COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments: Biology

No questions proved to be too easy for the candidates.

Question 4, **Question 10** and **Question 5** proved most difficult for the candidates.

Comments on specific questions: Biology

Question 1

This question, about living processes, discriminated well between candidates. The weaker candidates selected the three distractors equally.

Question 2

This question was easier and the majority of candidates were correctly able to calculate the length of the insect from the information provided.

Question 3

Candidates found this question relatively easy. Option **B** was the strongest distractor suggesting some confusion between hormones and enzymes.

Question 4

Candidates found this question difficult and there was some evidence to suggest many were guessing the answer. The question tested two areas of the syllabus and candidates need to practise linking the ideas in this way.

Question 5

This question also proved difficult. Option **C** was the strongest distractor suggesting some confusion between the epidermis and the palisade layer in a leaf.

Question 6

This question, about the alimentary canal, proved tricky for many candidates. Option **A** was the strongest distractor suggesting confusion about the order of the colon and small intestine.

Question 7

Candidates found this question easier, with the majority of them able to correctly identify a red blood cell and link it to the transport of oxygen.

Question 8

This question discriminated well between candidates. The weaker candidates were equally distracted by Options **A** and **B**. Candidates need to be encouraged to learn these important equations.

Question 9

This question also discriminated well between candidates. Approximately half the candidates were able to correctly identify the effects of adrenaline.

Question 10

Candidates found this question very difficult. The weaker candidates were most strongly distracted by option **C** suggesting that many are confused between phototropism and gravitropism.

Question 11

This question, which asked candidates to identify the function of the petals, was answered correctly by many of the candidates.

Question 12

Candidates found this question difficult. There was evidence to suggest that the weaker candidates were guessing the answer and were unsure about the processes in the carbon cycle.

Question 13

This question also discriminated well between candidates. The majority of the more able candidates correctly identified the negative effects of deforestation.

General comments: Chemistry

No questions proved to be too easy for the candidates.

Question 16, **Question 21** and **Question 22** proved most difficult for the candidates.

Comments on specific questions

Question 16

The incorrect **A** and **D** were chosen a little more often than the correct answer, **B**. Candidates chose **C** far more often than the correct answer. The question assumed that the whole mass of reactants is changed into the products. However, it is recognised that where candidates were familiar with equilibria they may have chosen **D** instead of **B**.

Question 18

The incorrect **A** was chosen more often than the correct answer, **B**. Candidates recognised that bromide ions move to the anode, but not realising that the anode product is bromine. More able candidates chose the incorrect **C**, clearly confusing the anode with the cathode.

Question 19

More able candidates chose the incorrect **C** rather than the correct answer, **A**. They were aware that oxygen is essential for combustion, but they did not realise that hydrogen was the gas that was burning.

Question 21

The incorrect **B** and **C** were chosen more often than the correct answer, **A**. Candidates did not realise that aqueous sodium chloride is a neutral solution, nor that excess acid would fully neutralise calcium carbonate leaving an acidic solution.

Question 22

More able candidates chose the incorrect **B** and **C** more often than the correct answer, **D**, whilst the incorrect **A** was also chosen more often than the correct answer. Candidates did not realise that the Universal Indicator contained in the acid would be red, and that this would be turned green when neutralised by the excess magnesium. They also did not realise that the gas produced was hydrogen and that this would have no effect on limewater.

Question 24

The incorrect **D** was chosen more often than the correct answer, **C**. Candidates did not recognise that all Group I elements are metals and that they conduct electricity, nor that potassium is more reactive than lithium.

General comments: Physics

Several of the physics questions were found to be difficult. These were questions **34** and **35** and, especially, **30**, **31**, **36** and **40**. No questions were found to be particularly easy.

Comments on specific questions

Question 28

A large proportion of less able candidates opted for **D** in this question on average speed, apparently comparing only the distances travelled rather than the speeds.

Question 30

This density question was particularly badly answered, with many more choosing **C** than the correct **A**. This incorrect value is obtained by dividing the mass by the surface area of the base of the cube rather than by its volume.

Question 31

The topic here was energy resources, and it was a very popular misconception that geothermal energy has the Sun as its source.

Question 34

In this question on double glazing, many weaker candidates probably failed to notice that the glazing unit being considered had a vacuum between the panes, rather than air. This led them to opt for **B**, as some convection would be possible in an air gap.

Question 35

Option **A** was a popular choice here; this was obtained by dividing the wavelength of the wave by its amplitude, rather than multiplying by its frequency. Candidates should be reminded that they should read the whole question rather than just using information in the diagram.

Question 36

Option **C** was more popular than the correct answer to this question on reflection by a plane mirror. Many candidates were unaware of the position of the image formed, or that the angle of incidence is measured between the incident ray and the normal.

Question 40

This question concerned a combination of resistors, two of which were in parallel. More than half the candidates simply added all the values together as if all the resistors were all in series, leading them to choose option **D**.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments: Biology

No questions proved to be too easy for the candidates.

Question 2 and **Question 11** proved most difficult for the candidates.

Comments on specific questions: Biology

Question 1

This question, about living processes, discriminated well between candidates. The weaker candidates selected the three distractors more frequently than the key.

Question 2

Candidates found this question, which asked about diffusion, difficult. Option **B** was the strongest distractor suggesting that many do not fully understand the random nature of the process.

Question 3

Candidates found this question relatively easy, although it did discriminate well between candidates. Option **D**, starch, was the strongest distractor.

Question 4

Candidates found this question difficult and many weaker candidates thought that vitamin C is required to prevent weak bones and teeth.

Question 5

This question, which asked for the photosynthesis equation, was answered correctly by the majority of candidates.

Question 6

Candidates found this question, about the alimentary canal, more difficult. Option **A** was the strongest distractor suggesting confusion about the order of the colon and small intestine.

Question 7

Approximately half of the candidates correctly identified platelets as the key. Options **A** and **C**, plasma and red blood cells, were equally strong distractors for the weaker candidates.

Question 8

Candidates found this question relatively easy. The majority were able to select the correct statements about respiration.

Question 9

This question, which asked about the changes to the rate and depth of breathing during exercise, was also answered correctly by the majority of candidates.

Question 10

Again, candidates found this question relatively easy and the majority were able to correctly identify the changes that occur in the body just before exercise.

Question 11

Candidates found this question very difficult. The weaker candidates were most strongly distracted by Option **C** suggesting that many are confused between phototropism and gravitropism.

Question 12

This question discriminated well between candidates. The weaker candidates thought that fertilisation takes place in the vagina rather than in the oviduct.

Question 13

Option **B** was a strong distractor in this question suggesting many candidates have the common misconception that plants get their energy from the soil.

General comments: Chemistry

Candidates performed very well on **Question 15** and **Question 17**.

Question 23 proved most difficult for the candidates.

Comments on specific questions

Question 14

The incorrect **C** was chosen as often as the correct answer, **B**. Candidates did not recognise that oxygen, O_2, although an element is also a molecule.

Question 15

Candidates understood very well the sequence of physical changes that occurs during fractional distillation.

Question 16

More able candidates chose the incorrect **D** rather than the correct answer, **B**. They thought that the thermal decomposition of calcium carbonate, rather than the crystallisation of copper sulfate from solution, was a physical change.

Question 17

Candidates had no difficulties in deducing the formula of propane from its structural representation.

Question 22

More able candidates tended to choose the incorrect **D** rather than the correct answer, **C**. They knew that one ion of iron produces a dark green colour with the addition of aqueous sodium hydroxide, but they confused iron(II) ions with iron(III) ions.

Question 23

The incorrect **C** and **D** were chosen more often than the correct answer, **A**. Candidates did not appreciate the change in the metallic character of elements across a period in the Periodic Table.

General comments: Physics

The physics questions causing the greatest difficulty were **Questions 33**, **34**, **37** and **40**. No questions were found to be particularly easy.

Comments on specific questions

Question 28

A large proportion of less able candidates opted for **D** in this question on average speed, apparently comparing only the distances travelled rather than the speeds.

Question 33

This question concerned transfer of energy thermally, and the same proportion of candidates chose **C** as chose the correct answer **A**; their error was failing to realise that convection could not transfer energy from a heater placed above the thermometer.

Question 34

For candidates of all abilities option **A** was a very popular choice here; this was obtained by dividing the wavelength of the wave by its amplitude, rather than multiplying by its frequency. Candidates should be reminded that they should read the whole question rather than just using information in the diagram.

Question 37

A majority of candidates of all abilities opted for the incorrect **A** in this question on echoes and speed of sound. Their mistake was the very common one of failing to take into account that the sound had to travel to the cliff and back again, leading to an answer that was half of the correct one.

Question 38

Rather than reading the first part of this question, it appeared that approximately one in three candidates relied on recognising a shape that looked very roughly like a resistor, so chose the incorrect option **B**.

Question 40

This straightforward question on current in a series circuit seemed to lead to widespread guessing, with even the more able candidates not knowing that the current would be the same at all points.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice (Core)

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

General comments: Biology

Candidates did very well on **Question 2** and **Question 12**.

Question 5 and **Question 11** proved most difficult for the candidates.

Comments on specific questions: Biology

Question 1

This question, about living processes, discriminated well between candidates. The majority of candidates found the question easy, although many weaker candidates were distracted by Option **C**.

Question 2

Many candidates found this question, about cell structure, easy. Weaker candidates incorrectly selected Option **C**, believing that there is no nucleus in an animal cell.

Question 3

Candidates also found this question relatively easy. Option **D**, starch, was the strongest distractor for the weaker candidates.

Question 4

Many candidates could identify the chemicals used in photosynthesis. The weaker candidates were equally distracted by Options **B** and **D**. Candidates need to be encouraged to learn these important equations.

Question 5

Candidates found this question, about the alimentary canal, more difficult. Option **D** was the strongest distractor suggesting confusion about the order of the colon and small intestine.

Question 6

This question was also more difficult for candidates. Option **D** was the strongest distractor suggesting confusion about how different environmental factors affect the rate of transpiration.

Question 7

This question, about the internal structure of the heart, was well answered by the majority of the candidates. Option **D** was the strongest distractor.

Question 8

Candidates also found this question relatively easy. The majority were able to correctly link the blood cell to its function.

Question 9

This question, which asked about the composition of expired air, was more difficult. Option **B**, which shows the composition of inspired air, was the strongest distractor.

Question 10

Candidates also found this question more difficult. It seems that many candidates incorrectly believe that hormones are produced by a target organ.

Question 11

Candidates found this question very difficult. Candidates were most strongly distracted by Option **C** suggesting that many are confused between phototropism and gravitropism.

Question 12

Candidates demonstrated a good understanding of germination, with the majority of them answering this question correctly.

Question 13

This question discriminated well between candidates and Option **C** was a strong distractor. The sewage would need time to affect the number of species, hence why it must have entered the river at point B.

General comments: Chemistry

Candidates performed very well on **Question 16**.

Question 21 proved most difficult for the candidates.

Comments on specific questions

Question 14

More able candidates chose the incorrect **C** more often than the correct answer, **B**. They did not recognise that oxygen, O_2, although an element is also a molecule.

Question 16

Candidates understood very well how to identify chemical and physical changes.

Question 19

More able candidates chose the incorrect **C** rather than the correct answer, **A**. They were aware that oxygen is essential for combustion, but they did not realise that hydrogen was the gas that was burning.

Question 20

More able candidates chose the incorrect **A** and **B** rather than the correct answer, **D**. They did not recognise that in this redox reaction copper oxide is reduced when it loses oxygen and carbon is oxidised when it gains oxygen.

Question 21

The incorrect **B** and **D** were chosen more often than the correct answer, **A**. Some candidates thought that copper(II) oxide reacts with dilute sulfuric acid to form a colourless solution and a gas. More able candidates knew that the solution formed would be blue, but they also thought that a gas would be formed.

Question 22

The incorrect **B** was chosen more often than the correct answer, **A**. Candidates did not appreciate that only ammonia in the list forms an alkaline solution that would turn red litmus to blue, whilst carbon dioxide is a weakly acidic gas that would have no effect on red litmus, chlorine is an acidic bleaching gas, and hydrogen gas has no effect on acid-base indicators.

Question 24

More able candidates chose the incorrect **C** rather than the correct answer, **D**. They did not recognise that transition elements have high melting points and high densities.

General comments: Physics

In the physics section only **Question 35** and, particularly, **Question 32**, were badly answered. No questions were found to be particularly easy.

Comments on specific questions

Question 29

This question was reasonably answered although a significant proportion of candidates did not realise that mass does not change with position.

Question 32

The topic here was change of state, and more than half the candidates opted for the incorrect **B**, confusing the relevance of the region of the graph at constant temperature with the region at changing temperature.

Question 34

For candidates of all abilities option **A** was a popular choice; this was obtained by dividing the wavelength of the wave by its amplitude, rather than multiplying by its frequency. Candidates should be reminded that they should read the whole question rather than just using information in the diagram.

Question 35

In this question on total internal reflection a common error was to choose **C**, these candidates failing to notice that the light was reflecting off a more dense medium, so making *internal* reflection impossible.

Question 38

Rather than reading the first part of this question, many less able candidates relied on recognising a shape that looked very roughly like a resistor, so choosing the incorrect option **B**.

COMBINED SCIENCE

Paper 0653/21
Multiple Choice (Extended)

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

General comments: Biology

Candidates did very well on **Question 2** and **Question 3**.

Question 4 proved most difficult for the candidates.

Comments on specific questions: Biology

Question 1

The majority of candidates found this first question, about living processes, relatively easy.

Question 2

This question, about cell structure, was also answered correctly by the majority of the candidates. Options **B** and **C** were equal distractors for some candidates.

Question 3

Candidates also found this question relatively easy. Option **D**, the idea that the enzyme would continue to increase the rate of reaction above the optimum temperature, was the strongest distractor.

Question 4

Candidates found this question much more difficult. The question tested two areas of the syllabus and candidates need to practise linking the ideas in this way.

Question 5

This question discriminated well between candidates. Some candidates were strongly distracted by Option **C** – this response has the correct chemicals but the equation is not balanced.

Question 6

This question, about the alimentary canal, proved tricky for many candidates. Option **A** was the strongest distractor suggesting confusion about the order of the colon and small intestine.

Question 7

Candidates also found this question more difficult, although it did discriminate well between candidates. Option **D** was a strong distractor suggesting many candidates believe that sugar is absorbed through the root hair cells.

Question 8

This question also discriminated well between candidates. The weaker candidates were distracted by all the options, suggesting some may have been guessing the answer.

