COMBINED SCIENCE

Paper 0653/11
Core Multiple Choice

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

General comments: Biology

The questions within the test were challenging and did get candidates to think about their responses. Whilst individual candidates may have resorted to guessing, there was no evidence that any question caused the majority of candidates to guess.

Question 11 and **Question 12** were the most accessible questions. One is a relatively easy recall question whilst the other is an equally simple application question. Candidates found **Question 7** the most difficult.

Comments on specific questions

Question 4

A good number of candidates selected the correct answer **D.** One would have suggested that **B** would have been the incorrect answer of choice. Candidates may have selected the substrate for respiration rather than the substrates for photosynthesis, however, this does not appear to have been the case here.

Question 7

Students that identified **B** as the correct response either had a good understanding of heart valve action, or were able to work out the answer from the picture. Students need to be reminded that the semi-lunar valves and the atrioventricular valve actions are paired. For example, when the bicuspid valve shuts, the tricuspid valve shuts. Therefore, during a compression step there should always be two valves open and two closed.

Question 10

This question asked candidates to identify which conditions were required for germination. The majority of candidates did correctly identify that oxygen and moisture were required. Some candidates incorrectly selected **C** as their response. Seeds starved of carbon dioxide will germinate, but their development will arrest soon after germination as they run out of stored reserves. Germination requires respiration. Even though the experiment was carried out in glass tubes, candidates may need reminding that most seeds germinate underground and have limited access to light. Once the shoot has grown through the soil and reached light it can then photosynthesise and then start to supply the plant with the energy it needs.

General comments: Chemistry

No questions proved to be either very easy or very difficult for the candidates. **Question 27** gave the candidates most difficulty.

Comments on specific questions

Question 18

More candidates chose the incorrect **D** than the correct answer **C**. They were able to identify the correct ratio of atoms of phosphorus to atoms of hydrogen, but thought that the four separate molecular representations together represented just one molecule.

Question 24

Candidates needed to know the properties of transition metals to answer this question. Candidates tended to choose the incorrect **A** almost as much as the correct answer **B**. As a result, this question did not discriminate between candidates of different abilities very well.

Question 27

More candidates chose the incorrect **B** than the correct answer **D**. They knew that ethene molecules contain double bonds and that the combustion of hydrocarbons produces carbon dioxide and water, but they incorrectly thought that ethane is the main constituent of natural gas and that molecules of ethane and ethanol do not contain the same number of carbon atoms.

General comments: Physics

In the physics section, candidates found only questions **34** and **39** very difficult.

Comments on specific questions

Question 28

In this question on average speed, a significant number of candidates of all abilities failed to convert the time given to hours, therefore arriving at option **A**.

Question 34

The incorrect option **B** was a very popular choice here. Candidates could generally find the amplitude of the wave, but a large number gave the period as the frequency, perhaps confusing the question with one asking for the wavelength, and misreading the horizontal axis.

Question 35

One in four candidates believed that the angle of refraction is measured to the interface, leading them to opt for **D**.

Question 36

Many weaker candidates believed that light waves are not electromagnetic.

Question 39

This question concerned fuses, and a majority of candidates of all abilities seemed unaware that ratings are given in amperes, rather than in any of the other quantities given in the question.

COMBINED SCIENCE

Paper 0653/12
Core Multiple Choice

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

General Comments: Biology

Question 9 was answered very well by the majority of candidates.

Question 2 and **Question 6** were the most difficult with evidence of guessing for **Question 2**.

Comments on specific questions

Question 2

Whilst there was a lot of reading to access the question, the task itself was not difficult. In the presence of starch the iodine would turn from orange to blue-black. The enzyme would digest the starch to simple sugars and when fully digested there would be no starch remaining. No starch would mean that the iodine could not change to blue-black but instead would remain orange. Candidates may have thought that **D** was a control; this was not indicated in the question stem. The preferred option was **C** indicating that the candidates needed to see the presence of blue-black in the two

minute column to validate their answer. Candidates need to be reminded that enzyme activity is fast and it may be that two minutes is a sufficient time to allow complete digestion of the substrate.

