understanding of the Physics involved. Many knew that they needed to be substituting into the relationship, work = force · distance. What was less well-realised was that the distance term had to be obtained from the speed-time graph given in the question. Partial credit was awarded to candidates who stated a correct formula that was relevant to the calculation. Many candidates gained the mark for stating that the units would be Joules (J). The symbols j and Nm were not accepted as alternative for J. The final answer to this calculation is **1 500 000 000 ($1.5 \cdot 10^9$) J**.

(ii) Most candidates gained one mark for stating that the train is decelerating. Slowing down was an acceptable alternative to decelerating. A minority gained the second mark for recognising that this deceleration is non-uniform. Any clear indication of the non-constant nature of the deceleration was accepted but in the context of this question the wording, *slowing down at a non-constant speed,* could not be allowed for the second mark. A small number described, quite accurately, the motion of the train up to the 500s point, rather than after it.

(iii) This part of the Physics syllabus was quite familiar. Those candidates who showed they knew that the area under the graph for the first 200s had to be calculated gained at least partial credit. Full credit was awarded to those who worked through to the final answer **2.5** (km).

(iv) Candidates that had successfully calculated the distances travelled in part **(b)(i)** and **(iii)** were left with a simple addition sum to arrive at the final answer **12.8** (km). Errors from earlier parts of the question were taken into account in part **(iv)**.

Question 4

(a) (i) Most candidates gained full or partial credit for their food chains, showing good understanding of the term *trophic level*. Partial credit was awarded for a correct but incomplete food chain provided at least three trophic levels were included.

(ii) Candidates gained the mark if they made it clear that food chains are unusual if they contain **more than** four trophic levels. Answers such as *there are too many levels* did not gain the mark, nor did those that described reasons for energy losses on moving through trophic levels. Some candidates attempted to answer in terms of animal behaviour or numbers of consumers.

(b) There was a lot of evidence that candidates had rushed into their answers without taking time to read the question carefully enough. Many of the suggested answers could not apply to **all** of the organisms in the food chain, and so could not gain credit. The successful candidates avoided answers such as *movement* and even *respiration* itself. Many other answers referred more to reasons for energy losses through trophic levels rather than energy use within an organism.

(c) Candidates who gained full credit understood that questions testing energy losses in food chains refer to energy lost by the predator and not the prey. Answers such as *energy is lost by the sealion when it tries to escape* are frequently seen when this part of the syllabus is tested. Similarly, it is often suggested that energy is wasted when the whale moves to try to catch the sealion. Such energy use would not be considered energy wasted, and in any case occurs before the sealion is consumed. Partial credit was often awarded for the idea that the whale does not consume all of the sealion and for references to excretion or egestion.

Question 5

(a) (i) Careful reading of this question should have prompted candidates to restrict their suggestions to compounds and not elements. A large number of candidates included calcium as one of their substances and, of these, many suggested sulfur as the other reactant. This question from the acids, bases and salts section of the Chemistry syllabus requires candidates to select a suitable calcium compound to react with (aqueous) sulfuric acid. Partial credit was often awarded for identifying the acid. Credit was also given where the candidate suggested two aqueous solutions that would produce calcium sulfate by precipitation.

(ii) Large numbers of candidates identified filtration as the required separation technique. Those gaining full credit emphasised the way that filter paper acts to separate the solid particles from the liquid. Many did this. Those stating simply that the solid is *left in the funnel* did not gain the second

mark unless they had referred to the presence of the filter paper in the funnel. No credit was available for candidates suggesting evaporation, distillation or simply heating the mixture.

(b) (i) With only one mark available candidates needed to give both descriptions correctly. It was apparent that large numbers of candidates did not associate calcium with metallic properties, despite the question reminding them that calcium is in Group II of the Periodic Table.

(ii) Candidates are usually familiar with the way that electronic structure is shown and many gained this mark. In some cases, candidates showed they knew the numbers of electrons in each of the energy levels in a calcium atom but did not represent them properly. With only one mark available answers such as *all inner shells full with two electrons in the outer shell* could not, regrettably, gain the mark.

(c) (i) The question leads candidates towards thinking about reactivity within the Group 1 metals. Those who had learned the reactivity trend gained the mark, even if they did not have experience (from for example video footage) of observing the violent reaction of caesium in water.

(ii) Questions asking for an estimate of a fixed point of an unfamiliar element require candidates to use information given in the question. An exactly correct answer is not expected. In this case the question gives a clear indication of the upper and lower limits and so any value in between these was accepted.

(d) Candidates needed to state clearly that reaction does not occur because potassium is more reactive than copper. Answers such as *copper is unreactive* were not detailed enough to gain the available mark.

Question 6

(a) The required answer, thermal expansion, was stated by a relatively small number of candidates. Many candidates were not familiar with the underlying principle of the way that liquid in glass thermometers work. Large numbers gave the names of liquids that are used e.g. mercury, and others wrote about the relative values of the fixed points of the liquids.

(b) (i) Most of the candidates that scored this mark referred to the fact that the melting point of ethanol is lower than that of ammonia. It was important that candidates used wording that made a comparison between ethanol and ammonia.

(ii) One of the available marks was for describing the idea that the thermometer would not work below 30 °C because gallium would be solid. The second mark was awarded to those candidates that made the additional explanatory point that normal room temperature is below 30 °C. Large numbers of candidates gained at least partial credit. Some candidates lost credit by using the word *melt* when they most probably intended to mean *freeze,* for example *if the gallium is below 30 °C it would melt.*

(c) (i) Underlying the context of this question was the inverse relationship between frequency and wavelength. Many candidates realised this and gained both marks. Provided candidates described the inverse relationship clearly it was not essential that they stated the relationship as an equation.

(ii) Rays should be drawn carefully using a ruler. Many very good diagrams were seen and the mark was awarded provided all three rays were continued and came to a single point very close to or inside the detector.

Question 7

(a) The equation for photosynthesis is often tested and large numbers of candidates from across the mark range were well-prepared for it.

(b) Large numbers of candidates realised that their explanations had to involve photosynthesis. Many made the essential point that the oxygen or gas is released by the plant. Others suggested that photosynthesis was using up the water in the test-tube, but this idea was not credited. Vague answers such as *because of photosynthesis* were not uncommon but could not be credited. Some

candidates suggested answers comparing the density of gases and liquids but these did not gain credit in the context of this question.

(c) (i) The majority of candidates drew a lower surface level within the test-tube and gained the mark. Lower levels drawn down in the beaker did not gain credit.

(ii) Many candidates correctly referred to the increased rate of photosynthesis and gained the mark. Answers that did not refer to increased photosynthesis such as *more light intensity makes more oxygen* could not be credited since this adds no new information to that contained in the question.

(d) (i) Candidates needed to suggest clear scientific ideas in their answers. The candidates gaining this mark avoided answers such as *acid rain kills plants* or *acid harms the plant* or *acid is not suitable for photosynthesis*. Instead they referred to damage to leaves, damage to enzymes or damage to soil fertility. Generally, this aspect of ecology appeared to be understood only superficially by the majority of candidates.