Question 9

Candidates found this question easier, with the majority of them able to correctly identify a red blood cell and link it to the transport of oxygen.

Question 10

This question, which asked about the effects of tobacco smoke, was answered well. Option **D**, tar, was the strongest distractor.

Question 11

The majority of candidates also answered this question correctly. Many of the weaker candidates believe that the amniotic fluid provides oxygen and nutrients to the fetus.

Question 12

Candidates found this question difficult. There was evidence to suggest that the some candidates were guessing the answer and were unsure about the processes in the carbon cycle.

Question 13

This question, about acid rain, proved easy for the majority of candidates.

General comments: Chemistry

Candidates performed very well on **Question 15**.

Question 23 proved most difficult for the candidates.

Comments on specific questions

Question 15

Candidates had very little difficulty in identifying fractional distillation as the process used to separate petroleum.

Question 20

More able candidates chose the incorrect **C** more often than the correct answer, **A**. They were aware that oxygen is essential for combustion, but they did not realise that it was hydrogen that was the gas that was burning.

Question 23

The incorrect **A** and **B** were chosen more often than the correct answer, **C**. Candidates did not recognise that Barium sulfate is insoluble in water and so would be separated from the aqueous mixture by filtration. More able candidates did not appreciate that the solution formed would also contain nitric acid, and that evaporation could not be used to obtain barium sulfate from the reaction mixture.

Question 27

The incorrect **C** was chosen more often than the correct answer, **A**. Whilst all four processes involve heating the substances in order to change them, candidates did not recognise that cracking is a decomposition process.

General comments: Physics

In the physics section only **Question 40** caused particular difficulty, with no questions being found very easy.

Comments on specific questions

Question 28

In this question about a speed-time graph many candidates opted for **B**, selecting the correct acceleration but omitting the factor of ½ when calculating the distance travelled.

Question 30

More than a third of candidates in this question on the extension of a spring simply looked for the increase in extension with each increase in load, leading them to choose option **A**.

Question 32

A common misconception here, particularly among less able candidates, was to believe that evaporation does not affect the temperature of the remaining liquid.

Question 34

Option **A** was a popular choice here; this was obtained by dividing the wavelength of the wave by its amplitude, rather than multiplying by its frequency. Candidates should be reminded that they should read the whole question rather than just using information in the diagram.

Question 35

More than a third of candidates opted for **A**, with a higher proportion of able candidates making this mistake than the less able. It seems likely that, having correctly deduced that the angle of incidence at mirror X is 30°, these candidates did not read the question carefully and so failed to notice that the question referred to mirror Y.

Question 37

A large majority here were able to identify compressions and rarefactions, but a significant proportion of these also believed the wave to be transverse.

Question 40

This question on an electrical circuit caused problems for many, and these candidates appeared to resort to guessing.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments: Biology

Candidates did very well on **Question 2** and **Question 6**.

Question 3 and **Question 5** proved most difficult for the candidates.

Comments on specific questions: Biology

Question 1

The majority of candidates found this first question, about living processes, relatively easy. The question discriminated well between candidates.

Question 2

This question, about cell structure, was also answered correctly by the majority of the candidates. Options **B** and **C** were strong distractors for the weaker candidates.

Question 3

Candidates found this question, about the manufacture of yoghurt, much more difficult. Option **A** was the strongest distractor amongst the candidates.

Question 4

Candidates also found this question, about the alimentary canal, more difficult. Options **A** and **D** were strong distractors suggesting confusion about the order of the colon and small intestine.

Question 5

This question about malnutrition was not answered very well. Candidates need to read the question carefully as they were asked for the direct results of an imbalance of energy intake and output. This does not include constipation.

Question 6

Candidates found this question, about the functions of root hairs, very easy.

Question 7

Over half of the candidates correctly identified platelets as the key. Options **A** and **C**, plasma and red blood cells, were strong distractors for the weaker candidates.

Question 8

This question discriminated well between candidates. The weaker candidates were strongly distracted by Option **B**, the equation for photosynthesis. Candidates need to be encouraged to learn these important equations.

Question 9

This question, which asked about the changes to the rate and depth of breathing during exercise, was answered correctly by the majority of candidates.

Question 10

Candidates found this question more challenging. Option **B** was a strong distractor which did not take into account that the card was turned 90° every day.

Question 11

The majority of candidates answered this question correctly. Many of the weaker candidates believe that the amniotic fluid provides oxygen and nutrients to the fetus.

Question 12

Option **B** was a strong distractor in this question suggesting many candidates have the common misconception that plants get their energy from the soil.

Question 13

Candidates found this question, about deforestation, relatively easy.

General comments: Chemistry

Candidates performed very well on **Question 15**, **Question 21** and **Question 24**.

No questions proved to be too difficult for the candidates.

Comments on specific questions

Question 14

More able candidates chose the incorrect **C** more often than the correct answer, **B**. They did not recognise that oxygen, O_2, although an element is also a molecule.

Question 15

Candidates understood very well the sequence of physical changes that occurs during fractional distillation.

Question 20

More able candidates chose the incorrect **C** more often than the correct answer, **A**. They were aware that oxygen is essential for combustion, but they did not realise that it was hydrogen that was the gas that was burning.

Question 21

Candidates understood very well how increasing the temperature affects the collisions of the reacting particles, and how this increases the rate of the reaction.

Question 24

Candidates knew the use of helium in weather balloons.

Question 22

More able candidates chose the incorrect **A** rather than the correct answer, **B**. They did not appreciate that copper oxide is reduced to form copper in this reaction.

Question 25

The incorrect **A** was chosen more often than the correct answer, **D**. There may have been some guesswork by candidates answering this question. They did not easily recognise that calcium carbonate undergoes thermal decomposition to form calcium oxide, which then reacts with silicate impurities in iron ore, removing these impurities as slag.

General comments: Physics

In the physics section **Question 33**, **Question 38**, and **Question 40** caused difficulty. No questions were found to be particularly easy.

Comments on specific questions

Question 28

Although generally well answered, some candidates opted for **C**, this being the maximum speed rather than the maximum acceleration.

Question 30

Nearly a third of candidates in this question on the extension of a spring simply looked for the increase in extension with each increase in load, leading them to choose option **A**.

Question 32

A very large majority of candidates knew that the average speed of the molecules in the gas would be increasing, but they often believed that the forces between molecules were strong.

Question 33

This question concerned transfer of energy thermally, and a greater proportion of candidates chose **C** than chose the correct answer **A**; their error was failing to realise that convection could not transfer energy from a heater placed above the thermometer.

Question 34

Many less able candidates selected option **A**; this was obtained by dividing the wavelength of the wave by its amplitude, rather than multiplying by its frequency. Candidates should be reminded that they should read the whole question rather than just using information in the diagram.

Question 35

This question concerned reflection by plane mirrors, and a common error was lack of knowledge of the fact that the angle of incidence is always measured to the normal rather than to the mirror, leading to the choice of option **C**.

Question 37

A large majority here were able to identify compressions and rarefactions, but a significant proportion of these also believed the wave to be transverse.

Question 38

This question on electrical resistance of a wire was badly answered, with many candidates apparently either guessing or believing that the effects of the two changes would cancel.

Question 39

Rather than reading the first part of this question, it appeared that approximately one in four candidates relied on recognising a shape that looked very roughly like a resistor, so chose the incorrect option **B**.

Question 40

This question concerned a circuit with two parallel branches; it caused widespread difficulty, seemingly leading to much guessing.

COMBINED SCIENCE

Paper 0653/23
Multiple Choice (Extended)

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

General comments: Biology

Candidates did very well on **Question 1**, **Question 2** and **Question 12**.

Question 6 proved most difficult for the candidates.

Comments on specific questions: Biology

Question 1

The majority of candidates found this first question, about living processes, relatively easy.

Question 2

This question, about cell structure, was also answered correctly by the majority of the candidates.

Question 3

Candidates found this question, about the manufacture of yoghurt, more difficult. Option **A** was the strongest distractor amongst the weaker candidates.

Question 4

Many candidates could identify the chemicals used in photosynthesis. Some candidates were distracted by Option **D**. Candidates need to be encouraged to learn these important equations.

Question 5

Candidates also found this question, about the alimentary canal, more difficult. Options **A** and **D** were strong distractors suggesting confusion about the order of the colon and small intestine.

Question 6

Candidates found this question, about the root hair cells, much more difficult. Option **D** was a very strong distractor suggesting candidates are unsure how temperature affects the rate of water uptake.

Question 7

Candidates found this question relatively easy. The majority were able to correctly link the blood cell to its function.

Question 8

This question was also answered well by candidates and most identified mucus and cilia as the correct features. Some weaker candidates confused cilia with saliva.

Question 9

This question discriminated well between candidates. Many weaker candidates selected Option **B** suggesting they are confused about how cell elongation is linked to the direction a shoot bends.

Question 10

Candidates found this question, about wind-pollinated flowers, relatively straight forward.

Question 11

The majority of candidates answered this question correctly. Some candidates believe that the amniotic fluid provides oxygen and nutrients to the fetus.

Question 12

This question was answered correctly by the majority of the candidates.

Question 13

Candidates also found this question relatively easy. Option **C** was a strong distractor amongst weaker candidates. The sewage would need time to affect the number of species, hence why it must have entered the river at point B.

General comments: Chemistry

Candidates performed very well on **Question 15**, **Question 22** and **Question 26**.

No questions proved to be too difficult for the candidates.

Comments on specific questions

Question 15

Candidates understood well the practicalities of how chromatograms are obtained.

Question 20

More able candidates chose the incorrect **C**, rather than the correct answer, **A**. They were aware that oxygen is essential for combustion, but they did not realise that it was hydrogen that was the gas that was burning.

Question 21

The incorrect **D** was chosen more often than the correct answer, **C**. Candidates understood that the results showed that changing the concentration of the acid had a greater effect on the rate of the reaction than changing the marble pieces had. However, they did not make the appropriate link between the time taken for the reaction and the rate of the reaction.

Question 22

Candidates understood very well why some reactions are described as redox reactions, and they were able to identify the substances being oxidised and reduced.

Question 23

There was evidence that many candidates had guessed the answer to this question. It is also clear that the more able candidates chose the incorrect **B** rather than the correct answer, **C**. Candidates did not realise that the products of the reaction include nitric acid as well as barium sulfate, that barium sulfate is insoluble and that the solid barium sulfate is separated by filtration.

Question 26

Candidates knew very well the composition of clean air, properties of noble gases and the products of combustion.

General comments: Physics

In the physics section question **31** was found the most difficult and question **29** was particularly well answered.

Comments on specific questions

Question 30

In this question on the extension of a spring a large proportion of less able candidates simply looked for the increase in extension with each increase in load, leading them to choose option **A**.

Question 31

This question involved a power calculation, and significantly more candidates chose option **C** than the correct option **A**; this was arrived at by failing to convert the time from minutes into seconds.

Question 34

Some candidates selected option **A**; this was obtained by dividing the wavelength of the wave by its amplitude, rather than multiplying by its frequency. Candidates should be reminded that they should read the whole question rather than just using information in the diagram.

Question 35

Many seemed to resort to guessing the answer to this question on the properties of the image formed by a plane mirror.

Question 37

A large majority here were able to identify compressions and rarefactions, but a significant proportion of these also believed the wave to be transverse.

Question 40

The topic here was electric circuits, and approximately two thirds appeared to guess. More able candidates who failed to choose the correct response **D** generally opted for **C**, meaning that they could identify the current but did not realise that the p.d. across the 2.0 Ω resistor should be subtracted from the e.m.f. of the battery.

COMBINED SCIENCE

Paper 0653/31
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and take care to answer exactly the question that is being asked. There was evidence in the answers seen that candidates had misunderstood some of the questions or not read them carefully and this is covered in the comments on specific questions below.

Care should be taken to give a complete answer to the question that is being asked. In particular, where there are two marks for a question, two points will usually need to be made.

General comments

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

Sometimes candidates struggled with their explanations of basic syllabus terms because of the context in which the question was being asked. When giving an explanation it is important to avoid simply restating words given in the question. Examiners are expecting a clear and complete answer to award credit.

Comments on specific questions

Question 1

(a) This question part was attempted by all candidates, with a full range of answers seen. Many recognised that oxygen is carried in red blood cells and a good number identified capillaries as the blood vessel in tissue. Few candidates correctly identified the pulmonary vein as taking blood from lungs to heart, with many different incorrect responses seen for this and for the aorta.

(b) (i) This question was testing recall of the syllabus definition of a 'target organ'. Many candidates had not understood the question and responded with answers about the importance of the heart to the body as a vital organ, making no comment on the fact that it is a target organ because it is affected by the hormone adrenalin.

(ii) More able candidates were able to recall that adrenalin is destroyed in the liver and gave clear and precise answers. Some weaker candidates suggested it was exhaled, while others gave vague answers or simply commented that it was not being produced anymore after the race.

(c) This question was well answered with many candidates correctly identifying A as the trachea. Oesophagus was the most frequent incorrect response here. Examiners are able to give credit when spelling is incorrect as long as it is clearly identifiable as the correct term. Many variant spellings of trachea could be awarded. For structure B this was more difficult as 'bronchiole' the correct response is quite similar to 'bronchus' an incorrect response. Examiners needed to be sure that candidates meant the correct term before being able to give credit. Candidates would benefit from a careful learning of the spelling of this term in order to give a precise answer.

(d) Many candidates did not read the question here and a lot of answers seen were about effects on heart rate rather than the pattern of breathing. Candidates found it hard to state 'deeper' breathing precisely and while descriptions such as 'more oxygen taken in in each breath' were credited,

vague answers such as ‘heavier’ breathing were not precise enough to gain credit. ‘Faster’ breathing was identified by more candidates.

Question 2

(a) (i) This question required recall both of the terms ‘cathode’ and ‘anode’ and also recall of which is the negative and positive electrode. A good number of candidates gained credit here. A few correctly remembered the terms but applied names to the wrong electrode. Some candidates had not read the question carefully and provided either specific names of the substances produced at the electrodes (which is the next question) or the general ‘anion’ ‘cation’ which did not answer the question.

(ii) Correct responses here needed to identify that an element, not an ion was produced as well as associating the correct element with each electrode. A common error was to identify ‘bromide’ at the positive electrode.

(iii) The vast majority of candidates either identified the correct answer here or the incorrect ‘covalent’ bonding. There were a significant number of blank responses to this question.

(iv) Candidates were being asked to explain that in a chemical change a new substance or substances are formed. Vague answers that talked about ‘substances changing chemically’, were not precise enough to gain credit. Some candidates simply described the particular experiment in the question rather than explaining why this was an example of chemical change.