Question 6

This question highlighted a potential misconception. Here the majority of candidates identified the stomata **D** as the route of entry of water into a leaf rather than the xylem. It may be that candidates correctly linked the stomata with transpiration, but confused the entry of water with the exit of water. It may also be possible that the candidates may not have been able to discriminate the xylem **B** from the phloem **C**.

Question 7

This was an example of where candidates can use the diagrams in the question to develop their answer. Students that identified **B** as the correct response either had a good understanding of heart valve action, or were able to work out the answer from the picture. Students need to be reminded that the semi-lunar valves and the atrioventricular valve actions are paired. For example, when the bicuspid valve shuts, the tricuspid valve also shuts. Therefore, during a compression step there should always be two valves open and two closed. Many of the more able students may have over-complicated their answer, and may have talked themselves out of the correct answer.

Question 10

Candidates ended up choosing between **C** and **D**. Candidates need to be reminded that one of the advantages of sexual reproduction is to increase genetic variation and this could be used to determine the correct answer.

Question 11

This was another plant question that put the candidates under strain. Here the preferred option for the flower structure containing the anthers was the stigma. An easy way to remember this is that the male gamete from the plant is pollen and stamen contains the word ‘men’.

General Comments: Chemistry

Candidates performed very well on **Question 18**.

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

Comments on specific questions

Question 16

Candidates chose the incorrect **D** more often than the correct answer, **C**. They thought that rusting iron, rather than the evaporation of petroleum, was a physical change.

Question 17

There was evidence that many candidates had guessed at the answer. They chose the incorrect **B** and **C** more often than the correct answer, **A**. The more able candidates tended to choose the incorrect **B**, recognising that ions are formed as a result of the movement of electrons rather than protons, but confusing the formation of anions with the formation of cations.

Question 18

Candidates could easily identify the number of elements represented in the formula of a compound.

Question 22

There was evidence that many candidates had guessed at the answer. They chose the incorrect **A**, **B** and **C** more often than the correct answer, **A**. The more able candidates tended to choose the incorrect **B**.

Candidates are expected to know the specified tests for sulfate ions, for chloride ions, for carbonate ions and for nitrate ions.

Question 24

Candidates needed to know the properties of transition metals to answer this question. More able candidates tended to choose the incorrect **A** almost as much as the correct answer, **B**.

Question 26

More able candidates chose the incorrect **B** rather than the correct answer, **A**. They recognised that sodium hydroxide does not remove nitrogen and noble gases from the air, but they did not realise that it would not remove the water vapour.

General Comments: Physics

In the physics section, candidates found **Questions 30**, **31** and **39** particularly difficult.

Comments on specific questions

Question 28

In this question on average speed, a significant number of candidates of all abilities failed to convert the time given to hours, therefore arriving at option **A**.

Question 30

The topic here was energy transfer, and more than half the candidates failed to realise that the ball was moving horizontally, so did not gain any gravitational energy.

Question 31

Here almost one in two candidates opted for **C**, not appreciating that time could not be deduced from knowledge only of work done and distance travelled.

Question 32

Many less able candidates appeared to resort to guessing in this question on evaporation.

Question 35

The popularity of the incorrect option **C** here showed that a very common mistake was to fail to notice that the incident rays were not parallel to the principal axis of the lens.

Question 39

Here it was commonly believed that a fuse should be connected in parallel with the component it is protecting, leading to a choice of option **D**.

Question 40

One third of candidates thought the conventional current decreases as charge moves around a circuit, therefore choosing **C**.

COMBINED SCIENCE

Paper 0653/13
Core Multiple Choice

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

General Comments: Biology

There were four questions in particular that the candidates found straightforward. **Questions 9**, **10** and **13** were simple recall questions and **Question 12** was an accessible application question. **Question 2** and **Question 6** proved the most difficult.

Comments on specific questions

Question 2

Many candidates chose option **B**. With the range of available answer it is difficult to understand why candidates selected **B**. It could be that they went for the 50:50 answer.

Question 5

This question was generally done well, but there were many candidates that incorrectly believe that the pulp of a tooth is the hardest part of the tooth.