(ii) The best answers here referred specifically to the reduction of sulfur dioxide emissions, the increasing use of catalytic converters in vehicles burning hydrocarbon fuels, the general move towards reducing the burning of fossil fuel and the move towards increasing the use of alternative energy sources. Although there were many ways candidates could answer this question, the majority made vague or impossibly impractical suggestions that could not be credited. Hence the mark was not gained for unqualified answers such as *stop using fuel, stop using cars, reduce pollution, use public transport, electric cars.* Some candidates answered in terms of reducing the greenhouse effect.

Question 8

(a) Candidates from across the full range of total marks were familiar with the decreasing size of molecules from fractions collected higher in a fractionating column. They were also able to connect this with decreasing intermolecular forces. Full or partial credit was gained by the majority of candidates.

(b) Full marks for a correctly balanced combustion equation tended to be restricted to candidates from the higher end of the total mark range. A very small number of candidates were awarded one mark for a correctly balanced equation showing incomplete combustion to either CO or C.

(c) (i) A majority of candidates scored the available mark for referring to the presence of a double bond in alkene molecules.

(ii) The bromine test for unsaturation is frequently tested and each time it appears, a minority of candidates show that they are well-prepared for it. It continues to be the case that large numbers of candidates are not familiar with this test. Common incorrect suggestions include the use of litmus paper, a lighted splint or limewater. Of those who have some knowledge of the bromine test, marks are lost if candidates refer to the use of bromide or state that bromine becomes *clear* or *transparent* rather than colourless.

Question 9

(a) (i) Most candidates scored this mark. The common mistakes, seen mainly from candidates towards the lower end of the mark range, included *series, electrical* or *complete.*

(ii) Full credit for this circuit diagram was awarded to a minority of candidates although many gained at least one mark. In the best answers, the lamp symbol did not show the wire passing through it, showed switches correctly in an open state and avoided any series connection of a heater and a motor. A very large number of different versions of the circuit were seen, including many simple series circuits.

(b) (i) Provided candidates realised that they needed to use the relationship I = P/V and that the value of V was shown in the diagram in **(a)(ii)** they could work through successfully to the correct final answer. The correct final answer is **10**(A).

(ii) Candidates seemed to find this question more challenging than it really was. Even when a continued error from part **(b)(i)** was allowed, only a minority scored the mark. Only one mark was available and this should have given candidates an indication that a simple calculation was required. The correct final answer is **12.4**(A).

(iii) Candidates are usually good at describing how a fuse works but this task of selecting a suitable fuse and explaining reasons for the selection proved too challenging for the majority. An error for the value of the fuse was allowed to be carried forward from part **(b)(ii)** however unlikely the current value suggested in **(b)(ii)**. This allowed a reasonable number of candidates to gain at least partial credit. Only a very small number gained both marks.

COMBINED SCIENCE

Paper 0653/42
Extended Theory

Key messages

Those candidates who scored well on this paper ensured that:

- They had read the questions carefully and used the number of marks available for each question as a guide to how much detail to include
- they had learned a definition of the term haploid
- they understood that energy losses through a food chain are associated with the predator and not the prey
- they had learned the tests for aqueous ions **Question 2(c)(ii)**
- they explained the changing brightness of a bulb in terms of power consumed or energy used and not just in terms of current or voltage
- they thought carefully when interpreting a speed/time graph, **Question 1(b)(i)**, and realised that a straight, sloping line shows constant acceleration or deceleration
- their handwriting was reasonably legible and not too small.

General comments

- Some scripts were seen from candidates of high ability who had mastered most parts of the syllabus and who were very well-prepared for examinations of this type. In Biology, topics relating to the developing fetus were answered well. In Chemistry, questions relating to organic topics were done well. In Physics, candidates were well-prepared for calculations and describing the difference between liquids and solids in terms of particles.
- Some of the candidates who were less successful might have been better suited for entry to the core paper.
- Success in answering questions covering the three Science disciplines was well balanced, and candidates were able to complete the paper in the available time.
- Candidates should write their answers legibly to ensure that Examiners award as many marks as possible. A number of scripts in this examination were very difficult to read either because letters were incorrectly formed or because candidates' handwriting was extremely small.

Comments on specific questions

Question 1

(a) (i) The great majority of candidates scored this mark.

(ii) Many candidates gained full or partial credit here. There were two common types of mistake. The first was the suggestion that the force **Y** is not 2 000 N because the tractor is moving. The second was that force **Y** is 2 000 N because forces have to be balanced. Many candidates showed that they believed that a body moving with constant speed could not have balanced forces acting upon it.

(b) (i) This mark tended to be gained only by those candidates towards the higher end of the total mark range. Better-prepared candidates knew that the term *acceleration* can be used to refer to decreasing as well as increasing speed or velocity. Better-prepared candidates realised that constant acceleration is shown in a speed/time graph as a sloping line that is also straight.

(ii) Candidates tend to do these types of calculations very well and many gained full credit. Credit was awarded for a clear indication that an area under the curve had to be determined. A mark was also given for showing that the final distance would have contributions from the three sections of the graph. For this reason, those candidates who set out their working neatly and clearly often gained partial credit even if they did not arrive at the final answer, **168.5** (m).

(c) (i) The use of the relationship, work done = force · distance, was very familiar and large numbers of candidates worked through to the final answer **75 000** (J).

(ii) Candidates towards the higher end of the total mark range recognised that they had to use the relationship power = energy/time, and also that the power term in this relationship has to be in watts to give the final answer in joules. Partial credit was gained by candidates whose only mistake was to use 25 W as the power term. Candidates towards the lower end of the mark range usually did not use the correct relationship and were often distracted by inclusion of the distance term, 50 m, in the question. The final answer is **375 000** (J)

(iii) Many candidates, particularly those in the upper half of the total mark range, gained at least partial credit for an acceptable version of the relationship *efficiency = useful work/total energy input*. Many then lost their way by inverting the data when they substituted their answers from parts **(c)(i)** and **(ii)**. Others made mistakes when they attempted to express the efficiency as a percentage. Errors from parts **(c)(i)** and **(ii)** could be carried forward but candidates lost credit if their final answers exceeded a value of 1 or 100%.

Question 2

(a) (i) The majority of candidates were very familiar with these practical techniques and large numbers scored both marks. Distillation was not accepted for the second method since candidates were asked for a method suitable for obtaining the solute from a solution rather than the solvent.

(ii) The great majority of candidates scored this mark.

(iii) This part of the Chemistry syllabus was very familiar to the majority of candidates. Full credit was awarded to candidates whose explanations referred to increased collision frequency rather than simply suggesting *there are more collisions*. Some candidates suggested that *the reaction rate increases when the acid is more concentrated*. Candidates should be advised to assume that explanation of reaction rate changes requires them to use ideas about particle collisions, even when this is not explicitly stated in the question.

(b) The question directs candidates to think about energy changes in their explanations. Having gained the credit for stating *exothermic,* candidates needed to state more than *heat is released*. They needed to refer to the change from chemical to thermal (heat) energy. Many did this and large numbers gained full credit.

(c) (i) Many perfectly correct balanced equations were seen mainly from candidates in the upper half of the total mark range. Two frequently seen reasons for the loss of credit was an incorrect formula for magnesium chloride, and the suggestion that hydrogen rather than water was a product.