(b) (i) A good number of stronger candidates identified hydrochloric acid here. While a few incorrect acids were seen (e.g. sulfuric acid) most incorrect responses were not acids at all; ‘chlorine’ being the most frequent incorrect response.

(ii) Candidates were asked specifically about the pH of the solution in this question and Examiners were looking for recognition that the pH increases during the reaction. Many candidates incorrectly thought that the solution was becoming more acidic. A few answers were seen where a correct response about pH was contradicted by a reference to ‘becoming more acidic’.

(iii) Only the most able candidates were able to give the correct test and observation here and almost all of them gained both marks. The weakest candidates made no attempt at a response here and a number of incorrect responses suggested a range of other chemical tests such as tests with litmus paper or food test solutions.

Question 3

(a) (i) Examiners were looking for candidates to explain that 80 Hz meant ’80 waves per second’ or similar words. Even the few candidates who understood and could explain the term ‘frequency’ generally answered by simply stating that ‘frequency means number of waves per second’ rather than answering the actual question. Those that defined frequency in terms of ‘waves per unit time’ did not gain credit here, since they did not precisely make reference to Hz, which are waves ‘per second’.

(ii) Many candidates correctly identified that the first sound is louder than the second. An answer that ‘one was louder than the other’ did not fully answer the question and vague answers that the first sound was ‘higher’ (or the second ‘lower’) could not be credited unless it was clear that volume rather than pitch was being referred to.

(iii) In this question candidates were being asked to compare the frequencies produced by the guitar with the normal range of human hearing and with that comparison come to a judgement about whether all the guitar frequencies can be heard. It was necessary to state ‘yes’ in order to gain credit. While it was not necessary to state actual values for human hearing only stating that 5000Hz is less than the maximum for humans was insufficient to gain credit.

(b) Very few candidates correctly identified the type of wave. The most frequent incorrect responses identified radio waves as ‘sound’ waves or ‘longitudinal’ waves.

(c) (i) Many candidates thought that the girl would see a magnified image or an inverted image. Weaker candidates simply described what the girl would see rather than stating characteristics asked for by the question. A few of the strongest candidates did state that the image was virtual.

(ii) This question was answered correctly by the majority of candidates. Occasionally an answer of 'angle of incidence is equal to angle of reflection' was seen which did not state the value asked for in the question.

(d) (i) Many answers here suggested that candidates had not read the question carefully enough. Examiners were looking for an answer of the highest tension in the straight-line segment of the graph, since the question stated that the guitarist must only increase the tension while extension remains proportional to tension force. Only the strongest candidates were able to give an appropriate answer. A few candidates gave values of extension rather than force.

(ii) This was well answered by the majority of candidates with many realising that the string might even break, although stating that it would be permanently deformed also gained credit.

Question 4

(a) Most candidates identified that large petals suggested insect pollination. Some candidates failed to score the second mark because they mentioned features that were not evidenced from the figure in the question (such as scent or colour of petals). Fewer candidates correctly identified that having the anther/stigma inside the flower was evidence of insect pollination, where this was given credit it was often for expressing the negative, e.g. 'anthers are not outside the flower'.

(b) Most candidates realised that self-pollination would happen because pollen would fall so those that knew that pollen is produced in the anther correctly identified flower D and explained why. Those that did not gain full credit usually only identified that the anther is above the stigma without explaining how this makes self-pollination more likely.

(c) This question tested candidates' ability to explain clearly how genetic material passes from parent to offspring in cross-pollination. Some candidates were able to gain credit for recognising that there would be two parent plants involved in cross-pollination. However very few candidates gained full credit and there were often errors in the explanations, with a number of candidates stating that pollen from more than one flower was involved in producing the seeds.

(d) (i) Candidates demonstrated a good understanding of food chains with the vast majority able to construct the correct food chain from the information in the question. A few lost full credit by showing the energy flow in the wrong direction.

(ii) This question was also answered well by the majority of candidates, many of whom identified the three consumers and were able to explain that a consumer gains energy by eating other organisms.

Question 5

(a) (i) Strong candidates here gained full credit for being able to recall accurately the definition of a hydrocarbon. Many candidates failed to gain full credit by neglecting to state specifically that only hydrogen and carbon atoms are present in the molecule and weaker candidates often incorrectly stated that a hydrocarbon was a mixture rather than a compound.

(ii) Examiners were looking here for a double bond between the two carbon atoms and a structure with 2 carbon atoms and 4 hydrogen atoms. Stronger candidates had good recall of the structural formula of ethene. A number of candidates were able to gain some credit for the correct number of each type of atom, even though they omitted the double bond or for realising that there was a C=C but not completing the formula correctly.

(iii) Only the strongest candidates gained both marks here, with a good number recalling either carbon dioxide or water. Weaker candidates often responded with the 'hydrogen' and 'carbon' suggesting that they had not understood the question.

(b) (i) This was well answered by the majority of candidates who were able to recall two coal and petroleum. Answers giving a specific fraction of petroleum that is a fuel were accepted but full credit could not be gained if both answers were petroleum or derivatives of petroleum.

(ii) Some weaker candidates gave a source of methane here rather than stating methane as the main constituent. However stronger candidates gained the mark easily with good recall.

Question 6

(a) (i) Candidates were not readily able to identify the symbol as being a fuse, with many incorrect answers seen. Most frequently it was mis-identified as a variable resistor but cell/battery and switch were also seen.

(ii) This question was particularly tricky for those that had not identified a fuse in part **(a)(i)**. A common misunderstanding was the idea that the component would 'control' the current rather than the idea of protecting the heater by stopping the current if it overloaded the circuit.

(iii) A good number of candidates correctly recognised that both switches needed to be closed for the heater to work.

(b) (i) The first mark here, for giving the correct symbol for an ammeter was scored by a good many candidates. Fewer were able to place the ammeter in the correct part of the circuit. Some candidates lost credit by placing additional components in the circuit (often a voltmeter across the motor) which contradicted their correct ammeter symbol.

(ii) Strong candidates found this calculation straightforward and were able to rearrange the formula, substitute values and apply the correct unit to their answer for full credit. Those with incorrect units were still able to gain calculation marks and the weaker candidates, who often recalled the formula incorrectly still gained credit for recall of the unit of resistance.

Question 7

(a) Examiners were looking for accurate recall of the word equation for photosynthesis and a good number of candidates demonstrated secure knowledge. Some weaker candidates gained partial credit for remembering either the two reactants or the product. Unfortunately other candidates had all the required terms but with glucose as a reactant and either carbon dioxide or water as a product of photosynthesis, suggesting a less secure understanding of the reaction.

(b) (i) Here candidates were being asked to make a connection between a graph of how oxygen concentration changes during the day with the rate of photosynthesis (i.e. the rate of production of oxygen). Very few candidates realised that the rate of photosynthesis would be highest when the graph of oxygen concentration is steepest. Most candidates incorrectly picked out the time for the peak oxygen concentration.

(ii) Many candidates correctly explained that less light would mean less photosynthesis and that therefore the oxygen concentration would be below the level of the existing graph. A number of weaker candidates seemed to think that they were being asked to identify the oxygen concentration on the graph at 14.00 and put their cross on the dotted line at 14.00, even if they then went on to explain that less light would mean less photosynthesis, suggesting that they had not understood the question.

(c) The strongest candidates found this question straightforward and made the correct connection between humidity and rate of transpiration. A number of candidates incorrectly linked warmer temperature to increased transpiration without taking into account humidity.

Question 8

(a) (i) The vast majority of candidates gained credit here, with the most popular correct answer being to 'paint' the nail. A few weaker candidates had not understood the question and tried to modify the apparatus shown in the question rather than describing one <u>other</u> method of rust prevention.

(ii) Many correct answers here suggested candidates were able to deduce or recall that oxygen combines with iron to form iron oxide. Only the very weakest candidates failed to gain credit here.

(iii) Examiners were testing candidates' knowledge of how to speed up a reaction. Most candidates did not seem to understand the question. Many strong candidates failed to gain credit here often suggesting putting a lid on the beaker or adding oxygen to the water. The very few candidates who gave creditworthy answers either identified the addition of salt as relevant to the context or more generally recalled that increasing temperature or the addition of a catalyst were both methods of speeding up a reaction.

(b) (i) Supplied with all the information candidates were asked to extract the reactants and products and complete the word equation here. Many candidates did this correctly. Some incorrectly thought that hydrogen was a reactant rather than a product.

(ii) Simple recall of the term exothermic was required here and stronger candidates answered correctly. Some mixed up the terms endothermic and exothermic and the weakest candidates often left this response blank.

(iii) Some candidates tried to over complicate this question which simply required recall of the relative positions in the reactivity series of calcium and sodium. Answers referring to position in the periodic table and number of electrons in outer shell were seen suggesting that candidates were imagining a much harder question than the one asked. A few candidates incorrectly stated that calcium was more reactive than sodium and some simply restated the question.

(c) (i) This question expected candidates to recall that copper belongs to the transition elements and generally stronger candidates answered correctly. Some candidates who could not recall the answer often left this blank.

(ii) Many correct answers were seen, with candidates often referring to alloys being more hard-wearing or stronger. A number of candidates seemed to forget that copper is unreactive and therefore an answer of 'less likely to rust' was not worthy of credit in this context.

Question 9

(a) (i) Many candidates correctly identified force B as being resistive or a friction force. The most common incorrect answer was to label this as the gravitational force.

(ii) With candidates allocated two marks for comparing forces A and B, Examiners were expecting a comparison of both their size and direction for the full marks. Most candidates only commented on the relative size of the forces and many of those failed to realise that the reference to the car travelling at constant speed must mean that the two forces are of equal size.

(b) Candidates were expected to know that it is light energy from the sun which is transferred to the solar cells and so the vaguer suggestion of 'solar' energy, which could be light or thermal energy was not worthy of credit. Very few candidates recognised that the solar cells converted this to electrical energy. Very few candidates scored full marks here.

(c) (i) Many candidates remembered that substances expand when heated and correctly explained that on a hot day the bridge expanding would cause the gap to close. There was evidence that some candidates did not understand the language of the question and believed the 'gap' to be the whole structure, including metal, of the figure in the question. They could still gain credit for recognising that heat caused things to expand.

(ii) Almost all candidates correctly placed 'evaporate' in the sentence. Only the strongest candidates related this to speed of molecules with a number of candidates incorrectly believing size of molecules determines those that escape rather than speed.

(iii) The weaker candidates connected all the boxes together here suggesting that they had not read the question carefully. Stronger candidates were able to identify the correct two boxes.

COMBINED SCIENCE

Paper 0653/32
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and take care to answer exactly the question that is being asked. There was evidence in the answers seen that candidates had misunderstood some of the questions or not read them carefully and this is covered in the comments on specific questions below.

Care should be taken to give a complete answer to the question that is being asked. In particular, where there are two or three marks for a question, multiple points will usually need to be made.

General comments

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

Sometimes candidates struggled with their explanations of basic syllabus terms because of the context in which the question was being asked. When giving an explanation it is important to avoid simply restating words given in the question. Examiners are expecting a clear and complete answer to award credit.

Comments on specific questions

Question 1

(a) Almost all candidates attempted this question and answers showed the full range of marks, though only the very strongest scored full marks. Recall of day 14 as the approximate day the egg is released was the weakest part of the question.

(b) Here candidates were given four different cell names in a diagram and asked to identify a haploid and diploid cell. The strongest candidates often gave the name of both haploid cells and usually identified the zygote as a diploid cell. A common response from weaker candidates was to see ‘zygote’ as the haploid cell and ‘embryo’ as the diploid cell, suggesting candidates either had not understood or had not read the question carefully.

(c) In this question, worth two marks, candidates needed to state a comparison between the genetic material in the body cells of twins and then explain their answer. Stronger candidates often explained correctly that the twins came from the same zygote (or from same haploid cells) but often failed to score both marks by neglecting to state that this meant the genetic material in the twins was identical.

Question 2

(a) (i) Candidates found this question challenging. They needed to use their knowledge of the reactivity series to place four metals in order of reactivity so that they could identify four unknown metals from the amount of gas given off during a timed experiment. Only the very strongest candidates were able to gain credit here. There were very few blank responses suggesting that candidates used the information to make an attempt even if unsure of the answer.

(ii) Many candidates were able to recall that hydrogen gas is produced in the reaction between magnesium and dilute hydrochloric acid. Some candidates put Magnesium chloride, perhaps

suggesting that they had not read the question carefully and were identifying the other product. There was a variety of wrong answers including carbon dioxide and Magnesium hydroxide.

(iii) This question was well answered with the majority of candidates stating clearly that an increase in temperature increases the rate of reaction.

(iv) This question asked for one other way of changing the rate of reaction (not temperature). Candidates who put decreasing the temperature had not identified another way. A number of candidates did gain credit by mentioning the use of a catalyst or by varying the concentration of acid or the size of metal particles. Candidates who suggested changing the type of acid or metal did not gain credit as these changes alter the actual reaction, not just the rate of the reaction.

(b) Candidates were asked to recall the correct observations when testing for iron (II) and iron (III) ions. A significant number of weaker candidates made no attempt at this question. The correct observation for iron (II) was seen more often than that for iron (III).

(c) (i) This question required recall of the properties of transition metals. Only the strongest candidates were able to gain credit here. Weaker candidates often just named metals or gave examples of properties of metals, generally, such as being a good conductor of electricity. Correct answers covering the full range of the mark scheme were seen.

(ii) The most common answers here referred to alloys being more resistant to rusting/corrosion. Sometimes candidates were unclear in their answers, not distinguishing between pure iron and iron alloys carefully enough and so they were not able to gain credit.

Question 3

(a) Examiners expected candidates to make use of the information in the question and label an arrow vertically upwards with 'uplift' since this information was provided. Applying their knowledge of forces candidates should have realised that weight acts vertically downwards. This was poorly answered. The third mark was awarded either for showing that the forces are acting on the helicopter by making the arrows touch the helicopter, or by giving an indication that the forces were balanced by showing the arrows of approximately equal length.

(b) This question was generally well answered with most candidates scoring at least some of the marks. Identifying the kinetic energy of the rotor blades seemed to be the hardest energy for candidates to recognise.

(c) (i) This was well answered by a good many candidates. Those who scored full marks had read the question carefully and realised that the constant speed was maintained for 100s after reaching that speed at a time of 20s. Candidates who had not read the question carefully often began the deceleration after 100s.

(ii) Most candidates realised that distance travelled was the area under the graph (speed × time) but a number tried to calculate the area under the whole graph or incorrectly identified the points where speed was constant, suggesting they had not read the question carefully enough and so could only gain partial credit. Other candidates used an incorrect method, calculating speed/time.