Question 6

This question highlighted a potential misconception. Here the majority of candidates identified the stomata **D** as the route of entry of water into a leaf rather than the xylem. Only a few candidates correctly identified the xylem. It may be that candidates correctly linked the stomata with transpiration, but confused the entry of water with the exit of water. It may also be possible that the candidates may not have been able to discriminate the xylem **B** from the phloem **C**.

Question 7

In some cases the candidates could use the diagrams in the question to develop their answers. Students that identified **B** as the correct response either had a good understanding of heart valve action, or were able to work out the answer from the picture. Students need to be reminded that the semi-lunar valves and the atrioventricular valve actions are paired. For example, when the bicuspid valve shuts, the tricuspid valve shuts. Therefore, during a compression step there should always be two valves open and two closed.

Question 8

The incorrect option **D** was dismissed by most students. It was clear that some students are confusing the word equation for respiration with the equation for photosynthesis.

General Comments: Chemistry

Candidates performed very well on **Question 18** and **Question 21**.

Question 22 proved most difficult for the candidates.

Comments on specific questions

Question 18

Candidates could easily identify the number of elements represented in the formula of a compound.

Question 20

Many candidates chose the incorrect **D** rather than the correct answer, **C**. They recognised that endothermic reactions involve a change in the temperature, but they confused endothermic with exothermic.

Question 21

Most candidates were easily able to use the word equation to identify the oxidation of magnesium in its reaction with water. However, some of the more able candidates chose the incorrect **C**, rather than the correct answer, **B**, confusing oxidation with reduction.

Question 22

There was evidence that many candidates had guessed at the answer. They chose the incorrect **A**, **B** and **C** more often than the correct answer, **D**. The more able candidates tended to choose the incorrect **B**. Candidates are expected to know the specified tests for sulfate ions, for chloride ions, for carbonate ions and for nitrate ions.

Question 25

Candidates chose the incorrect **A** more often than the correct answer, **D**. They did not understand that alloys are mixtures of metals.

Question 26

More able candidates chose the incorrect **B** rather than the correct answer, **A**. They recognised that sodium hydroxide does not remove nitrogen and noble gases from the air, but they did not realise that it would not remove the water vapour.

General Comments: Physics

In the physics section, candidates found **Question 33** and, particularly, **Questions 30**, **31**, **32**, **35**, and **36** difficult.

Comments on specific questions

Question 28

In this question on average speed, a significant number of weaker candidates failed to convert the time given to hours, therefore arriving at option **A**.

Question 30

The topic here was energy transfer, and more than four out of five candidates of all abilities failed to realise that the ball was moving horizontally, so did not gain any gravitational energy.

Question 31

Here more candidates opted for **C** than the correct answer, not appreciating that time could not be deduced from knowledge only of work done and distance travelled.

Question 32

A common error here was to believe that evaporation only happens when the room reaches a certain temperature.

Question 33

Many appeared to resort to guessing the answer to this question on convection.

Question 35

The popularity of the incorrect option **C** here showed that a very common mistake was to fail to notice that the incident rays were not parallel to the principal axis of the lens.

Question 39

Here it was quite commonly believed that a fuse should be connected in parallel with the component it is protecting, leading to a choice of option **D**.

Question 40

Many candidates thought the conventional current decreases as charge moves around a circuit, therefore choosing **C**.

COMBINED SCIENCE

Paper 0653/21
Extended Multiple Choice

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

General comments: Biology

Question 10 and **Question 11** were very straightforward. Both were recall questions and did not cause the students any difficulty. **Question 3** was most difficult for candidates.

Comments on specific questions

Question 3

Candidates may have misread this question. A lot of reading was required to establish the background to the question. Failure to read the question fully may have led to the incorrect answer being chosen. The graph clearly shows the activity of the enzyme at 0°C, 40°C and 70°C, the three temperatures that are stated directly in the question. Most candidates incorrectly chose **A** as the answer. This could be because they just read the activity of the enzyme at the temperatures in the table (0°C and 70°C). The actual question asks what is the activity of the enzyme after storage at 0°C and 70°C. The enzyme is used to digest starch at a temperature of 40°C. The correct answer is

C. Storage at 70°C would have denatured the enzyme, whereas the enzyme would have remained native, and therefore active, when stored at 0°C.