(ii) Some candidates had learned the test for chloride ions very well and produced perfect answers. This was not always the case and many candidates were reduced to guessing. A variety of incorrect suggestions were seen but one which was more frequent than others was the test for chlorine.

Question 3

(a) Some candidates had learned a text-book definition of the term *haploid* and these candidates usually scored both of the available marks. Large numbers of candidates gained the mark for their knowledge of the function of the nucleus and so partial credit was frequently awarded. Answers for haploid that did not gain credit included *contains only 23 chromosomes, not fused with another nucleus, contains half the genes* and a large number of suggestions that made no reference to chromosomes or the contents of a cell. The most common answer for nucleus that did not gain credit described the role of the cell membrane. Candidates should be advised to avoid stating only that *the nucleus is the brain of the cell* when answering examination questions.

(b) The great majority of candidates were very familiar with the characteristics of wind-pollinated flowers and most gained full credit.

(c) Many candidates scored one mark for suggesting that leaf **A** has a larger surface area than **B**. Very few candidates gained full credit. The most popular suggestions other than area referred to the number of veins or the general shape of the leaves. Some candidates lost credit because they did not relate their suggestions to either leaf.

(d) (i) A majority of candidates drew their lines in the correct general position.

(ii) This mark was gained mainly by candidates in the upper half of the mark range. No error could be carried forward from part **(d)(i)**. Candidates needed to make a clear connection between higher humidity and lower transpiration rate. It was not enough simply to state *because humidity is greater.* The term *evaporation* was accepted as an alternative to *transpiration.*

Question 4

(a) Only a minority of candidates recognised both **P** and **S** as veins.

(b) Most candidates gained full or partial credit for this question, showing good understanding of blood flow through the heart. There were several ways that credit was lost but the most common one was reversing the words right and left.

(c) (i) This part of the Biology syllabus had been learned very well by the majority of candidates who correctly named **X** and **Y**. Small spelling mistakes were not penalised provided a good attempt had been made. Two common incorrect suggestions from lower scoring candidates were *fetus* and *fallopian tube* for structure **X**.

(ii) Many very good answers were seen from candidates who clearly understood the function of amniotic fluid as protection for the fetus. Most were able to explain why loss of the fluid would be harmful and risks from physical damage, infection and premature birth were all suggested. A variety of incorrect answers were seen and common ones included describing how the fetus prepares to be born or that loss of the fluid would prevent nutrients reaching the fetus.

(iii) The Biology tested here had been very well learned by the majority of candidates and most gained full credit. The terms *nutrients* and *waste products* did not gain credit. Candidates who were not so well-prepared had to guess and there were no particularly common incorrect answers.

Question 5

(a) (i) The majority of candidates knew that the water molecule is covalently bonded.

(ii) The majority of candidates drew the structure of an ethane molecule correctly. The mark for drawing a carbon to carbon single bond was not awarded to candidates who included more than two carbon atoms in the structure.

(b) (i) Identifying fractional distillation is frequently tested and large numbers of candidates were well-prepared for this question. Lower-scoring candidates seem to have used the word *separated* in the question as a prompt to suggest almost the full range of separation techniques mentioned in the syllabus. The other popular incorrect answer was *cracking.*

(ii) The large numbers of candidates who could identify fractional distillation in **(b)(i)** were also able to gain full or partial credit in explaining the differences between gasoline and gas oil. Many perfectly correct answers relating boiling point, molecular size and intermolecular forces were seen.

(c) Most candidates recognised cracking. The most common incorrect answer was fractional distillation. Both thermal and catalytic cracking are acceptable answers.

(d) Most candidates were able to state the electronic structure of a carbon atom correctly. The incorrect answers included *2, 6, 6* and the full chemical symbol for carbon. Descriptions such as *there are six electrons with four in the outer shell* are not accepted. Candidates had to show that they knew how electronic structures are written.

Question 6

(a) Some excellent answers were seen from large numbers of candidates who clearly understood the differences between solids and liquids in molecular terms. Candidates from across the full mark range usually gained at least partial credit.

(b) Candidates in the upper half of the mark range usually recognised thermometer. Common incorrect answers included measuring cylinder and beaker.

(c) Most candidates gained at least partial credit in this question and many scored both marks. There was no obvious pattern in the mistakes.

(d) (i) The importance of a medium in energy transfer by conduction and convection was well understood by the majority of candidates. Some candidates lost the mark with suggestions such as *there is no conduction in space because there is no oxygen* or *the stars do not have solids or liquids in them*. Answers like this suggest the candidate has relevant knowledge but has not expressed it in a way that can be rewarded.

(ii) Candidates needed to state that gamma radiation has the highest frequency. It was not enough if they stated simply that gamma has a high frequency. This mark was usually scored only by candidates towards the top of the mark range. The very broad range of incorrect suggestions from most of the other candidates suggests that they did not see this question as being simply about associating gamma with the highest frequency in the spectrum.

Question 7

(a) Candidates near the upper end of the mark range tended to give sensible answers. Any valid carbon compound gained credit. The most common incorrect answer was carbon dioxide which suggests that candidates may have assumed that if carbon dioxide transfers from the air into the grass then it remains there unchanged. Some candidates suggested *chloroplasts* which was not accepted.

(b) The equation for respiration is often tested and many candidates, particularly those in the upper half of the mark range, were well-prepared for it. There was no particular pattern in the answers that contained mistakes. Credit was not lost if candidates added additional items such as *+ energy* or *+ ATP* but candidates should be advised that this equation normally shows only the formulae of the chemical species involved.

(c) (i) Candidates who gained full credit understood that questions testing energy losses in food chains refer to energy lost by the predator and not the prey. Answers such as *energy is lost by the rabbit when it tries to escape* are frequently seen when this part of the syllabus is tested. Many candidates gained at least partial credit for knowing that the fox might not consume all of the rabbit and for references to excretion, egestion and processes related to respiration in the fox. Suggestions such as *the fox loses energy when it runs after the rabbit* do not gain credit since this occurs before the rabbit is eaten.

(ii) This part of the Biology syllabus had been learned very well and many excellent answers were seen from candidates across the mark range. The very best answers clearly referred to the break down of the fox's body by decomposers who release carbon dioxide by their own respiration. Terms such as *bacteria, fungi* or *microorganisms* were accepted as alternatives for *decomposers*.

Question 8

(a) Candidates tended to be well-prepared for this question and large numbers gained full or partial credit. Most candidates referred to the need for lead(II) bromide to be in a liquid form and many could go on to discuss the movement of ions. Some candidates did not give quite enough detail with answers such as *there is no electrolyte present*. This is not an incorrect statement but the question directs candidates specifically to write about physical states and ions.

(b) (i) The words **other** and **transition** in this question are printed in bold type. Candidates in the upper half of the total mark range tended to understand the importance of avoiding answers referring to

coloured compounds and general metal properties such as electrical conductivity. These candidates were able usually to state a property specific to transition metals.

(ii) Candidates who scored both marks made sure that they used the term *bromide* and not *bromine*. Partial credit was awarded if candidates reversed their answers

(c) (i) Only a small number of candidates realised that coke is used as the fuel in the blast furnace. Carbon was accepted but coal was not. It emerged that candidates generally had not considered the idea of a fuel used in the blast furnace and a very wide range of suggestions were seen across the mark range including, petroleum, methane, ethanol and other organic compounds.