Question 4

(a) The majority of candidates correctly recalled the iodine test for presence of starch and a good number also correctly identified the colour change for a positive result. Weaker candidates were more likely to confuse the test with other food tests and also to give the vaguer, and not creditworthy, observation as an unqualified 'blue'.

(b) Candidates found it hard to interpret the information given in the question for this part. Examiners were expecting them to apply their knowledge of the effect of temperature and acidity on enzyme activity to this new situation. Only the strongest candidates linked the result that starch was present around A and B to the effect of the temperature or pH on enzymes.

(c) This was poorly answered with many candidates failing to gain credit by using imprecise language, such as 'breaks down food into smaller pieces' which is a description of mechanical rather than chemical digestion. Stronger candidates often gained partial credit for recognising that chemical digestion enables absorption into the blood, even if their language about what is broken down was imprecise.

(d) Most candidates recognised the molar tooth, with only a few unable to name it correctly. However full credit was often missed by candidates who had not read the question carefully and failed to identify some aspect of the structure of the tooth, even though they realised its function was for grinding/chewing. This is a case where candidates need to read carefully and consider that for three marks, they need to give a detailed answer.

Question 5

(a) Candidates had great difficulty in recalling the syllabus definition of atomic number and only the strongest candidates were able to give a clear and correct answer here.

(b) (i) Almost all candidates attempted this question and many were able to identify at least one of the elements with the stronger candidates generally scoring full marks here.

(ii) Most realised that they needed to give an answer of either ionic or covalent here. Generally though it was only the stronger candidates who consistently gave the correct response.

(iii) A good number of correct answers were seen to this question. Some candidates failed to mention that it was thermal energy that is released and so did not gain credit.

(c) (i) Almost all candidates attempted this question and wrote down a colour. Very few were able to correctly identify that chlorine gas is green.

(ii) There were a few more blank spaces here than in **(c)(i)** and only the strongest candidates correctly identified bromine as the orange-brown substance.

(d) (i) This question was well answered by the majority of candidates who could recognise electrolysis from the diagram.

(ii) This question tested candidates' knowledge of electrolysis as only taking place in liquids.

Question 6

(a) (i) Candidates did not understand that this question was asking about the method of heat transfer through the radiator. Even the strongest candidates, who realised it must be one of the three methods of heat transfer, were more likely to put radiation or convection than the required answer of conduction.

(ii) The majority of candidates correctly identified that metal was a suitable material for the radiator.

(b) (i) Examiners were looking for a sequence of arrows that went up from the given arrow, across the upper part of the room and down near the people, then returning to the radiator at or close to floor level. Some good answers were seen, however a significant number of candidates made no attempt at this question at all.

(ii) Here, unlike **Question (a)(i)**, strong candidates were able to correctly identify convection here. However, some candidates struggled here and a large number made no attempt at an answer.

(c) (i) This question was well answered with many correctly able to add X-rays to the electromagnetic spectrum.

(ii) Candidates found this question hard and microwaves, infra-red and ultra-violet were all incorrect answers seen as often as the correct response. A few candidates failed to score because they placed an additional tick in another box as well as putting a tick by radio waves.

(d) This question was intended to give candidates an opportunity to describe an experiment they had performed to demonstrate electrostatic effects. A few candidates did describe such experiments

and gained credit. Many candidates simply restated the information given in the question about the cloth and TV screen. A significant number of candidates made no attempt this question at all.

Question 7

(a) (i) Candidates found it difficult to use the information in the question to explain their answers here, even though a good number realised that more water is lost from the lower surface of the leaf. Even some stronger candidates preferred to answer here in terms of their knowledge of leaf structure rather than by interpreting the data in the figure. Only the very strongest candidates gained full credit here.

(ii) Having struggled with part **(a)(i)** a number of candidates did not attempt this question. Answers often talked about the leaf's exposure to the sun rather than the structure of the leaf itself. Overall this question was poorly answered by most candidates.

(b) This question required recall of the term xylem and its correct identification in a diagram. Stronger candidates gave clear, correct answers. Some knew that the tissue was xylem but incorrectly identified the phloem, gaining only partial credit. Many candidates made no attempt at this question.

(c) The majority of candidates showed a good recall of the word equation for photosynthesis. Weaker candidates sometimes remembered the correct substances but placed glucose or oxygen as a reactant and carbon dioxide as a product.

(d) Candidates often found it hard to explain this clearly. The best answers recognised that carnivores do not make their own food but feed on other animals which themselves get energy by eating producers. Those who were less careful forgot that carnivores do not themselves eat producers.

Question 8

(a) (i) This question tested candidates' ability to extract information about the reactants and products in a chemical reaction from the information given. Many were able to do this accurately. The most common error was failing to realise that copper is a product.

(ii) Many candidates simply gave a specific example of the combustion of a fossil fuel here, rather than another process. Respiration was the most common correct answer seen.

(iii) Candidates demonstrated good knowledge of fossil fuels. Often questions simply require two examples but here candidates were specifically asked for a solid and liquid and a few candidates failed to gain credit by writing, for example, 'coal' as a liquid fossil fuel. Candidates do need to be careful to read the question carefully and respond to the actual question asked.

(b) (i) Only the strongest candidates were able to identify ethanol. Most candidates made some attempt at this question though a number of weaker candidates wrote down the formula C_2H_5OH rather than naming the compound.

(ii) Examiners were looking for accurate recall of the syllabus term 'hydrocarbon'. Weaker candidates often referred to a mixture of hydrogen and carbon rather than clearly stating that it is a molecule made up of only hydrogen and carbon atoms.

(iii) This question was well answered with many candidates realising that the presence of oxygen in the formula meant that it was not a hydrocarbon, even if they could not write a creditworthy response to part **(ii)**.

Question 9

(**a) (i)** Candidates needed to read the question carefully, as it told them the rays should emerge from the lens parallel to each other. Many candidates had the rays converging below the lens suggesting they had not understood the question. Candidates were also asked to draw a total of three rays from the bulb and a number did not get full credit because they only drew two rays.

(ii) This question was hard and only the strongest candidates were able to apply their knowledge of focal length correctly in this context.

(b) (i) Knowledge of basic circuit symbols was weak among candidates and only the strongest candidates were able to gain credit here for a correct variable resistor symbol.

(ii) All that candidates needed to do here was recognise that current in the branches is less than the total. In fact many found it easier to answer by assuming the lamps were identical and stating that each lamp received half the total, even though this level of detail was not required.

(iii) Again, here, candidates did not need to talk about parallel circuits but simply state that the other lamp was still in a complete circuit, however most who gained marks found it easier to simply state that this was a parallel circuit rather than describe in words that there was a complete circuit in the other branch.

COMBINED SCIENCE

Paper 0653/33
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and take care to answer exactly the question that is being asked. There was evidence in the answers seen that candidates had misunderstood some of the questions or not read them carefully and this is covered in the comments on specific questions below.

Care should be taken to give a complete answer to the question that is being asked. In particular, where there are two or three marks for a question, multiple points will usually need to be made.

General comments

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

When candidates are asked to explain what is meant by a term or phrase, it is important that they explain clearly the whole phrase, and avoid simply restating words used in the question. Such terms are defined clearly in the syllabus and Examiners are expecting a clear and complete answer to award credit.

Comments on specific questions

Question 1

(a) This question was poorly answered with many answers suggesting that candidates had not read the question carefully enough. 'Root hair cells' was a common answer in the first space, perhaps because candidates recognised that this is where water comes into the plant, but they had not read carefully that they were being asked for a named part in the stem of the plant. Stomata were correctly identified by a good number of candidates.

(b) Many candidates correctly identified the role of water in photosynthesis and a good number identified the role of water in in transport of substances.

(c) A wide range of correct responses were seen when marking this question. Common incorrect responses were *oxygen* and either *red or white blood cells*, suggesting that candidates had not read the question carefully enough.

(d) (i) A good number of candidates recognised that haemoglobin was used to transport oxygen in the blood. A few candidates gave answers that suggested haemoglobin was simply storing oxygen which were not given credit.

(ii) This question expected candidates to make the link between blood lost during menstruation meaning that iron is lost, since iron is contained in red blood cells. Stronger candidates made this connection and gave a clear answer while some weaker candidates wrongly thought that menstruation was somehow connected with pregnancy and thought that the woman needed iron for a developing baby.

(iii) This question was hard with weaker candidates confusing iron deficiency with calcium deficiency and mentioning weak bones as a common incorrect answer.

Question 2

(a) (i) Knowledge of physical properties of metals was good with most candidates gaining at least one mark here, most often for recalling that metals are good conductors (either thermal or electrical). Stronger candidates remembered properties such as malleability and ductility. Some candidates confused properties of all metals with properties of transition metals by suggesting that they had high density or melting points, which is not true for all metals.

(ii) This question was much more challenging than **(a)(i)** and it was only the stronger candidates who correctly identified a suitable property to distinguish transition metals, most often that they have high melting points.

(b) (i) This question was well answered. The majority of candidates were able to take the information given in the question and use it to complete the word equation for the reaction between iron and sulfuric acid.

(ii) Given a test and the result, candidates were asked to identify the anion present in an acid and then name the acid. They found this very hard with many candidates making no attempt at the question and only the strongest candidates gaining one mark for hydrochloric acid. The most common wrong answer for the anion was silver.

(c) This question tested recall of the meaning of the term *atomic number*. Candidates had great difficulty expressing the meaning precisely. Several answers of *it is the number of atoms it has* were seen and weaker candidates confused atomic number with mass number.

Question 3

(a) This question was attempted by almost all candidates and a large number of completely correct answers were seen.

(b) In this context, many candidates were able to deduce that the forces P and R must be the same size since the submarine is travelling at a constant depth.

(c) (i) Candidates found this question straightforward, with even many of the weakest candidates recognising that P needed to increase to bring the submarine to the surface.

(ii) This question was well answered with many candidates correctly placing radio waves in the electromagnetic spectrum.

(iii) Quite a few candidates chose other examples of electromagnetic waves, suggesting that they had not read the question carefully.

(d) Use of hydroelectric power was a common incorrect response seen here, suggesting that candidates had not understood that the energy source needed to be stored in the submarine. Nuclear energy was a more common correct response than batteries.

(e) Candidates showed a good ability to perform this calculation. When full marks were not gained it was most often for a power of ten error in one of the steps or a conversion from hours to minutes, rather than to seconds.

Question 4

(a) Many correct responses were seen to this question, suggesting candidates had sound knowledge of the human alimentary canal.

(b) (i) This question expected candidates to use the information given in the question to work out that the enzyme worked in an acidic environment and then combine this with their knowledge of the stomach as having an acidic environment. Many candidates gave the name for the enzyme rather than suggest the source, possibly misunderstanding the question. Stronger candidates did identify that the enzyme in test-tube 1 was working in an acidic environment.

(ii) Stronger candidates realised that the enzyme would be denatured or destroyed at the higher temperature. Some candidates tended to state just that the temperature was *too hot*, which did not answer the question why it is not suitable.

(iii) Examiners were looking for the idea that the change from cloudy protein to clear solution suggested that protein molecules had been broken down by the enzyme. Only the strongest candidates were able to make this connection.

(iv) The majority of candidates identified chewing as an example of mechanical digestion, with just a few weaker candidates giving an example of chemical digestion or making no attempt at an answer.

Question 5

(a) (i) This question was well answered by the vast majority of candidates.

(ii) Almost all candidates correctly identified that the temperature decreases with just a few weaker candidates stating that temperature would rise.

(b) Many candidates recognised that chlorination kills bacteria, but some of the weaker candidates were less able to explain how filtration purifies water with a number suggesting that it removes salt (from sea-water) rather than insoluble particles.

(c) (i) While a good many candidates were able to identify an appropriate use of refinery gas a number failed to gain credit for a use of gas oil because they were too vague, giving answers such as 'cars' or 'transport' rather than being clear that it provides the diesel fuel for such vehicles.

(ii) Candidates were being asked to recall the syllabus definition of a hydrocarbon. To gain credit they needed to be precise and answers that talked about a mixture of hydrogen and carbon were seen frequently from weaker candidates.

(d) (i) For both this question and **(d)(ii)** what was being tested was that candidates could identify the structural compounds of the specific substances. A number of strong candidates failed to use the letters to identify the compounds, writing *water* and *carbon dioxide* instead and while these were the correct products of complete combustion of hydrocarbons the candidates had not demonstrated that they knew which were the structural formulae for these substances. It is very important that candidates read a question carefully and answer exactly the question that is asked in order to gain full credit.

(ii) See comment for **(d)(i)**.

Question 6

(a) Credit here was given for a precise meaning of the term melting point. This needed to include temperature and the change of state from solid to liquid. A number of answers were seen that had one of these ideas but not the other, for example 'it is the point at which a solid melts to a liquid' or 'it is the temperature at which a solid melts', and so they could not gain credit.

(b) (i) Only the strongest candidates were able to identify both methods of energy transfer correctly and so gain credit here. Some candidates did not even give methods of heat transfer, suggesting that they had not understood the question at all.

(ii) It was only the strongest candidates, who answered **(b)(i)** correctly, who were able to describe how the foam reduces thermal energy transfer.

(c) Although weaker candidates did not know the answer to this question many made an attempt and wrote down a named electromagnetic wave.

(d) Candidates doing the core paper show that they are generally strong at calculation questions, with the vast majority gaining both marks here.

Question 7

(a) This was well answered by the vast majority of candidates.

(b) (i) To gain full credit here candidates needed to identify the carbon compound in air that is used, carbon dioxide, and then state that it is used in photosynthesis. Many stronger candidates gained both marks, but a few identified photosynthesis but did not state the name of the carbon compound used by the leaves.

(ii) Candidates found this question much harder. Examiners expected them to identify the process here as respiration and carbon dioxide as a product of that process. Even the stronger candidates often did not mention respiration and a lot stated that carbon is released into the air (rather than carbon dioxide) which was not precise enough to gain credit.

(c) Examiners were looking to reward a sensible explanation and so credit could be gained for arguing for either an increase or decrease in rainfall, even though a decrease was the more usual response. Candidates generally linked removal of trees with less evaporation and many gained credit here.

(d) Candidates often failed to answer the actual question, which was about the effect on the soil of the heavy rainfall. Many answers focused on crops not growing or simply stated flooding rather than realising that without roots to hold it, soil would be washed away with the rain.

Question 8

(a) (i) Examiners were testing recall of syllabus terms for the positive and negative electrodes here and a good number of candidates gained either full credit, or partial credit if they knew both names but not the correct position for each.