Question 6

With this question most candidates identified **B** as the correct response because of a good understanding of heart valve action, or an ability to work out the answer from the picture. There were two main incorrect answers **A** and **C**. These were relatively evenly selected. Candidates that did not know the correct answer identified one incorrect answer **D**, then guessed. Students need to be reminded that the semi-lunar valves and the atrioventricular valve actions are paired. For example, when the bicuspid valve shuts, the tricuspid valve shuts. Therefore, during a compression step there should always be two valves open and two closed.

Question 7

Whilst many candidates correctly identified the correct answer, some incorrectly put **B**. Possibly they failed to read the question and put the value for glucose.

Question 8

This question highlighted a common misconception. Candidates often think that tar from cigarettes sticks to blood vessel walls. Possibly because they are linking the cigarette smoke with the formation of a plaque/atheroma. The correct answer is that tar causes cancer as it is a carcinogen.

Question 9

There may be some evidence of misconception here. Most students correctly identified the effect of auxin on cell elongation, the misconception is where the auxin accumulates in the shoot.

General comments: Chemistry

No questions proved to be either very easy or very difficult for the candidates.

Comments on specific questions

Question 23

More able candidates chose the incorrect **D** rather than the correct answer, **C**. They understood how to obtain pure copper sulfate crystals from aqueous copper sulfate. However, they did not appreciate that the use of excess copper oxide would result in unreacted solid, which would then need to be removed from the reaction mixture before pure crystals could be obtained. As a result, this question did not discriminate between candidates of different abilities very well.

General comments: Physics

In the physics section candidates found **Question 36** difficult and they found **Questions 32** and **39** very difficult.

Comments on specific questions

Question 28

The most common mistake here was to confuse the distance-time graph with a speed-time graph, leading to a choice of option **A**.

Question 30

In this question on extension of a spring, many failed to take into account the original length, therefore choosing **D** (from Y = (6 / 2) × 14 = 42 cm).

Question 31

Although the great majority knew that hydroelectricity is renewable, almost one in three believed that it involved a store of chemical energy.

Question 32

This question on power was very badly answered. Both options **A** and **C** were popular, involving either dividing the time given by the work done, or multiplying these two values, taking no account of the units.

Question 36

Many candidates were unaware of the fact that pulses of electromagnetic waves are used in communication, believing the waves to be of constant amplitude.

Question 37

Most knew that the density of the air in a compression is different from that in a rarefaction, but many confused ‘rarefactions’ with ‘refractions’.

Question 39

This question was also badly answered. A large proportion of candidates failed to convert the time to seconds and chose option **B**.

Question 40

This question concerned fuses, and half of the candidates seemed unaware that ratings are given in amperes, rather than in any of the other quantities given in the question.

COMBINED SCIENCE

Paper 0653/22
Extended Multiple Choice

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

General comments: Biology

The biology component of this paper provided a good range of questions. There were some that candidates would not have found taxing. There were also some more challenging questions, where higher ability candidates would have had to think carefully about the answer.

There were four very straightforard questions that were easily accessed by most candidates. **Questions 1**, **3** and **8** were simple recall questions. **Question 5** was an easy to answer question where the students had to apply their knowledge of recovery time.

Candidates found **Question 2** the most difficult of the Biology questions.

Comments on specific questions

Question 2

Candidates may have misread the question. This question required a lot of reading to establish the background to the question. Failure to read the question fully may have led to the incorrect answer being chosen. The graph clearly shows the activity of the enzyme at 0°C, 40°C and 70°C the three temperatures that are stated directly in the question. Most candidates incorrectly chose **A** as the answer. This could be because they just read the activity of the enzyme at the temperatures in the table (0°C and 70°C). The actual question asks what is the activity of the enzyme after storage at 0°C and 70°C. The enzyme is used to digest starch at a temperature of 40°C. The correct answer is **C**. Storage at 70°C would have denatured the enzyme, whereas the enzyme would have remained native, and therefore active, when stored at 0°C.