(ii) The role of carbon monoxide or carbon in iron oxide reduction was very familiar and large numbers of candidates scored this mark.

Question 9

(a) Most candidates gave general answers that did not focus on the performance of the investigation. Examples of this type of answer are *so the bulb does not blow* or *so that the resistance in the circuit can be varied*.

(b) Only a minority of candidates answered in terms of energy consumption or power being supplied to the lamp. Most tended to extract trends from the table of data giving answers such as *when voltage decreases current decreases so the lamp is dimmer*. Answers like this add no new information or science to that given in the question and so do not gain credit.

(c) (i) This is a straightforward addition of a lamp symbol to the given circuit and most candidates who answered gained the mark.

(ii) Many candidates scored one mark for stating that the current through one of the lamps is **0.38**(A). Award of the second mark for the reason was gained in only a minority of cases. Candidates needed to explain that the current is equally divided and any wording that clearly stated this gained the second mark. Marks could not be given for vague answers such as *the current splits, because it is a parallel circuit.*

COMBINED SCIENCE

Paper 0653/43
Extended Theory

Key messages

Read all of the questions carefully.
There were several responses which indicated that candidates had missed important information in the introduction of the questions. These questions will be discussed as they arise.

Take care with handwriting.
Some candidates lost credit due to illegible writing of the key words needed for the response. An example of this in the paper is that it was sometimes difficult to determine whether a response was 'ethene' or 'ethane'.

Use the correct spelling of scientific terms. See the comment about **6(c)(i)**.

Bring a pencil. In **Questions 6(c)** and **9(a)(i)** some candidates changed their responses and the results were often illegible.

General comments

There were some excellent scripts from candidates who demonstrated sound knowledge of the syllabus across the three science disciplines. These candidates demonstrated good examination technique.

Some candidates found the paper challenging and were less successful. These candidates would possibly be higher scoring if they had been entered for the core paper.

Generally, candidates scored well on straightforward recall questions. They were less successful responding to questions set in an unfamiliar situation. These questions require the application of their scientific knowledge and understanding in a new context.

It is recommended that candidates read this report in conjunction with the examination paper and the published mark scheme.

Comments on specific questions

Question 1

(a) Some candidates correctly identified the parts of the ciliated cell and scored full marks. Some candidates could have improved their answer by spelling cilia correctly. Candidates are reminded that the main function of the cilia is to remove mucus from the airway. Pathogens and dust are removed from the airway by attaching to the mucus.

Many candidates stated that **C** is a goblet cell which secretes mucus. Careful reading of the question shows that cell parts are required, in this case the cytoplasm.

(b) (i) The majority of candidates described how the structure of structure **X**, (the stigma) is adapted to its function of collecting pollen. Candidates who did not score included those who described the adaptations of the anther.

(ii) Most candidates scored full credit in this question, explaining that wind-pollinated flowers do not need to attract insects with brightly-coloured flowers.

Question 2

(a) (i) The higher-scoring candidates drew the dot-and-cross diagram correctly. Some candidates omitted to draw the second oxygen atom in the molecule of carbon dioxide, therefore attempting to draw the diagram for carbon monoxide. All candidates are reminded that the dot-and-cross diagram should show the unbonded electrons in the oxygen atoms. These were left out by some candidates.

(ii) The majority of candidates correctly identified covalent bonding in the molecule.

(iii) Most candidates knew the limewater test for carbon dioxide but the use of an acid to produce carbon dioxide from the aqueous solution of carbonate ions was challenging for many candidates. Incorrect methods included heating the solution, or just adding limewater to the aqueous solution.

(iv) Many candidates used the prompt contained in the stem of the question to describe the energy change during an endothermic reaction. A complete description of the energy transfer was needed to obtain the mark. Partial descriptions which stated that an endothermic reaction takes in (thermal) energy, and explanations of the energy changes in an exothermic reaction were not awarded credit.

(b) (i) The correct electronic structure of calcium was known by the majority of candidates who completed the diagram correctly.

(ii) Most candidates scored full credit in this question, showing that they understood the principles of ion formation.

Question 3

(a) (i) The vast majority of candidates wrote the letter **C** in the correct place on the graph to show constant acceleration.

(ii) The equation needed for this response was average speed = total distance travelled/total time taken. Some candidates tried to find the total distance travelled by calculating the area under the graph. This could not be done because the deceleration between 25 and 30 seconds was not constant. Candidates could find the total distance travelled by careful reading of the information in the question. The graph was needed to find the total time taken.

(b) (i) The majority of candidates identified **Z** as the force exerted by the man on the trolley.

(ii) Many candidates incorrectly stated that force **Z** was bigger than force **X** since the trolley was moving forward in the first five seconds. Candidates are reminded that the forces are balanced on an object travelling at a constant speed.

From 25 to 30 seconds the trolley is decelerating so it must have unbalanced forces acting on it, in this case force **X** must be greater than force **Z**. Many candidates did not score credit in this part of the question because they did not compare the sizes of the two forces.

(c) Many candidates scored full marks in this question. Others knew the formula but read the speed from the graph incorrectly, stating that the speed was 0.75 m/s. A minority of candidates changed kilograms to grams, not realising that the mass quantity in the equation is kilograms.

(d) The higher-scoring candidates frequently scored full credit in this question. Other candidates misinterpreted the information given and used 2400 J as the energy input instead of the output.

Question 4

(a) Candidates had to use their knowledge of effects of carbon particles in cigarette smoke on the gas exchange system, and apply it to the effect of carbon particles in suspension in the haze. Candidates of all abilities found this question challenging. Some candidates interpreted the term ‘carbon particles’ as molecules of carbon dioxide and carbon monoxide, therefore missing the point of the question. Others incorrectly referred to the disadvantage of carbon particles entering the bloodstream by diffusion.

(b) (i) Many candidates scored full marks in this question, showing an understanding of the role of chlorophyll. Some lower-scoring candidates used the term 'Sun's rays' instead of 'light energy' when they referred to the layer of carbon preventing light energy from entering the leaves. Other candidates demonstrated confusion about the role of chlorophyll, saying that chlorophyll was responsible for the whole process of photosynthesis, rather than trapping light and converting it into chemical energy. The chemical energy then facilitates the process of photosynthesis.

(ii) Candidates had to focus on the two main factors causing a reduction in the concentration of oxygen in the air; less oxygen produced during photosynthesis because the trees were disappearing, and the use of oxygen during combustion of the trees. Responses referring to respiration by living organisms were not considered relevant to the question, since the fire would have killed them.

(c) The majority of candidates gained full marks in this question. The most frequent incorrect answer was 'ultraviolet' quoted for the radiation given out by the Earth.

Question 5

(a) (i) Almost all of the candidates identified the correct order of reactivity of the four metals.

(ii) Many candidates had prepared well for this type of question and scored full credit. Areas where candidates lost marks referred to 'more collisions' without including an idea of the time during which these collisions would occur. Therefore 'more collisions per second', 'increased collision rate' or 'more frequent collisions' are examples of how these responses could be improved.

(b) (i) Most candidates gave 'coke' as one correct response. Candidates gave a variety of incorrect answers for the second raw material, including limestone, iron ore/haematite, both already in the stem, and slag.