(ii) This question required candidates to work out the name of the substance at the positive electrode and then its appearance. This was hard and only the strongest candidates correctly identified that it was an orange/brown gas.

(b) With just one mark here candidates needed to do more than just state that copper oxide is reduced and only the strongest candidates were able to do this clearly, usually by saying that copper oxide had lost oxygen or the carbon had gained the oxygen.

(c) Candidates were able to make good use of the information in the question and the vast majority placed all four metals in correct order of reactivity, demonstrating a good understanding of the reactivity series.

(d) (i) Since the question explicitly asked for changes that would increase the rate of reaction, candidates needed to do more than just state factors such as ‘temperature’ or ‘concentration’. A clear statement of how altering that factor would increase the reaction rate was needed for credit to be given.

(ii) The majority of candidates correctly identified magnesium chloride as the product of this reaction.

(iii) To answer this question correctly candidates needed to realise that magnesium was insoluble. A number of candidates suggested crystallisation, perhaps having misread the question and believing they should be obtaining the dissolved salt.

Question 9

(a) Almost all candidates gained some credit here but very few candidates gained all the marks. Recall of the correct circuit symbol for a variable resistor was poor and a number of candidates had difficulty placing a separate switch that controlled only the headlamps and not the motor.

(b) Examiners were looking for candidates to link a decrease in resistance with an increase in current. Some candidates gave vague answers such as ‘there will be more electricity’ which did not gain credit.

(c) Most candidates gained at least some of the marks here and recognition that the headlamps are connected in parallel was the most frequently seen correct answer.

(d) The question specifically asked for an electrical hazard and stronger candidates often identified water as a potential hazard and the need for some sort of shelter to protect from rain. Answers that referred to people tripping over the cable or the car driving over the cable were not given credit as they were not electrical hazards.

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
they added new information in their answers rather than simply rephrasing the question
in Chemistry they had learned the tests for ions and for unsaturated hydrocarbons
in Physics they drew diagrams of light rays using a ruler and included arrows on the rays according to the context, **Question 3(c)**
they had learned concise definitions that appear in the syllabus, for example, the meaning of decomposer, **Question 4(c)(i)**, the exact meaning of hertz, **Question 3(a)(i)** and a statement of Hooke's Law, **Question 3(d)(i)**; candidates who do this gain credit very efficiently
credit was not lost unnecessarily because of illegible handwriting.

General comments

Many 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. Some candidates found these questions challenging. Examination practice of this type of question is very useful.

Success in answering questions covering the three Science disciplines was well balanced. There was no evidence that the time allowed for the paper was insufficient.

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. Very small handwriting can be a particular problem in writing clear subscripts in chemical formulae.

Comments on specific questions

Question 1

(a) The majority of candidates gained credit and many scored full marks. Marks were usually gained for correctly identifying red blood cells and the aorta. Pulmonary artery was often suggested instead of pulmonary vein and muscles was frequently given instead of capillaries.

(b) Partial credit was gained by large numbers of candidates who correctly identified thick walls as the structural feature required. A minority went on to gain the second mark which was for the idea that the blood inside an artery is at high pressure and so the thick wall prevents the artery from bursting. Many candidates referred to high blood pressure without linking this to the prevention of bursting. Credit was gained by candidates who described the elasticity of the artery wall.

(c) This was answered well by the majority of candidates. The most common mistakes were the suggestions of oesophagus or larynx for trachea and alveoli or bronchus for bronchiole.

(d) Candidates across the full mark range showed good knowledge of the harmful effects of nicotine and tar from cigarette smoke. The effects of tar were better known than those of nicotine. Harmful effects of tar were sometimes suggested for nicotine. Alternative valid points for tar included reference to diseases such as bronchitis and emphysema. Some candidates made statements such as *tar has a negative effect on the gas exchange system.* This does not add any new detail to that given in the question and so cannot gain credit.

Question 2

(a) (i) Large numbers of candidates correctly identified cathode and anode. Some suggested the substances that would be formed. This was tested in the following question and yet these candidates were not prompted to return to this question to check they had answered this question properly.

(ii) Most candidates gained at least partial credit. One mark was awarded if the names of the electrode products were reversed but no error was carried forward from **(i)**. Substituting the answer *bromide* for *bromine* was a common reason for loss of credit.

(iii) Only those candidates towards the higher end of the mark range tended to show understanding of the importance of **ionic** mobility. Candidates had to discuss the idea that ions needed to be able to move towards the electrodes. There was evidence that many candidates probably knew this and phrases such as *so that ions can be attracted* were often suggested, although did not gain credit. Common suggestions that could not be rewarded included *electrolysis needs to be done in a liquid, potassium bromide needs to be broken down, an electric current must be able to flow.* Although these all show relevant knowledge, credit was not awarded because the question pointed candidates towards an answer that required an answer in terms of ions.

(b) (i) Full credit was gained by a minority of candidates. Candidates often gained credit for knowledge of the chemical formula of hydrochloric acid and a correctly balanced right hand side of the equation. In general, candidates suggested the state symbol *(l)* for hydrochloric acid and sometimes the symbol *(aq)* for water.

(ii) Some candidates had learned the chemical tests in the syllabus and gave perfect answers. Many had to guess and in general it was clear that candidates were not recalling this part of the syllabus. A popular incorrect suggestion was the bleaching of damp indicator paper.

(iii) It was clear that many candidates had practical experience of this crystallisation procedure as shown by some excellent diagrams and descriptions. For the award of full credit, the initial step of filtering off excess potassium carbonate had to be included. If candidates' descriptions clearly stated that filtration would leave the final product, potassium chloride, as the residue, then full credit for their answers was not awarded.

Question 3

(a) (i) Credit was awarded for an accurate definition of frequency in terms of number of waves or oscillations per second. Credit was not awarded for any other time period nor for phrases like *number of waves in a certain time.* Many candidates gained the available mark. Many others needed to remember that amplitude refers to loudness rather than the pitch of the sound.

(ii) Candidates found it easier to gain credit here compared to **part (a)(i)**. The most common mistakes were to answer in terms of the pitch of the sound or to its duration.

(iii) Recall of the numerical details of the frequency range of human hearing was not essential but if it was not given then candidates had to state that all of the frequencies produced by the guitar would fall within the range of human hearing. Some candidates lost credit because they recalled the range of human hearing incorrectly which caused them to conclude that all of the guitar notes would not be heard. In this case there was no possibility of allowing an error carried forward. It was also important that candidates stated that a person would be able to hear all the guitar notes, and some lost credit because they forgot to include this.

(b) Many candidates understood that the context of this question was based on the difference in speed of electromagnetic waves compared to sound waves. Many candidates thought the different times of arrival resulted from the different distances the listener was from the stage or from his radio. Some candidates gave confused answers in terms of echoes or the difference in the speed of sound from a radio or from the live event.

(c) (i) Candidates should remember that ray diagrams must always be drawn carefully using a ruler, and that arrows should be drawn on the light rays according to the context of the question. In their diagrams, candidates had to show the incident and reflected rays meeting at a point somewhere on the mirror, with the angles of incidence and reflection at least looking reasonably equal. Some candidates lost credit because they drew broken lines to show the rays, and others omitted arrows or drew them in the reverse direction. A minority of candidates wasted time by redrawing their own diagrams instead of drawing rays onto the supplied figure.

(d) (i) Hooke's Law was well-known by most candidates towards the higher end of the mark range. Some lost credit by describing the meaning of elastic limit rather than stating Hooke's Law.

(ii) This was very well answered and large numbers of candidates were able to identify co-ordinates that marked the end of the linear section of the graph. Candidates could state their answer either in terms of load (80 to 84 N) or extension (3.9 to 4.1 mm). The most common incorrect answer was 100 N.

Question 4

(a) Candidates generally were able to measure the bacterial cell accurately and knew that the magnification would be given by dividing the measured length by the actual length. Many of these candidates lost credit because they used centimetres rather than millimetres for the measured length of the cell in the calculation.

(b) (i) This question proved to be rather challenging for many candidates. Candidates who may have been aware that increased acidity causes yoghurt to thicken, decided that the increasing acidity would speed up the activity of enzymes. Some suggested that the acid acts as an additional catalyst. The available mark was not always gained by candidates who correctly stated that enzymes would be denatured as acidity increased. This was because they forgot to state that this would reduce the rate of milk sugar breakdown. Another common reason for loss of credit was the suggestion that microorganisms rather than enzymes would be denatured.

(ii) Candidates answered this question very well showing good understanding of the concept of optimum temperature for enzyme activity and that denaturation of enzymes occurs at higher temperatures.

(c) (i) A large number of candidates had not learned a definition of decomposer and so lost the credit for this question. Although the general idea of the role of decomposers in the carbon cycle was familiar to many candidates, they should also remember that decomposers are themselves living organisms. Answers often started with wording such as *This is when waste is decomposed* or *Decomposer is the same as decay*. Many candidates suggested that decomposers are themselves dead organisms.

(ii) Although large numbers of candidates were generally familiar with the importance of decomposers only a minority could express their ideas in scientifically valid ways. In answering this particular question, credit was lost if candidates described the release of *carbon* to the air rather than stating *carbon dioxide*. The idea that decomposers have an important role in removing dead organisms and waste material from the environment was familiar to many and any suitable wording that expressed this idea was accepted.

Question 5

(a) (i) The great majority of candidates were familiar with fractional distillation. Common answers not gaining credit included *separation* and *boiling*.

(ii) All three answers were required for this mark and in general the question was answered very well. The words in the list were similar in meaning and so any combination of answers that conveyed the correct sense scientifically was accepted.

(b) Cracking was not quite as well-known as fractional distillation but, in general, candidates tended to score this mark.

(c) (i) Only candidates towards the higher end of the mark range tended to be familiar with the bromine test for unsaturated hydrocarbons. Many candidates suggested pH tests or did not attempt to answer the question.

(ii) Many candidates correctly identified ethene. Common mistakes included ethanol and a range of other alkanes and alkenes. Candidates towards the lower end of the mark range were very unfamiliar with organic chemistry in general and so ended up guessing the answer to this question.

(d) (i) Candidates needed to do more than simply restate the information in the question. Answers such as *because more hydrocarbons are being burned* did not gain credit. Some candidates suggested the increasing size of the human population, which did not gain credit.

(ii) This was well-answered and large numbers of candidates were familiar with the link between carbon dioxide, global warming and its potential consequences.

Question 6

(a) The majority of candidates across the full mark range correctly stated switches 1 and 3.

(b) (i) This calculation was completed correctly by large numbers of candidates across the mark range. In this case credit was not lost if candidates gave the answer to more significant figures than appeared in the question data. However the answer 5 (A) was not accepted. The most common reason why credit was lost was the incorrect recall of the relationship between power, current and voltage. A minority attempted to use Ohm's Law.

(ii) This was one of the most challenging questions on the paper and only a very small number of candidates near the top end of the mark range realised what was required. Any evidence that candidates calculated the current through or power consumed by both heaters and the motor when switched on together gained credit. If candidates gained this mark then they had a choice of answer for the second mark. They gained this mark if they compared the total current with the fuse rating. They could suggest either that protection was acceptable because the maximum current was less than 10 A, or that it was not acceptable because the total current was too close to 10 A.

(c) This was generally well-answered. Many candidates across the mark range gained at least partial credit here for a correct drawing of an ammeter, wherever it appeared in the circuit. Candidates were penalised if they drew additional components such as voltmeters. Some candidates drew several ammeters or connected the ammeter in parallel with the heaters or with the motor.

Question 7

(a) Many candidates gained at least partial credit for knowing that plants produce carbon dioxide and many gained the second mark for referring to respiration. Candidates who did not realise that this question was based on the carbon cycle produced a variety of suggestions, a common one being that plants do not use all that much carbon dioxide and so what is initially in the jar would be enough to last.

(b) Most candidates could describe the high surface area or elongated shape of the root hair cell. It was less easy to gain the second mark which was for a reference to diffusion (osmosis also gained credit) or for explaining that high surface area would increase the speed or the efficiency with which water would enter the root. Although many candidates suggested that large amounts of water could be absorbed, this idea needed to be developed to include the idea of increased **rate** of uptake. As often happens in questions concerning root hair cells, many candidates assumed that the diagram showed a root, and so answered in terms of plant anchorage or soil penetration.

(c) (i) This was one of the most challenging questions on the paper and only a very small number of candidates realised that the rate of photosynthesis is highest when the change in oxygen concentration is highest. The great majority thought that the maximum in the graph rather than the steepest gradient showed the required time.

(ii) Large numbers of candidates gained at least partial credit for making the connection between oxygen production, photosynthesis and amount of light available. The line that they needed to draw on the graph had to start at 1000 hours and continue to rise but have a smaller gradient than the original line. Any evidence that the line rose after 1000 hours was enough to score a mark. Many candidates interpreted the idea that the environment of the plant became darker to mean that there was suddenly a total absence of light and so their graphs decreased rapidly to zero after 1000 hours.

Question 8

(a) (i) Atomic structure was very familiar to the majority of candidates and large numbers gained full credit.

(ii) Most candidates drew the electronic structure of the phosphorus atom correctly. A minority were unfamiliar with how this question should be answered but some of these candidates knew that the outer shell would contain five electrons. This fact on its own could not be rewarded.

(b) (i) The great majority of candidates recognised that the nitrogen molecule would be covalently bonded.

(ii) Only those candidates towards the higher end of the mark range tended to draw the dot-and-cross bonding diagram of the nitrogen molecule correctly. Although the question had guided candidates towards five outer electrons in the nitrogen atom, many drew a singly bonded molecule analogous to a halogen molecule.

(c) The great majority of candidates gained the mark for reference to the use of helium in balloons of various types. Any valid use of helium gained credit.

(d) It was essential that candidates made a reference to the relative reactivity of the Group 1 metals compared to carbon. Many stated simply that Group 1 metals are highly reactive which did not score the mark.

(e) Most candidates stated that astatine would be a solid and suggested sensible estimates of the melting point. There was often evidence of the logical use of the melting point trend shown for the other halogens.

Question 9

(a) (i) The great majority of candidates across the full mark range correctly identified the downward force acting on the car.

(ii) Most candidates gained at least partial credit for drawing a line that started at the origin and passed through a point at a speed of 10 m/s and a time of 12 seconds or greater. Only a minority realised that the non-constant nature of the frictional force meant that the line should be curved.

(b) (i) Partial credit was awarded to some candidates for stating the relationship between efficiency and useful output energy and total input energy. Only candidates towards the higher end of the mark range tended to complete the calculation correctly. Many inverted the energy terms and many calculated the value of 20% of 40 000 000 J.