(ii) Most candidates scored well in this section, giving a correct definition. Many candidates gave their responses in terms of the gain of electrons. Responses stating that reduction is the gain of electrons were credited for using correct scientific knowledge.

(c) (i) Many candidates demonstrated a sound knowledge of the reactivity series and explained that aluminium was more reactive than carbon. Incorrect responses included 'aluminium is not reactive enough', or statements considered to be too vague such as 'aluminium is very reactive'.

(ii) Many candidates correctly gave 'electrolysis' as their response to this question.

Question 6

(a) The prompts by the question pointed candidates in the direction for the response to this question. Therefore, correct comparisons of distances between molecules, and their intermolecular forces, were correctly described by many candidates. These answers could have been improved by reference to the equation for density. An example of this is a statement that water has more molecules (mass) than steam in a particular volume.

(b) (i) There were many correct responses to this question. Most candidates gained credit for describing that the more energetic molecules escaped the surface of the water. Some candidates did not explain the effect of the evaporation on the remaining water in enough detail. Reference to the reduction of energy in the remaining water molecules was needed, not just that it became cooler. Candidates who wrote about hot and cold molecules were not credited.

(ii) Some candidates answered this question correctly by describing the effect of the reduced surface area on evaporation. Many candidates focused on the fact that the container was insulated to suggest that more thermal energy was retained, therefore the evaporation rate would increase, losing more mass. Careful reading of the information at the beginning of part **(b)** shows that the original container was insulated too so heat loss through the walls of the container was not considered significant.

(c) (i) The higher-scoring candidates generally gave the correct answer, refraction. Other candidates should be aware of the importance of spelling scientific terms correctly, especially if a spelling mistake results in another scientific term, or a word which could indicate two possible terms. Incorrect words included diffraction, rarefaction, refrection and reflaction.

(ii) Some candidates drew the ray diagram correctly showing a refracted ray which bent away from the normal at the surface of the water. There were numerous incorrect diagrams indicating that many candidates found this question challenging. A diagram showing a second ray of light coming straight from the bulb to the eye without bending at the surface was frequently seen, demonstrating that candidates had not understood that the dotted line indicated the virtual nature of the ray, and that the original ray was refracted at the surface.

Question 7

(a) (i) Candidates generally responded well to this question. Answers they had to make clear that the coronary arteries supply the muscle of the heart with oxygenated blood. Therefore, a response such as 'they take blood to the heart' was not considered precise enough to gain credit because this statement could apply to veins too.

(ii) Candidates had to describe the narrowing of the arteries by the build-up of fatty deposits. Most candidates stated this. Credit was not given for just the word 'fat', or descriptions of poor lifestyle activities.

(iii) The risk factors for developing CHD were well known and most candidates scored full marks in this question.

(b) (i) Most candidates scored full marks on this question. Since this equation is stated on the syllabus, it is a recall-type question, therefore the process of balancing an equation, as in chemistry, is not necessary if the candidate is well prepared.

(ii) Better responses stated 'contraction', as stated in the syllabus. Widely seen incorrect responses included 'for movement', 'to keep the muscles going'.

(iii) Many candidates scored full credit in this question, recognising the fact that not only do oxygen and glucose need to be supplied to the muscles, but carbon dioxide has to be removed from the muscles. Some poorer responses included reference to an increased breathing rate to take in more oxygen. These references were not considered relevant to the question which focused on heart rate.

Question 8

(a) (i) Many candidates identified the two hydrocarbons. A frequent incorrect response was 'methene' for hydrocarbon **A**. Since there two carbon atoms are necessary to have a double bond, there is not alkene molecule with the prefix 'meth' in this context. Candidates should take care with their handwriting and make clear that they are writing ethene and not ethane for hydrocarbon **A**.

(ii) The standard test to distinguish between an alkene and an alkane was known by many candidates who wrote that the change with an alkene is from brown to colourless. Candidates who wrote 'clear', 'transparent' or 'discoloured' did not score.

(iii) Many higher-scoring candidates wrote the equation successfully. They had to use the correct formula displayed in the question, react it with oxygen, and remember that for complete combustion water and carbon dioxide are produced. Lower-achieving candidates found putting together these pieces of information challenging. Some candidates did not have all the reactants present. Others attempted a cracking reaction, while several wrote word equations. These responses did not gain credit.

(b) (i) Some candidates identified process **Y** correctly. Careful study of the diagram shows that process **Y** takes one fraction from the distillation column and changes it to a mixture which includes ethene. Therefore, process **Y** is not fractional distillation, but cracking. In addition to fractional distillation incorrect answers included heating, combustion and fracking.

(ii) The majority of candidates answered this correctly and scored full credit. Some lower-scoring candidates did not take the cue from the question, and their answers did not include references to molecular size and intermolecular forces.

Question 9

(a) (i) The circuit was drawn successfully by many candidates who concluded that a parallel circuit was necessary. Incorrect circuits included series circuits and short circuits. A minority of candidates did not know the symbol for a lamp. Others drew the symbol with the connecting wire running through the centre of it, which was not accepted.

(ii) The symbol for the a.c. power supply was not known by many candidates. Candidates are reminded to familiarise themselves with the symbols required by the syllabus. Incorrect answers that were frequently seen included ‘battery’, ‘cell’, ‘fuse’, ‘switch’ and ‘resistor’.

(b) Many candidates gained full marks in this question. Credit was lost by those candidates who did not recall the equation correctly and wrote I = V/P. Others knew that both current values had to be calculated, but did not realise that the voltage, 240 V, is the same across both branches of the parallel circuit. They doubled the value to give a voltage of 480 V, leading to incorrect answers.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

To achieve well in this examination, candidates need to have a thorough grounding in practical work during the course. Candidates should have as much personal experience of carrying out experiments themselves, as possible.

Centres are provided with a list of required apparatus well in advance of the examination date. Where centres wish to substitute apparatus, it is essential to contact Cambridge to check that the change is appropriate and that candidates will not be disadvantaged. Any changes must be recorded in the Supervisor's report.

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical biology, chemistry and physics techniques.

The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of every practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly and record observations clearly.

The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator.

Comments on specific questions

Question 1

(a) Most pencil drawings of the leaf provided were neatly drawn and included some detail of the leaf. Occasionally candidates ignored the instruction to draw a large diagram and drew diagrams that only occupied a very small space within the box provided for their sketches.

(b) (i) The longest length of the actual leaf was usually recorded, as requested, in millimetres. A minority of candidates who confused the millimetre and centimetre graduations on the ruler used, gave answers such as 4 mm.

(ii) A significant number of candidates ignored the instruction to draw a straight line on their diagram to indicate the longest length they had measured in **(i)**. The Examiner could not award credit for their measured length on the diagram as he had no means of telling which length the candidate had measured.

(iii) The magnification of the candidate's drawing was usually calculated correctly. Occasionally, the equation used to calculate the magnification was written upside down.

(c) (i) Few candidates gave a correct and detailed description of the method used to test the leaf for the presence of starch. Most descriptions merely stated that a few drops of iodine should be added to the leaf. Detail such as placing the leaf in hot water and adding alcohol were almost always omitted.

(ii) Most candidates knew the observation that would give a positive result for the presence of starch.

Question 2

(a) (i) Although the temperature of solution J was almost always recorded, in most cases there was no evidence in the table of results that it had been taken to the nearest 0.5 °C, as requested.

(ii) Most candidates produced a complete table with temperatures recorded at half-minute intervals up to a time of four minutes after solid H was added to solution J. Tables usually indicated that the temperature of the mixture increased to a maximum value before starting to decrease again.

The descriptions of the appearance of the solid and the solution after the final temperature reading were generally accurate. Credit was sometimes lost because the colourless solution was often described as clear or transparent. Candidates should be encouraged to avoid the use of these two words, as a clear or transparent liquid is not necessarily colourless.

(b) (i) Correct answers to this part were uncommon. Candidates usually quoted the maximum temperature reached by the mixture and not the maximum temperature rise of the mixture, as requested.

(ii) Candidates found this more testing question difficult. Only a minority of candidates were able to explain why the maximum temperature rise calculated on **(i)** was only an estimate. Few candidates realised that because the readings were taken at half-minute intervals, the temperature might have been higher between readings.

(iii) Again, only a minority of candidates realised that the procedure could be improved, and a better estimate of the maximum temperature reached, by taking readings more frequently.

(c) Most candidates scored one of the two available marks by substituting correctly into the given equation. A much smaller number of these candidates scored the second mark because their answers, although correct, were not given to 2 significant figures, as requested in the stem of the question.

Question 3

(a) The unstretched length l_0 of the spring was usually recorded to the nearest millimetre. Occasionally, candidates measured this length in centimetres and forgot to multiply by 10. This resulted in very small lengths such as 2.1 mm being recorded. Candidates should be encouraged to look at their answers and decide if the recorded length is a sensible one.

(b) The stretched length of the spring when loaded with a mass of 200 g was almost always recorded in the table and the extension produced by this mass calculated correctly and added to the correct box in the table.

(c) (i) Most candidates recorded a sensible value for the time for 20 oscillations of the oscillating mass.

(ii) The table was usually completed with a full set of values of the time for 20 oscillations. In the majority of cases the times recorded correctly displayed an increasing trend as the oscillating mass increased.

(iii) The period of the oscillations *T* for each mass were usually calculated and recorded correctly.

(iv) Most candidates calculated the value of T^2 correctly, but a significant number ignored the instruction to give their answers to 2 significant figures and lost the mark as a consequence of this.

(d) (i) The standard of graph plotting continues to improve. The plots were generally accurate, although often untidy. Many candidates drew large 'blobs' to display the plotted points and left it to the Examiner to decide where the centre of the point was. Candidates should be encouraged to use thin crosses, with the intersection of the two cross lines at the point being plotted.

(ii) The judgement of the placing of the line of best-fit was usually very good.

(iii) The calculation of the gradient was not done well. Many candidates were unsure what to do and often chose just one point on the line and divided its *y*-coordinate by its *x*-coordinate.

If candidates use data from their table to calculate the gradient, these data points must lie on the best-fit line, otherwise credit will not be awarded.

(iv) The majority of candidates used the given equation correctly with their result from part **(iii)**, to calculate a value for the acceleration due to gravity. Credit was given for any correctly evaluated value. Where candidates truncated their answers by rounding, the rounding was expected to be correct.

COMBINED SCIENCE

Paper 0653/52
Practical Test

Key messages

If doubling one physical quantity doubles another physical quantity then the two physical quantities are directly proportional to each other.

General comments

This paper was finished by all candidates and it was rare to see a part that had not been attempted.

Comments on specific questions

Question 1

The colours observed in the food tests were usually recorded accurately. The response 'no change' should be avoided as an alternative to stating the final colour. If the final colours did not match the mark scheme but did match the Supervisor's results, then marks were awarded. It is always essential that a set of Supervisor's results are included with the scripts.

In part **(c)** candidates were very good at identifying the nutrients present. Errors in parts **(a)** and **(b)** were carried forward to these conclusions. It was pleasing that most candidates referred to reducing sugars or glucose rather than simple sugars for a positive Benedict's test.

Most candidates correctly suggested the use of test-tube holders for handling hot apparatus in part **(d)**.

For the fat test in part **(e)** alcohol or ethanol was commonly stated but water was often omitted. If water was included it was usually incorrectly used before the alcohol. The result was well known. Less' white precipitate' responses were seen than in the past.

Question 2

A significant number of candidates used the wrong format, e.g. 0:25 for 25 seconds. Generally candidates observed the correct colours, indicating that the practical was well done. Times greater than 60 seconds for magnesium and **L** were credited if there was evidence from the Supervisor that this was correct. Again this emphasises the need for Supervisor's results to be sent with the scripts.

Candidates were able to convert the order of times into an order of rates and all knew that the gas was carbon dioxide.

Despite there being a large number of possibilities for the answer in part **(b)(i)**, relatively few candidates were awarded two marks. The most common response referred to the volume of limewater.

For the alternative method in **(b)(ii)**, many candidates were able to draw a suitable diagram but few linked time and volume.

Question 3

Nearly all candidates were awarded the first two marks in part **(a)**. Most candidates were able to calculate the power and correctly round the answer. The units of power were well known. In **(a)(iv)** the marks for current, voltage and power were usually awarded. Many candidates were not consistent in the number of

significant figures for the power values. In **(a)(v)** some candidates referred to heating of the wire and others referred to the state of the battery. The latter tended to be rather poor at describing the effect on the battery, often confusing voltage, power and energy.

In part **(b)** most candidates saw that the greater the length the greater the power but few referred to proportionality. Candidates did not analyse their results mathematically for the second mark.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental technique, to have carried out experiments similar to the ones shown in the paper and be able to draw assembled apparatus. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates need to read questions carefully so that they answer the question being asked, e.g. **3(d)(iii)** where the values needed for the gradient calculation should have been indicated on the graph.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments and use of a ruler was good. The standard of graph drawing was generally high although candidates need to remember that axes scales should be linear and the axes should cover at least half of the grid. Candidates who chose difficult scales also tended to make errors in plotting. Where candidates are asked to record data in tables, it is important that their additions should be to the same number of significant figures as the rest of the data. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1

(a) (i) Diagrams were usually of a high standard with many candidates gaining full credit. A small number of diagrams had feathery outlines or an incorrect number of spikes on the leaf.

(ii) Measuring of the line was generally accurate, a significant number of candidates gave the length in centimetres.

(iii) A significant number of candidates omitted to draw the line on their drawing meaning that any length quoted could not gain credit.

(iv) Many candidates calculated the magnification correctly. Inverting the division, subtracting the values and multiplying the values were common incorrect responses.

(b) (i) Many candidates treated the leaf with alcohol and some heated, most knew the test for starch.

(ii) The positive result for the starch test was well known. Blue was a common non-creditworthy response.

Question 2

(a) (i) Candidates found this very difficult, most gave a temperature from the table, 20.5°C was the most common.

(ii) Some candidates subtracted the values correctly. Many gave the highest value from the table, 56.0°C, and some subtracted the first reading from the final reading, 14.5°C

(iii) Few candidates gained credit. Rounding to the nearest 0.5°C was the most common reason given for the value being an estimate.

(iv) Few candidates gained credit. Most answered in terms of a more accurate or precise thermometer being required.