(ii) Most candidates could state the names of two renewable energy sources. The term *eolic* meaning wind-related was accepted although candidates are advised to use the words *wind energy* or *wind turbines*. Any reference to the use of water as an energy source was accepted on this occasion. Candidates should use a more specific term such as hydro-electricity.

(c) (i) Candidates generally understood that they needed to discuss thermal expansion and many gained credit. References to the thermal expansion of metal or the road or the bridge were all accepted. When candidates attempt to answer questions on thermal expansion of materials they need to remember that it is the space between particles that increases and not the particles themselves that increase in size.

(ii) Candidates generally understood the consequences for the bridge if expansion gaps were absent.

(iii) Nearly every candidate gained a mark for correctly identifying *evaporates* as the first answer, and many gained full credit. The fact that only one substance, water, was involved should have meant that candidates avoided the words *larger* and *smaller* as possibilities for the second answer.

(iv) This was answered very well and large numbers of candidates scored the mark. The question asks candidates to draw one line linking one box on the left to one box on the right. Many candidates lost credit by linking several boxes.

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 the processes that lead to oxygen depletion in polluted water environments
they used chemical symbols and formulae accurately; this means for example, they avoided mistakes such as $6CH_{12}O6$ for glucose
they had learned the important consequences of increased carbon dioxide levels in the atmosphere **Question 5(a)**
they had learned electrical circuit symbols, particularly how to draw a variable resistor, **Question 9(b)(i)**
when drawing a diagram showing balanced forces they drew force arrows carefully and in contact with the object on which the force acts, **Question 3(a)**
they thought carefully when interpreting a speed/time graph, **Question 3(c)(iii)**, and realised that a curved line shows non-constant acceleration or deceleration
their handwriting was reasonably legible and not too small.

General comments

Many 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. 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. Some candidates found these questions challenging. Examination practice of this type of question is very useful.
Success in answering questions covering the three science disciplines was well balanced. There was no evidence that the time allowed for the paper was insufficient.
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. Very small handwriting can be a particular problem in writing clear subscripts in chemical formulae.

Comments on specific questions

Question 1

(a) Candidates from across the full mark range answered this question very well, and large numbers gained full credit. Candidates usually knew that oxygen is carried in red blood cells, the most common incorrect alternative was plasma. Some candidates reversed placenta and umbilical cord.

(b) Candidates towards the higher end of the mark range tended to gain credit for this question. The suggestions of *non-identical twins* for **1** and *identical twins* for **2** were often seen from lower scoring candidates, who appeared to have misunderstood the question.

(c) This was answered well and large numbers of candidates showed understanding of the context. It was important for the first mark that candidates made it clear they were discussing genetic material and not the twins. In many cases where partial credit was gained, this was the mark that was not awarded.

(d)(i) The majority of candidates gained credit here and large numbers scored both marks. The most common mistake was to label the nucleus rather than the cell membrane as **C**. Carelessly drawn label lines that stopped outside the cell were penalised.

(ii) The balanced equation for aerobic respiration is frequently tested and large numbers of candidates had learned it perfectly.

Question 2

(a)(i) Most candidates were able to interpret the data and gained the mark.

(ii) Most candidates scored this mark. An error from part **(i)** was carried forward.

(iii) The idea that the rate of reaction would be greatest at the start was familiar to many candidates. The most common mistake was to suggest eight minutes which suggests confusion between total amount of gas produced and rate of reaction.

(iv) This important idea in chemical reaction rate theory is frequently tested and the majority of candidates answered this question very well. The better answers avoided the simple statement *there are more collisions* and instead gave responses that referred to *increased collision frequency*, or *increased chances of successful collisions*. Although the idea of activation energy is not currently part of this syllabus, any answers making valid references to this idea gained credit.

(b) Candidates towards the higher end of the mark range tended to be familiar with the tests for cations and many gave perfect answers. There were no particularly common incorrect answers and it appeared that many lower scoring candidates had to guess. Partial credit was given for perfectly reversed answers and for omitting to state that the coloured substances appeared as precipitates or solids.

(c)(i) The great majority of candidates recognised the structure of an alloy.

(ii) Most candidates were able to suggest a relevant advantage of using an iron alloy to manufacture knives. A minority appeared to have misread the question and described the difference in composition of an alloy compared to a single metal.

Question 3

(a) Three marks were available, the third mark being awarded for drawing the force arrows carefully. This mark was often not awarded even to candidates who appeared to be familiar with this kind of diagram. Valid alternatives to the term *uplift* were accepted. Despite the word *uplift* appearing in the question, this force was often mis-labelled as *air resistance, kinetic energy, kinetic force or driving force.*

(b) Correct energy types were completed by the great majority of candidates. The word *chemical* was required for the first answer. The second answer could be either *gravitational* or *potential* or both words.

(c)(i) The calculation of acceleration was done correctly by large numbers of candidates throughout the mark range although the correct units were not so frequently stated. Some candidates used confused symbolism, particularly m / s^{-2}.

(ii) This was answered very well by candidates from across the mark range, with large numbers gaining full credit. Candidates completed the calculation either by addition of the area of the triangle to the area of the rectangle or by calculation of the area of the trapezium.

(iii) Most candidates stated that the helicopter was decelerating. Credit was only given if the deceleration was described as non-constant. Credit was not given for answers such as *it is coming in to land.*

Question 4

(a) Many candidates towards the higher end of the mark range understood the context and realised that the question essentially concerned denaturation of enzymes. Any wording that showed the candidate realised that the results revealed that starch around **A** and **B** was still present or had not been broken down gained a mark. The other two marks were for discussing the two mechanisms of denaturation. The context proved very challenging for many candidates and some assumed that the starch was coming from inside the pieces of barley seed. Others described rather than explained the results of the experiment.

(b) The role of chlorophyll was familiar to many candidates who gained at least partial credit, usually for stating that chlorophyll traps light. The second mark for stating that light energy is converted into chemical energy was not awarded so frequently. Candidates needed to take care with wording, and phrases such as *chlorophyll produces glucose* or *chlorophyll reacts with light to make plant food* or *chlorophyll makes nutrients for the plant* did not gain credit.

Question 5

(a) Candidates generally were familiar with sources of carbon dioxide and the consequences for the environment, and many good answers were seen. Some candidates seemed to forget to state why carbon dioxide levels are increasing, and went straight into good discussion of the consequences. Credit was not given for suggesting that increasing respiration from an increasing human population was responsible for carbon dioxide build-up. Similarly, credit was not given for suggesting that increasing carbon dioxide is a concern because *humans breathe oxygen and not carbon dioxide* or *soon there will be no oxygen left for people*.

(b) Any version of the formula that showed the correct proportions of the elements in ethanol was accepted and consequently the majority of candidates gained the mark. Candidates whose handwriting is naturally very small need to be careful that that subscripts are clear, and candidates whose handwriting is naturally large need to ensure that subscripts are significantly smaller than the chemical symbols. Versions of the formula that were accepted were C_2H_6O (in any order), C_2H_5OH and CH_3CH_2OH.

(c)(i) This question was answered very well by candidates towards the upper half of the mark range. Large numbers of these candidates had learned the relationship between boiling point, molecular size and intermolecular forces. Some candidates gained only partial credit because even though they stated correct ideas about molecular size and intermolecular forces, they forgot to state which of octane or methane had the higher boiling point.

(ii) This proved to be a challenging equation for the majority of candidates. Those towards the higher end of the mark range often gained full credit. Many others may have seen C_8H_{18} and decided that this equation concerned cracking. Partial credit was awarded for recognising that the products would be carbon dioxide and water.

(d)(i) A majority of candidates across the mark range recognised cracking. Mistakes seen more frequently than others included *fractional distillation, combustion* and *boiling*.

(ii) The terms *alkene, alkane, unsaturated* and *saturated* were correctly stated by many candidates. Candidates towards the lower end of the mark range tended to guess. Some gave correct chemical formulae of ethene and ethane although no credit was available for these answers.

Question 6

(a) This question required an answer which described the way that vibrational energy is passed from particle to particle during the process of conduction. This was realised by only a minority of candidates towards the higher end of the mark range. Most others were distracted by the context and answered either in terms of convection currents inside the hot water of the radiator or the air outside.

(b)(i) Most candidates were able to draw the convection current operating in the room shown in the diagram. For full credit, candidates needed to show the path of air rising from the radiator, crossing the room to the people and then returning somewhere near the floor to the bottom of the radiator.

(ii) Many candidates gained at least partial credit for stating that warm air rises and a good number understood that this occurs because warm air is less dense than cooler air. A few candidates attempted to answer this question in terms of diffusion processes.

(c) Many candidates had learned that T.V. signals are transmitted via radio waves. The most common incorrect answers were microwaves and infra-red.

(d) Some candidates made the point that electromagnetic waves travel faster than sound waves. For full credit they also had to state that T.V. signals travel at the speed of electromagnetic waves. Some candidates showed they were thinking about sound from the stadium and sound from the T.V., and so attempted to answer in terms of the different distances between the listener and the T.V. or stadium.

Question 7

(a)(i) To obtain the mark, candidates had to recall that oxygen moves out of the blood into tissues and that oxygen is carried by red blood cells which are recognised by their bi-concave shape. Those who did recall all this information drew their arrows showing oxygen diffusion correctly. Arrows had to originate clearly from any of the red blood cells and point closely to any of the tissue cells. Candidates towards the higher end of the mark range usually gained the mark.

(ii) Any correct definition of diffusion in terms of movement down a concentration gradient was accepted although only a minority of candidates gained the mark. Many candidates did not attempt to answer this question and others described, rather than explained, the movement of oxygen.

(b)(i) Most candidates could describe the large surface area or elongated shape of the root hair cell. It was less easy to gain the second mark which was for explaining that large surface area would increase the speed or the efficiency with which water would enter the root. Although many candidates suggested that large amounts of water would be absorbed through a larger surface area, this idea needed to be developed to include the idea of increased **rate** of uptake. As often happens in questions concerning root hairs, many candidates assumed that the diagram showed a root rather than a root hair cell, and so answered in terms of plant anchorage or soil penetration.

(ii) This question challenged candidates' understanding of diffusion. Many gained a mark for stating that the rate of diffusion into the root hair cell would decrease. A smaller number understood that this was because the concentration gradient **of water** (some used the term water potential) had changed. Candidates often attempted to answer in terms of a concentration gradient and did not gain credit because the way they constructed their answer suggested they were thinking about salt concentration.

(c) Only a minority of candidates gained full credit for their descriptions of oxygen loss due to respiration of decomposers and the consequent impact on the fish. Many candidates suggested that the fish died because of breakdown of food chains. A common incorrect answer was that the fish were poisoned either by the initial inflow of fertiliser or by toxins from decaying organisms.

Question 8

(a)(i) Candidates towards the higher end of the mark range knew that the solid needed to be changed into a liquid form. In this case the suggestion that the copper chloride should be melted was accepted although in practice an aqueous solution is used. The second mark for stating the need for mobile ions was not awarded so often. Many candidates simply stated that *electrolysis has to be done in a liquid.* Some candidates stated that the copper chloride has to be dissolved (melted) to allow a current to flow. While this is not incorrect, an answer in terms of mobile ions was required as suggested by the wording of the question. Answers which showed some understanding but which did not gain credit in this case included *so that the copper chloride can separate* and *so that the electrodes attract the copper chloride particles.* Another popular mistake was to suggest an increase in potential difference.

(ii) Most candidates gained the mark for a correct atomic diagram.

(iii) Most candidates were able to draw the dot-and-cross diagram showing the shared pair of electrons and the majority of these also drew the non-bonding electrons correctly. Some candidates ignored the instruction to draw only the outer shell electrons. This was not penalised but was unnecessary. Some candidates drew very small overlapping regions of the outer shells which left no room for clear drawings of the shared electrons. Some of these were not clear enough to allow the mark to be awarded.

(b)(i) This was answered quite well with about half of the candidates correctly stating the energy change. The most common incorrect answer showed the two energy types reversed. The word *chemical* had to appear, *potential* or *stored* were not accepted on their own.

(ii) Reduction was correctly stated by most candidates in the upper half of the mark range. Many different incorrect suggestions were seen from other candidates who appeared to be guessing. The term *redox* was not accepted since the wording in the question clearly refers only to reduction.

(iii) This question proved to be challenging for candidates across the mark range. The most common answer that gained credit compared the reactivity of copper with carbon. The general ideas that reactive metals required extraction by electrolysis and that less reactive metals require carbon reduction were rarely stated. Many candidates did not attempt to answer this question.

Question 9

(a)(i) This ray diagram was successfully completed by large numbers of candidates. Full credit was awarded provided at least two more diverging rays were added to the existing ray, all of the rays emerging from the lens were parallel and at least one of them had an arrow in the correct sense.

(b)(i) Candidates should be able to recall the circuit symbol for a variable resistor and the majority were able to do this. Common reasons why credit was lost was forgetting to draw the arrow through the resistor symbol, drawing the symbol for a fuse and drawing invented symbols such as a circle or rectangle containing an **R**.

(ii) Many candidates were familiar with the idea that the current divides at the branch point in a simple parallel circuit and so could deduce that the current in the main circuit would be 20 A. Credit was not awarded for vague explanations such as *one lamp is 10 A so two are 20 A* or *there are two identical lamps.*

(iii) Most candidates understood that the second lamp would continue to work and referred to the parallel circuit in their explanation.

(c)(i) The great majority of candidates were able to re-arrange the relationship into $I = P/V$ and obtain the correct numerical answer to the calculation.

(ii) Only a minority of candidates realised that in order to maximise the power in the lamp the current needed to be maximised by setting the variable resistor to its lowest setting. Any answer that suggested the resistance needed to be reduced was accepted.

COMBINED SCIENCE

Paper 0653/43
Extended Theory

Key messages

- Include formulae used in all calculations.
- All forces are balanced on an object which is moving at constant speed.
- The state symbol for a dilute acid is (aq).

General comments

Candidates generally performed well on this paper, demonstrating good knowledge of all areas of the syllabus. Most candidates confined their answers to the space provided. Some candidates extended their responses to the area below the answer lines. This can be avoided by giving more concise responses that do not contain repetition of the question. The vast majority of scripts had legible handwriting. Those with poor handwriting of the key words risked losing marks. Candidates completed the paper in the recommended time.

It is recommended that this report is read in conjunction with the published mark scheme.