(b) (i) Many candidates performed the calculation correctly but did not give their value to 2 significant figures. Several calculated 3728 and put 37 on the answer line.

(ii) Few candidates gained credit. Many discussed using a more accurate thermometer or using a container made of glass or metal as these absorb more heat.

(c) Many candidates could not recall the test for copper ions. The whole range of quantitative analysis reagents were seen. Of those that used a correct reagent most either gave a colour, although this was often white, or gave precipitate; few gave both. The re-dissolving in aqueous ammonia was rarely seen.

Question 3

(a) The majority of candidates measured the spring correctly. A few candidates gave 50 or 50.5.

(b) Many candidates measured the spring and calculated the extension correctly. 130 and 130.7 were common incorrect responses.

(c) Candidates found squaring *T* difficult, some doubled the value or rounded the value incorrectly.

(d) (i) Whilst generally the graph was quite well executed, many did not start the axes at 0,0 and some had a non-linear scale or scales which did not cover at least half of the grid.

(ii) The line was drawn well by many candidates. Some thought that the line should go through the origin and ignored some points in so doing.

(iii) Many candidates omitted this question. Of those that calculated a gradient many used data points rather than their line or counted squares rather than using graph values. Many did not include evidence on their graph, did not use at least half of the line or inverted the division.

(iv) Most candidates who calculated a gradient went on to attain a value for *g*.

(e) Candidates found this challenging and many omitted the question. Repeat, start the ruler at 0 and hold the spring straight were common non-creditworthy responses.

Question 4

(a) (i) Many candidates read the scales correctly. Reading from the right hand side was a common error.

(ii) The majority of candidates subtracted the two values correctly, a significant number added them.

(iii) Many candidates divided their value in **(a)(ii)** by 30. Some divided by 10 or 20.

(b) Candidates found this difficult. Incorrect responses included: maggots sucking the liquid towards them, soda lime giving off carbon dioxide and the maggots attracting the coloured liquid.

(c) Stronger candidates knew why the clip was closed at the start but many thought it was to keep air or oxygen out of the apparatus. More candidates knew why the clip was opened at the end but many thought it was to let the carbon dioxide out.

(d) Many candidates could name one control variable and fewer named two. Amount of coloured liquid, gauze and soda lime were common non-creditworthy responses.

Question 5

(a) Many candidates named a suitable piece of apparatus; beaker was a common incorrect response.

(b) Candidates found the diagram quite difficult, conical flasks or test-tubes and clamp stands were drawn quite often in place of the beaker and tripod. The beaker was frequently empty. Many candidates gave correct labels but sometimes only two.

(c) More able candidates gained credit. The most common response was bubbles stop being formed.

(d) Many candidates labelled the apparatus correctly; far fewer labelled the substances correctly. Copper sulfate crystals in the filter paper and sulfuric acid in the evaporating basin were common.

(e) Candidates found this very difficult. Many thought it was to make a solution or that it hadn't been heated for long enough.

(f) Candidates found this very difficult and a significant number omitted this part of the question. Filtration was the most popular response. Also common was dissolving and repeating steps 5 and 6 or just looking at them for shininess or blueness.

(g) Candidates found this very difficult. Most thought it was to cool, crystallise or harden the crystals. Stopping them melting, shattering or breaking were also seen often.

(h) Candidates found this very difficult and a significant number omitted this part of the question. Copper sulfate, ammonia, hydrochloric acid and sulfuric acid were common responses.

Question 6

(a) (i) Many candidates read the measuring cylinder correctly. 96.6 was a common incorrect response.

(ii) Many candidates recorded the mass correctly. A significant number did not follow the data in the table and so gave the reading to four significant figures.

(b) (i) Most candidates plotted the points correctly, a significant number did not label the axes with both quantity and unit.

(ii) Stronger candidates circled the anomalous point and many omitted this part of the question. A small number circled a point on the line drawn.

(iii) Stronger candidates drew the line of best fit. Many included the anomalous point and so did not draw a straight line or did not consider the number of points above and below the line they drew.

(c) Whilst many candidates gave a value far fewer showed evidence on their graph and so did not gain credit.

(d) Candidates found this very challenging. Many described needing more accurate volumes, being more accurate or repeating with no mention of averaging.

(e) Almost no candidates gained credit and many omitted this question.

(f) Candidates found this very challenging. Contains dissolved carbon dioxide was the most popular response.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and should be able to read values from a variety of measuring instruments and record the values to the requested accuracy. When planning an experiment, candidates need to consider the steps involved and their sequence.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard, calculations were well executed and food tests were quite well known. The standard of graph drawing was generally high although candidates need to remember to include units on the axes and to draw straight lines with a single line and a ruler. Where candidates are asked to record data in tables, it is important that their additions should be to the same number of significant figures as the rest of the data. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1

(a) Many candidates gained credit. A significant number gave biuret or iodine.

(b) Food tests were generally well known. Candidates often gave only one nutrient for solution A (usually protein), omitted reducing for the reducing sugar in B and most candidates gave starch for C.

(c) The safety precaution was usually correct. A significant number of candidates did not explain the safety precaution.

(d) Many candidates added ethanol but omitted to add the solution formed to water. Many knew the result expected, precipitate was a common error.

(e) (i) The majority of candidates stated two variables. Some gave answers which were too vague such as volume or heat.

(ii) Candidates found this part more challenging. Many described a degree of colour, e.g. the darker the red the more concentrated or the darker the colour the more concentrated.

Question 2

(a) (i) Candidates found the drawing challenging. Many had bungs in either both tubes or neither or did not have the delivery tube under the level of the limewater. Most labelled the reagents correctly.

(ii) Very few candidates appreciated the problem of ‘suck-back’. Stopping the gas going into the limewater was a common response.

(iii) Most candidates gave the correct reading. Other responses included 00:65, 10:05 and 10:50.

(b) (i) Most candidates knew the test for carbon dioxide gas. A small number gave hydrogen or oxygen.

(ii) Most candidates gave the correct order with a very small number inverting it.

(iii) Candidates found the relationship more challenging and many gave snapshot answers such as the most reactive has a low rate rather than stating the comparative relationship. Some candidates discussed time rather than rate.

(c) Many candidates used a syringe or upturned measuring cylinder in water to collect the gas and measure its volume. Only a few candidates considered time.

Question 3

(a) (i) The unit for current was well known. The unit for power was less well known with J being the most common incorrect response. A significant number omitted the question.

(ii) Most candidates read the meter correctly.

(iii) Most candidates calculated P. A significant number of candidates did not follow the data in the table and so recorded the reading to three significant figures.

(b) Candidates found this difficult. Common incorrect responses included to stop the student being electrocuted, to let the meters reset and to stop the readings adding up each time.

(c) (i) Whilst generally the graph was well executed, units were often omitted from the labels on the axes. A small number had non-linear scales (0 10 20 40 60 80 being common) or scales which did not cover at least half of the grid and some reversed the axes.

(ii) The line was drawn well by many candidates, a few were dot-to-dot lines or not drawn with a ruler.

(d) Many candidates described the relationship correctly. Few explained their answer with many candidates stating the relationship in both parts of the answer.

Question 4

(a) Candidates found this challenging. The two white blood cells were often labelled as W and R. A significant number omitted the question.