Comments on Specific Questions

Question 1

(a) Most candidates answered this question successfully, demonstrating knowledge that the vena cava leads into the right side of the heart. Incorrect responses referred to the left side of the heart, or confused the order of blood flow, stating that the blood flows through the ventricle first.

(b) (i) There were two possible correct explanations for this question, as shown in the mark scheme. In one approach candidates had to state that the blood goes through the heart for each complete circulation of the body. Responses just stating that the blood goes through the heart twice without further qualification did not give a complete explanation so did not gain credit. The other approach was to describe the two separate destinations for the blood from the heart, the lungs and the body. Descriptions that the heart pumps both oxygenated and deoxygenated blood did not contain enough detail to be acceptable.

(ii) The difference in pressure of blood leaving the two sides of the heart was explained well by most candidates. Incorrect responses included the suggestion that the oxygenated blood is heavier than the deoxygenated blood and therefore needs more pressure to pump it around the body.

(c) (i) There were some excellent responses to this question, which explained the need for more oxygen to be carried by the blood to the muscles for increased respiration. Equally valid, but more rarely seen was the requirement for more carbon dioxide to be removed from the muscles, produced by the increased rate of respiration. Answers merely stating that more oxygen was needed by the body were not considered detailed enough for credit.

(ii) The majority of candidates correctly stated that the breathing rate increases during exercise to enable more oxygen to be taken into the blood for the increased rate of respiration described in **(c)(i)**.

(d) Most candidates answered this question well showing good knowledge about the harmful effects of tobacco smoke. Correct detail about the action of carbon monoxide to inhibit carriage of oxygen by

red blood cells was needed to gain credit, rather than a general statement about carbon monoxide being poisonous.

Question 2

(a) The majority of candidates answered this question correctly.

(b) (i) Candidates had to use the information to complete the balanced equation, including the state symbols. Only the higher-scoring candidates gained full credit in this question. Candidates should be aware that both a dilute acid and a salt in solution both have (aq) as their state symbol. The calcium chloride produced in the reaction is an example of a salt in solution, and is not a solid. The state symbol (*l*) is used when a liquid, usually water, takes part in the reaction.

(ii) This question was well answered by most candidates. Full credit was given to those responses which included an explanation of the reduction of the number of collisions over time, rather than just stating 'fewer collisions'. Reference to the mark scheme shows several acceptable ways of expressing this idea.

(iii) Many candidates successfully wrote the analytical test and the result for chloride ions. Approximately the same number incorrectly described the test for chlorine gas. Candidates are reminded that the chloride ion is different chemically from chlorine, so it is detected by a completely different method.

(c) Most candidates successfully derived the formula from the information provided. Candidates are reminded that the ions in the final formula are written without charges.

Question 3

(a) Generally, candidates successfully added the two components to the circuit in their correct places. The main reason why credit was lost was an incorrect or inaccurate symbol for the variable resistor.

(b) The higher-scoring candidates successfully stated that if the resistance decreases the current through the resistor increases. Some candidates wrote that the reduced resistance leads to more electrons being able to flow through. Credit was not given unless a time factor was included. An example of a correct answer of this type is 'more electrons per second can flow'.

(c) Many candidates scored well in the first two parts of this question. The last response was less well answered. Candidates should be aware that the addition of the branches containing the headlamps in this parallel circuit reduces the resistance.

(d) This question required a conversion of the 10 minutes into hours. Most candidates did this successfully, and arrived at the correct answer. The most frequent incorrect answer given by candidates was 50 km. In these cases, the conversion of the time was not done. Inclusion of the formula and working was often missing in these calculations and this prevented partial credit from being obtained.

Question 4

(a) The majority of candidates successfully added the label **A** to the ileum.

(b) (i) In order to gain full credit, candidates had to link the results of the experiment with the alimentary canal shown in Fig. 4.1. Many candidates knew that tube **1** was strongly acidic, and linked this with the stomach and its acidic environment. Incorrect responses included naming the enzyme, rather than using the information from Fig. 4.1 to identify the acidic area of the alimentary canal.

(ii) Most candidates wrote that a temperature of 60 °C was likely to denature the enzyme. Many responses included reference to the fact that the enzyme was from a human source. Credit was awarded for explaining that a temperature in the region of 37 °C is likely to be the optimum temperature for the enzyme.

(iii) The specification describes the process of chemical digestion. The focus is on the digestion of large, insoluble molecules into small soluble molecules by enzymatic action. Well-prepared

candidates answered this question well. An unacceptable answer seen frequently described the absence of physical digestion as a reason to conclude chemical digestion had taken place. Another unacceptable answer referred to a chemical change having taken place because a new substance was produced. Neither of these responses referred to the change in size of the molecules of protein as they are broken down.

Question 5

(a) Many candidates gained full credit in this question. Care had to be taken when answering the first part of the question about the trend of increasing boiling point. Therefore 'increasing' was acceptable as the trend. Some candidates referred to the position in the tower (higher or lower), and credit was only given if the candidates made reference to the boiling point trend elsewhere in their answer. Most candidates understood that larger molecules have larger intermolecular forces between their molecules.

(b) (i) Fig. 5.1 had to be interpreted correctly to answer this question, since there were two processes illustrated, namely fractional distillation and cracking. The majority of candidates correctly stated **Y** as cracking with only a minority stating fractional distillation.

(ii) The naming of the hydrocarbon as ethene was done correctly by most candidates. Incorrect responses included the written formula, methene, and ethane.

(iii) Most candidates understood that the molecule in Fig. 5.2 is an alkene due to the presence of the double bond.

(iv) The bromine test for distinguishing between alkanes and alkenes was known by many candidates. Candidates are reminded that the positive result for an alkene occurs when bromine turns from brown to colourless. The answers 'clear' and 'transparent' are not acceptable in this question.

(c) This question was answered well by many candidates who described the energy change and increase in temperature correctly. Some candidates who described the energy needed to start the combustion process incorrectly stated that an exothermic reaction is one that takes in energy. These candidates did not explain that the larger amounts of thermal energy given out by the combustion process are much greater than energy used to start the reaction.

Question 6

(a) (i) The knowledge that molecules in a solid are close together and can only vibrate in their fixed positions was important in responses to this question. The ideas of increased vibration due to heating, and the transfer of vibrations from molecule to molecule were both needed in the explanation. Several candidates did not score in this question because they omitted to mention vibrations of molecules.

(ii) Some candidates correctly stated that the molecules in a gas are too far apart for conduction to occur. Fewer candidates explained this in more detail by stating that this was due to the lack of contact between the molecules to pass the energy through the gas.

(b) Radiation was correctly given by most candidates who knew that the shiny surface of the foil is a poor emitter of infra-red radiation from the walls of the bag.

(c) (i) This calculation required the correct recollection and application of the formula $P = IV$. The most common errors were either incorrect recall of the equation or incorrect rearrangement of the formula, resulting in the calculation being 240 / 80 instead of 80 / 240 (A).

(ii) The formula used for this calculation, $E = IVt$, requires the time to be in seconds, so the hour has to be multiplied by 3600. The higher-scoring candidates did this successfully, but many others only multiplied the one hour by 60, the number of minutes, but not the number of seconds, so lost credit.

Question 7

(a) Many candidates correctly stated transpiration in this question. Those candidates who wrote respiration did not obtain credit.

(b) The decomposers are the group of organisms responsible for breaking down the leaves, therefore releasing minerals to be used by the trees again. Many candidates scored full credit in this question. Unacceptable responses included descriptions of the minerals being broken down, and the minerals being a waste product of respiration.

(c) Careful scrutiny of Fig. 7.1 was necessary here. The transpiration from the trees forming clouds is clearly shown, and most candidates concluded that there would be less rainfall as a result.

(d) Most candidates correctly stated that soil erosion would occur. The fact that the forest shown in Fig. 7.1 is on a hill is important in this question. The deforested area has no tree roots to stabilise the soil, so the soil is more likely to erode.

(e) The effect of deforestation on the concentrations of oxygen and carbon dioxide were well known and many candidates scored full credit. Several candidates referred to the trees turning carbon dioxide into oxygen during the process of photosynthesis. This is not correct scientifically and not creditworthy. The carbon dioxide taken in during photosynthesis becomes incorporated into carbohydrate molecules, whereas the oxygen is a by-product of the splitting of water, given out as a waste product.

Question 8

(a) (i) The majority of candidates drew the atomic structure of oxygen correctly.

(ii) The dot-and-cross diagram of the water molecule was drawn correctly by most candidates. Lower-scoring candidates either did not attempt this question, or put incorrect numbers of electrons into the covalent bonds.

(b) (i) Candidates across the ability range knew that two outer-shell electrons meant a Group II element.

(ii) There were some excellent responses to this question which gained full credit. Marks were lost when some candidates wrote ‘positive’ rather than ‘2+’ for the charge, and others left out the explanation after writing the correct charge. Better knowledge of the contributions of protons and electrons to the overall charge of an ion would have helped in this question.

(c) Placing the metals in the correct order of reactivity proved to be a straightforward task which enabled most candidates to score. The method of extraction of these metals was more challenging. Electrolysis as the method for extracting potassium and the blast furnace for extracting iron were both well known by the higher-scoring candidates. Extraction of copper using reduction by carbon was less well known.

Question 9

(a) (i) Most candidates correctly named force Q. Some candidates incorrectly interpreted force Q in the diagram as a forward-pushing force, so responses such as thrust or push were not accepted.

(ii) Only the highest-scoring candidates explained that the forces must all be balanced because the submarine was travelling at a constant speed and depth. Many candidates incorrectly stated that there must be a net forward force if the submarine is moving forwards. This only happens if the submarine is accelerating.

(iii) Most candidates did this calculation successfully. The most frequent incorrect answer was 300 000 (N), the result of candidates incorrectly using $F = m / g$ instead of $F = m \times g$.

(b) The work done in bringing the submarine up to the surface was answered well by the majority of candidates.

(c) (i) This question required correct recall of the wave equation, and correct rearrangement of the equation followed by the calculation. Most candidates could recall the wave equation $v = f \times \lambda$, and rearrange it. The main challenge for many candidates was knowledge that MHz means 10^6 Hz, not 10^3 Hz.

(ii) Most candidates wrote radio waves in the correct space in the electromagnetic spectrum.

(iii) This question required an explanation of the transmission of sound through water. Correct responses required a description of the vibrations being transmitted as longitudinal waves by water molecules. Incorrect responses included descriptions of the sound waves being travelling between the water molecules, or bouncing off them through the water.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

Candidates need to be more specific with their descriptions of solutions and precipitates, particularly in the Chemistry question.

General comments

Candidates were able to carry out all three practical exercises and obtain useful results.

Comments on specific questions

Question 1

For part **(a)** a significant number of candidates found that it took a shorter time for the milk to clear as the concentration of the enzyme added decreased. This was contrary to the results given by the supervisors. Candidates were asked to give the time values to the nearest whole second but this was often ignored, answers being incorrectly given in minutes or a combination of minutes and seconds.

Generally the standard of graph drawing was poor. Many graphs were very untidy, plotting was approximate all too often and the best-fit line judgement could have been a lot better. A minority of candidates plotted the time for the milk to clear against the volume of the enzyme solution.

In **(b)(ii)** most candidates were able to describe the relationship between the two plotted quantities. A common misconception was that any straight line indicates direct or inverse proportion.

The temperatures suggested for part **(c)** appeared to be guesswork in many cases. Most candidates were able to pick up the first mark but far fewer obtained the second. Some unrealistic temperatures were seen such as ones well below 0 °C and some as high as 500 °C.

Question 2

Part **(a)** was usually carried out well. A significant number of candidates did not label the filtrate and the residue. Very few candidates confused filtrate and residue.

In part **(b)(i) J** was usually correctly identified as copper nitrate however the observations which led to this conclusion were often confused and poorly expressed. It was often difficult to determine, from what the candidate had written, which of the solution or the precipitate was the darker blue.

Most candidates missed the blue precipitate that was formed in part **(b)(ii)**, and wrote that the solution had turned blue.

In **(c)** the reagent was usually identified correctly as sodium hydroxide although ammonia was a common incorrect answer. In the last part, despite all the clues in **(a)** and **(b)** and candidates performing the limewater test for carbon dioxide, calcium (oxide) was rarely given as the answer. A common incorrect answer was sodium. When calcium was correctly identified, only the more able candidates were able to give a convincing reason for their choice.

Question 3

The measuring and recording of the various currents and potential differences were well done by most candidates. Occasionally currents of more than 10 A were seen and it was assumed that candidates had read the meters incorrectly.

In part **(b)** the power values were usually calculated correctly and decreasing.

The idea of direct proportion is not well understood. In **(c)** the majority of candidates thought that if the power of the lamp increased as the current through it increased, then this was a sufficient condition for direct proportionality. Partial credit was awarded for a statement such as this. Only a handful of the most able candidates showed that the ratio of the current to the power did not have a constant value and so these quantities were not directly proportional.

COMBINED SCIENCE

Paper 0653/52
Practical Test

Key messages

A solid formed when one solution is added to another should be described as a precipitate.

General comments

Candidates were able to carry out all three practical exercises and obtain useful results.

Comments on specific questions

Question 1

Some drawings were too small but generally the quality of drawing was good. Labelling of the root and stem was usually accurate and rarely confused.

In part **(b)** the marking of the equivalent distance on the drawing was often poorly drawn and not the length of the seed excluding the root and the stem. Most lengths had been measured in millimetres as instructed. Calculation of the magnification rarely caused a problem. A very small number of candidates calculated the reciprocal of the magnification.

Several centres did not produce the expected results in **(c)**. Credit was given if this was stated in the Supervisor's Report. It would be helpful if the use of 'purple' for the iodine test could be discouraged, particularly when the biuret test is also being used. In **(c)(ii)** candidates made good conclusions and credit was given when candidates made correct conclusions for wrong observations.

Question 2

Most candidates completed the table well. 'Cloudy' should not be used as the description and colour of a precipitate. In **(a)(ii)** the test for ammonia with litmus paper caused few problems.

In part **(b)**, most candidates were able to discuss the similarity to the reagents used in Qualitative Analysis. Fewer stated that the results were different and fewer still discussed the implications of the ammonia test.

Part **(c)(i)** proved to be quite easy but part **(c)(ii)** proved much more difficult with relatively few giving a good answer.

Question 3

Most candidates gained all of the marks in **(a)**. Just occasionally the times were stated incorrectly, sometimes as minutes.

Part **(b)** was usually correct.

Part **(c)** was not well answered.

In part **(d)** most candidates could see if their results supported the suggestion. Many candidates found it difficult to express themselves to justify the statement.