(b) (i) Drawings were generally of a high standard. A small number had sketchy outlines or an incorrect number of lobes in the nucleus.

(ii) Most candidates measured the width of the cell and calculated the magnification correctly. Some inverted the division or subtracted the values. Rounding was sometimes incorrect.

(c) (i) Almost all candidates calculated the value correctly.

(ii) Stronger candidates produced detailed descriptions. Resting before taking the pulse was usually omitted. Many described where to find the pulse and how to count the beats for a specified time. Placing a hand over the heart and counting the heart rate was a common non-creditworthy response. Many appreciated the need for repeats.

Question 5

(a) (i) Many candidates drew the solvent below the spots. Many candidates omitted the question.

(ii) Many candidates appreciated that pencil does not dissolve in ethanol. A common response was to mention a line is needed on which to put the spots.

(iii) Candidates found this difficult. Stopping substances from entering the beaker was the most common response.

(b)(i) Many candidates worked out the number of colours correctly. Some stated that all four colours need to be mixed to make black.

(ii) Many candidates gained full credit. Sometimes the explanation was missing.

(c) (i) Candidates found this very difficult. Inks dissolve in water or they dissolve faster in ethanol were common responses.

(ii) Candidates found the idea of better separation challenging. More accurate was a common response.

(d) Running a chromatogram with the sweet and the red dye was well answered. Many candidates melted the sweet rather than dissolving it.

Question 6

(a) Candidates found this very difficult. Many used the ruler to measure 50 cm, marked this point and started the ruler again from the point and repeated until the top of the stairs was reached.

(b) (i) Many candidates gained credit, running out of energy was a common response.

(ii) Most candidates calculated the average correctly, some then gave the answer to 4 significant figures.

(c) (i) Most candidates read the scale correctly, 430 N was sometimes seen.

(ii) Candidates found this very difficult. Moving causing changing the persons weight or to get an accurate answer were common responses.

(iii) Candidates found this difficult. To get an accurate reading was the most common response. .

(d) (i) Most candidates calculated the value correctly.

(ii) Most candidates calculated the value correctly, some rounded the value incorrectly

(e) Most candidates knew the power was less and some gave a correct explanation. Having less energy, shorter legs or needing to train more often were common responses.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques, to have carried out experiments similar to the ones shown in the paper and to be able to draw apparatus. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates should have performed identification tests on the range of substances detailed in the specification.

General comments

Candidates from some centres demonstrated good understanding of practical knowledge. The standard of biological drawings was quite high. The standard of graph drawing was also good. Where candidates are asked to record data in tables it is important that their additions should be to the same number of significant figures as the rest of the data. Undertaking practical work helps the candidates to state observations and to interpret and evaluate experimental methods, techniques and results.

Comments on specific questions

Question 1

(a) (i) Drawings were generally of a high standard. Some had sketchy outlines particularly the petals or the style was not clearly visible at the top of the stigma. A few were smaller than the original.

(ii) Most candidates labelled the flower parts correctly. Some responses labelled the filament as the anther or labelled the anther or the style as the stigma

(b) (i) Many candidates added ethanol but omitted to add the solution formed to water. Many candidates knew the result expected, although precipitate was a common error. A few candidates described reducing sugar or protein tests.

(ii) Many candidates appreciated that milk is the same colour as the positive test result. Presence of protein or calcium or the milk clotting was seen quite often.

Question 2

(a) (i) Generally the standard of drawing was quite high. Some omitted the filter paper from the funnel or had a hole in the filter paper and often the test-tube was replaced by a beaker. The labelling was usually correct.

(ii) Many candidates gained credit. Cleaner and bacteria free were common non-creditworthy responses.

(b) Candidates found this part difficult. Copper was a common response.

(c) (i) Few candidates appreciated that an observation was required, ammonia given off was not creditworthy. Most candidates gave correct observations for litmus.

(ii) Many candidates appreciated that the reagent added would also give ammonia gas.

(iii) Candidates found this quite challenging. Chloride and sulfate were common responses for the nitric acid test and chloride was common for the barium nitrate test.

Question 3

(a) (i) Most candidates read the thermometer correctly. Some responses gave 61.5 or 60.3.

(ii) Candidates found this difficult. Most described letting the temperature of the water settle.

(iii) Candidates found this very difficult. Common responses included using the same starting temperature, using the same volume of water and repeating the experiment.

(b) (i) Most candidates gave the correct units. Degrees and F were seen occasionally.

(ii) Most candidates calculated the decreases in temperature correctly. Occasionally 32.5 or 23.5 were seen.

(c) Many candidates deduced the relationship between the rate of cooling and the surrounding temperature. Reference to the information or data was quite often missing.

(d) Candidates found this very difficult. Some suggested an improvement, the explanation was often omitted. Common responses included repeating the experiment, using a more accurate thermometer and ensuring the same room temperature.

Question 4

(a) (i) Almost all candidates counted the number of woodlice correctly.

(ii) Most candidates calculated the average correctly and many rounded the value to the nearest whole number of woodlice.

(b) The bar charts drawn were of a very high standard. A small number of candidates either omitted to label the axes or used less than half of the grid.

(c) (i) Almost all candidates gave the correct section.

(ii) Most candidates gained credit. A small number put them all in the same section, often damp and dark.

(iii) Most candidates gave one correct improvement and many gave two. Common non-creditworthy responses included: use a control, same room temperature, control the amount of dampness/light, at the same time of day and count at times during the 15 minutes.

Question 5

(a) (i) Candidates found this difficult. Of those that gave cobalt chloride many gave the reverse colour change, many checked melting point or boiling point. Copper chloride was seen quite often.

(ii) Many candidates gained credit. Cooling of the gases and condensing the hydrocarbon were common responses.

(b) (i) Many candidates omitted this question. Blocking off the exit on the bottle was a common incorrect response.

(ii) The test for carbon dioxide was well known.

(c) Candidates found this very difficult and many did not provide a response. Most responses agreed with the student, explaining that the tests proved that carbon dioxide and water were present. Few candidates considered the limitations of the experiment.

(d) Candidates found this very difficult. The water diluting the limewater and so stopping it testing for carbon dioxide was a very common response.

(e) Some candidates gained credit for the idea of a control. Cleaning the apparatus and removing impurities were common responses. Many candidates omitted this question.

(f) The identity of the black solid was well known. Common incorrect responses included carbon monoxide, carbon dioxide, hydrogen and tar.

Question 6

(a) Many candidates measured the angle correctly. 30° was the most common incorrect response.

(b) Most candidates measured the line correctly.

(c) (i) Generally the standard of graph drawing was good. A significant number of candidates omitted to label the axes or used less than half of the grid.

(ii) The line was drawn well by many candidates. Some responses had all of the points which did not lie on the line itself to one side of the line.

(d) Whilst many candidates used their graph correctly, many omitted to include evidence on their graph and so could not gain credit. Some misread their scale on the *x*-axis, often reading, for example, 43 instead of 46.

(e) (i) Few candidates gained credit and many omitted the question. Making the measuring easier was a common response.

(ii) Candidates found this difficult and many omitted the question. Changing or increasing the sugar concentration was a common response.

(f) Many candidates gained credit. A common response was that the change causes the sugar concentration to be too high.