'Room temperature' and 'initial water temperature' were the two common responses to **(e)**. Many candidates used 'water temperature' but this was not credited.

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 techniques and to have carried out experiments similar to the ones shown in the paper so that they are able to accurately describe experimental procedures. Candidates should have used standard laboratory apparatus, be able to read values from a range of measuring equipment and record values to the requested number of significant figures. Candidates need to be able to draw graphs accurately and construct lines of best-fit. Knowledge of identification tests for ions was limited.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of an excellent standard. The standard of graph drawing was generally high, but candidates need to remember to choose scales that cover at least half of the grid. Best-fit straight lines should be drawn with a ruler, be one single line of constant gradient and take into account all of the plotted points except where anomalies are clearly identified. Drawing diagrams of apparatus proved challenging for many candidates, as did subsequent labelling.

Comments on specific questions

Question 1

(a) Candidates found this challenging with the vast majority choosing a measuring cylinder. The responses beaker and test-tube were also seen quite often.

(b) Most candidates gained credit.

(c) The points on the graph were usually plotted correctly. The units must be included on the axes. The axes were often reversed, the *x*-axis sometimes started from 4 and counted down, and drawing the best-fit straight line caused some challenges.

(d) The majority of candidates described the relationship but a significant number did not use the variables in the question, often describing temperature and time rather than rate.

(e) (i) Most candidates suggested temperatures below 100°C; candidates needed to recognise that the enzymes would denature at high temperatures and choose temperatures less than 50°C. Many candidates gave only one temperature, often using terms such as room temperature or body temperature.

(ii) Candidates found this challenging, with many giving just the terms concentration and volume without specifying the substances being considered. Temperature and time were also common responses.

Question 2

(a) (i) The majority of candidates gained credit for T_1 but a very few appreciated that in order to read the temperature to the nearest 0.5°C, T_2 required the 0 after the decimal point.

(ii) Most candidates subtracted the values correctly, but a small number included an incorrect minus sign.

(iii) The term exothermic was not well known. Common incorrect responses included chemical reaction, endothermic and thermic.

(b) (i) Many candidates gained credit, but a significant number gave a generic answer without applying the result to the experiment.

(ii) Few candidates gained credit. Carbon dioxide was the most popular response. Nitrogen, hydrogen and sodium were other common responses.

(iii) Few candidates gained credit. Common incorrect responses included ammonia, sodium, copper, magnesium, hydrogen and iodine.

(c) Very few candidates gained credit. Many considered the blue precipitate and so gave the answer as copper. Magnesium, carbon, iron and hydrogen were other common responses.

(d) Few candidates gained credit. Chlorine was a response given by many. Copper, iron, sulfate, nitrate and carbon were other frequent responses.

Question 3

(a) The majority of candidates read the meters correctly.

(b) (i) Few candidates gained credit, with the majority thinking that the next reading would add to the previous reading. Other candidates thought switching off the circuit was to prevent electrocution.

(ii) Candidates found this challenging. Many thought that the glow of the lamp could still be seen.

(c) (i) The unit for power needs to be remembered. J and ($V \times I$) were common incorrect responses.

(ii) Many candidates calculated the two values correctly, and recorded the values to the correct number of significant figures commensurate with the values already printed in the table.

(d) (i) Many candidates gained credit for the straight line, but fewer drew the line through the origin. A number of curves were seen.

(ii) Candidates found this challenging. Many repeated the question stem.

Question 4

(a) The cell was reasonably well recognised but palisade, root and plant cell were common responses.

(b) (i) The drawings were usually magnified but fewer had the correct shape and many had a cell membrane. A significant number were not labelled.

(ii) Many candidates measured correctly, but 30.4 and 3.4 were frequent incorrect responses.

(iii) Most candidates gave a value but far fewer added points **C** and **D** to their drawing.

(iv) The calculation was performed well by stronger candidates. The formula was frequently inverted or the two values added or multiplied.

(c) The test was well known.

(d) Stronger candidates gained partial credit for microscope but far fewer named the anther or removed the pollen from the flower. A significant number removed the pollen from a bee or the stigma.

Question 5

(a) (i) Most candidates gave the masses to two decimal places.

(ii) Most candidates subtracted correctly but some either did not include the + and – sign or reversed them.

(b) Candidates found this part challenging.

(c) (i) The strongest candidates gained credit. Many reversed the electrodes. Candidates also needed to include an explanation in their answers.

(ii) Many candidates gained credit. Electrolysis and electrolyte were common incorrect responses.

(iii) Stronger candidates gained at least partial credit. Many described bubbles or rusting at the electrodes, and the electrolyte losing colour or rusting.

Question 6

(a) (i) Many candidates gained credit but many put the ball in the middle of the line.

(ii) Despite most candidates calculating the correct value, many did not round the final answer correctly. 0.86 was seen often.

(iii) Candidates must be able to determine why values are given to a limited number of significant figures.

(b) (i) Candidates found squaring the values challenging.

(ii) The points on the graph were often plotted correctly, but candidates found drawing the best-fit straight line challenging. Many drew a curve, joined the points or disregarded several of the points.

(iii) Few candidates showed on their graph how the values were obtained to calculate the gradient, and those that did often used a very small part of their best-fit line. A significant number inverted the division.

(c) (i) This calculation was generally performed well.

(ii) Candidates found this challenging with most repeating the question stem. Increased acceleration and faster speed were common responses.

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 so that they are able to accurately describe experimental procedures. Candidates should have used standard laboratory apparatus, be able to read values from a range of measuring equipment and record values to the requested number of significant figures. Candidates should have performed identification tests on the range of substances detailed in the specification.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of an excellent standard. The standard of graph drawing was generally high, but candidates need to remember to choose scales that cover at least half of the grid. Best-fit straight lines should be drawn with a ruler, be one single line of constant gradient and take into account all of the plotted points except where anomalies are clearly identified. Drawing diagrams of apparatus proved challenging for many candidates, as did subsequent labelling.

Comments on specific questions

Question 1

(a) The drawing was usually magnified and often accurate, although there were a number of non-continuous or feathery outlines. Drawings should be accurately labelled.

(b) (i) Many candidates gained credit, although a large number measured the whole seedling. A few gave the measurement in centimetres.

(ii) Most candidates gave a value, but far fewer added the line to their drawing.

(iii) The calculation was performed well by stronger candidates. The formula was frequently inverted or the two values added or multiplied.

(c) (i) Most candidates gained at least partial credit. However, a large number thought that light or oxygen was required.

(ii) Tests were well known, although some candidates gave only one nutrient and some added sugar.

Question 2

(a) (i) Candidates found this challenging. Many thought that because there was no reaction with ammonia the reagent could not be used for identification of cations.

(ii) Stronger candidates gained credit. Magnesium and calcium were common incorrect responses.

(iii) Although many candidates did not know the test, many could describe the expected observations. A common error was adding the litmus papers to the solution.

(b) (i) The test was quite well known although silver nitrate was a common response. Some candidates correctly described the test but then gave white precipitate as a result for the reaction of the carbonate.

(ii) Drawing apparatus proved challenging for many candidates. Many candidates drew acid being added to the carbonate. Of those who drew the correct apparatus, most had both test-tubes with bungs or had the delivery tube in the acid or not in the limewater.

(iii) Stronger candidates gained credit but descriptions of the bubbling were common.

Question 3

(a) (i) Most candidates read the temperature correctly, although a small number omitted the zero after the decimal point.

(ii) Most candidates read the temperature correctly.

(b) (i) Most candidates knew the units, but incorrect responses included m for minutes and cm^3 for temperature.

(ii) Most candidates gained credit. A small number gave only integer minutes.

(c) Stronger candidates gained credit. Many candidates thought that the time was needed to allow the water temperature to become uniform throughout.

(d) Candidates found this challenging; most repeated the stem.

(e) Candidates found this challenging and often gave vague statements with no reference to the data. Many of those who gained partial credit did not appreciate that the temperature changes should be considered over the same time period.

(f) Stronger candidates gained credit. Many incorrectly referred to the apparatus.

Question 4

(a) (i) The majority of candidates read the scale correctly. A significant number read to the left hand side of the bubble.

(ii) Most candidates calculated the three values correctly.

(iii) Many candidates calculated the values correctly, although a significant number repeated the value for 10 minutes.

(iv) Stronger candidates gained credit. Many did not use the variables in the question and referred to the movement of the bubble or the increased water-uptake.

(b) Although this appeared to be well-known, many candidates only discussed one improvement.

(c) (i) This was reasonably well-known but diffusion, osmosis and evaporation were other common responses.

(ii) Many candidates gained credit. Others referred to humidity or temperature affecting the water-uptake.

(d) Candidates found this challenging, with many giving the prediction with no explanation.

Question 5

(a) (i) Stronger candidates gained credit. The most common incorrect response was hydrochloric acid. Sulfate acid and sulfur acid were other common responses.

(ii) Many candidates gained credit. 'No more reaction' was a common response not worthy of credit.

(iii) This was reasonably well answered, but some candidates tested to show acid was still present.

(b) (i) Stronger candidates gained credit. Many candidates omitted the filter paper or used a dashed line, some omitted the funnel and labels were often missing or reversed.

(ii) Stronger candidates gained credit. Solid was the most common response not worthy of credit.

(c) Stronger candidates gained credit. Many thought the solid would evaporate or decompose.

(d) (i) Stronger candidates gained credit.

(ii) Candidates found this part challenging. Many only added the substances together and evaporated.

Question 6

(a) Candidates found this challenging, with few candidates showing their working.

(b) Most candidates calculated the values correctly.

(c) (i) The plotting of the points and drawing of the line usually gained credit. The scales need to be large enough, using more than half of the grid. A significant number plotted *d* against *p.*

(ii) Few candidates showed on their graph how the values were obtained to calculate the gradient, and those that did often used a very small part of their best-fit line. A significant number inverted the division.

(iii) Most candidates who attained a gradient in **(c)(i)** calculated the value correctly.

(d) Stronger candidates gained credit; many gave a generic response with no application to this experiment.

COMBINED SCIENCE

Paper 065/63
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 so that they are able to accurately describe experimental procedures. Candidates should have used standard laboratory apparatus, be able to read values from a range of measuring equipment and record values to the requested number of significant figures.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of an excellent standard. The standard of graph drawing was generally high, but candidates need to remember to choose scales that cover at least half of the grid. Drawing diagrams of apparatus proved challenging for many candidates. Data entered into a table should follow the pattern of the data already included.

Comments on specific questions

Question 1

(a) (i) The points on the graph were usually plotted correctly. Although the scales were linear, some candidates did not use at least half the grid. A significant number did not start the axes at the origin, and of those who did some did not extend their best-fit straight line to the origin.

(ii) Many described the relationship, but relating surface area to amount of foam or rate or distance were common errors.

(iii) Most candidates gave a correct value from their graph but a significant number did not mark their graph to show this value.

(b) Many gained credit, but amount of hydrogen peroxide and time were common responses.

(c) The test was quite well-known but many candidates described a lit or an extinguished splint relighting.

Question 2

(a) (i) Stronger candidates gained full credit. Common errors included limewater and **H** in the same test-tube, bungs in both test-tubes, no bungs in either test-tube and delivery tube not under the level of the limewater.

(ii) Few candidates gained credit. Common responses not worthy of credit included general safety points, not to give too much gas to the limewater, not overheating, to see what has happened and not to let too much pressure build up.

(iii) Majority of candidates gained credit. Oxygen was a common incorrect response.

(iv) Stronger candidates gained credit. Common incorrect responses included oxide, metal, iodine, carbon and zinc.

(v) Stronger candidates gained credit. Common incorrect responses included zinc, zinc oxide and oxide.

(b) (i) The majority of candidates knew the correct colour. Colourless and milky were common incorrect responses.

(ii) Candidates found this challenging with most describing bubbling, dissolving or decolourising.

(c) (i) Many candidates gained credit, but some used different results to those given.

(ii) Few candidates gained credit, with iodine and starch being the most common incorrect responses.

Question 3

(a) (i) Most candidates read the scale correctly. Some candidates gave 29.8.

(ii) The majority of candidates calculated the value correctly. A small number repeated the value from **(a)(i).**

(iii) Whilst the majority calculated the values correctly, many did not follow the pattern of data in the table or rounded incorrectly, giving the values as 1 and 1.6 or 1.66.

(iv) Most candidates calculated the values correctly.

(b) (i) The points were usually plotted correctly and stronger candidates gained credit for the line. However, some joined the points plotted, or had multiple lines.

(ii) Few candidates showed on their graph how the values were obtained to calculate the gradient, and those that did often used a very small part of their best-fit line. A significant number inverted the division.

(iii) Candidates found this challenging with many performing calculations on their gradient.

(c) Few candidates gained credit. Most discussed controlling the brightness of the lamp.

Question 4

(a) Most candidates gained at least partial credit, usually for water, but a large number thought that light or oxygen was required. A significant number discussed how the conditions of the five seedlings could be controlled.

(b) Many candidates gained full credit, but a significant number thought 25°C was too hot for good growth.

(c) Benedict's test was well known with many candidates gaining full credit. A small number described the protein or starch tests.

(d) Most candidates gained at least partial credit with the stronger ones gaining full credit. It was common for only one seedling to be tested in each condition, and some only had the light from above. Some candidates described experiments comparing light intensity.

Question 5

(a) (i) Candidates found this challenging. Common incorrect responses included metal oxide, sodium hydroxide and iron oxide.

(ii) Candidates found this challenging. Many discussed rusting, and common responses included yellow, orange, rust or changes colour. Of those that responded correctly, many did not include the term precipitate.

(iii) Few dissolved the solid but stronger candidates gave the correct test. Incorrect responses included electrolysis and using a magnet.

(b) (i) Stronger candidates gained partial credit for oil, with the most common incorrect responses being bung, cap and lid. Few gained full credit.

(ii) Stronger candidates gained credit. Incorrect responses included same temperature, all sealed with bungs, all contain water and all contain desiccant.

(c) Few candidates gained credit. Many repeated the stem, and most thought that test-tube **H** contained no water and therefore air alone causes rusting.

Question 6

(a) (i) Most candidates read the meters correctly. Incorrect responses were usually 5.8 or 4.8.

(ii) The majority of candidates gained partial credit, with mention of the surfaces being omitted quite often.

(iii) Many candidates gained credit, however a significant number answered in terms of numbers.

(b) Many candidates gained credit. Anomalous results and accuracy were the most common responses.

(c) Many candidates gained credit, but common incorrect responses cited a cause rather than an effect.

(d) Well answered by many candidates. Some chose materials with high friction, but which would not be used on a road such as carpet.