Question 4

Most candidates identified **B** as the correct response because of a good understanding of heart valve action, or an ability to work out the answer from the picture. There were two main incorrect answers **A** and **C**. These were relatively evenly selected. Candidates that did not know the correct answer identified one incorrect answer **D**, then guessed. Students need to be reminded that the semi-lunar valves and the atrioventricular valve actions are paired. For example, when the bicuspid valve shuts, the tricuspid valve shuts. Therefore, during a compression step there should always be two valves open and two closed.

Question 9

Candidates mainly opted for **C** or **D**. Most candidates correctly identified the correct answer, but some did think that after sexual reproduction the offspring were genetically identical to the parents. Candidates need to be reminded that one of the advantages of sexual reproduction is to increase genetic variation and this could be used to discriminate the correct answer.

General comments: Chemistry

Candidates performed very well on **Question 15**, **Question 18** and **Question 21**.

No question proved to be particularly difficult for the candidates.

Comments on specific questions

Question 15

Most candidates had no difficulty in identifying fractional distillation as the method used to separate a mixture of two liquids.

Question 18

Most candidates knew the names of the different parts of the apparatus used in electrolysis. They were therefore able to identify the correct and the incorrect labels used in the electrolysis diagram.

Question 21

Candidates understood very well the factors that affect the rate of the reaction between solid magnesium and dilute hydrochloric acid. They were therefore able to select the conditions that would produce the greatest rate for this reaction.

General comments: Physics

In the physics section, no questions were found to be particularly difficult.

Comments on specific questions

Question 28

The most common mistake for weaker candidates here was to choose option **A**, representing the greatest speed rather than the greatest acceleration.

Question 29

In this question on extension of a spring, many failed to take into account the original length, therefore choosing **D** (from Y = (6 / 2) × 14 = 42 cm.)

Question 30

Here many more of the less able candidates opted for **C** than the correct answer, not appreciating that time could not be deduced from knowledge only of work done and distance travelled.

Question 31

The topic here was change of state and molecular structure; there appeared to be much guessing by weaker candidates between options B, C and D.

Question 33

The most common errors here were either to fail to convert the wavelength to metres (leading to option **D**), or to omit this conversion and then to divide the frequency by the wavelength (option **A**).

Question 36

One in four candidates believed that gamma rays had the highest speed of any electromagnetic waves.

Question 39

Here it was quite commonly thought that a fuse should be connected in parallel with the component it is protecting, leading to a choice of option **D**.

COMBINED SCIENCE

Paper 0653/23
Extended Multiple Choice

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

General comments: Biology

There were four questions that the candidates found very straightforward, **Questions 1**, **5**, **12** and **13**.

Question 10 was the most difficult. Candidates may have misread the question for **Question 2** and **Question 8.**

Comments on specific questions

Question 2

This question required a lot of reading to establish the background to the question. Failure to read the question fully may have led to the incorrect answer being chosen. The graph clearly shows the activity of the enzyme at 0°C, 40°C and 70°C the three temperatures that are stated directly in the question. Most candidates incorrectly chose **A** as the answer. This could be because the just read the activity of the enzyme at the temperatures in the table (0°C and 70°C). The actual question asks what is the activity of the enzyme after storage at 0°C and 70°C. The enzyme is used to digest starch at a temperature of 40°C. The correct

answer is **C**. Storage at 70°C would have denatured the enzyme, whereas the enzyme would have remained native, and therefore active, when stored at 0°C.

Question 3

This question threw up an unusual misconception. Most candidates identified lactose as the sugar that is broken down to lactic acid during yoghurt manufacturing. The next most common answer was glucose.

Question 6

Most candidates identified **B** as the correct response because of a good understanding of heart valve action, or an ability to work out the answer from the picture. There were two main incorrect answers **A** and **C**. These were relatively evenly selected. Candidates that did not know the correct answer identified one incorrect answer **D**, then guessed. Students need to be reminded that the semi-lunar valves and the atrioventricular valve actions are paired. For example, when the bicuspid valve shuts, the tricuspid valve shuts. Therefore, during a compression step there should always be two valves open and two closed.

Question 7

Candidates seemed to be confused as to what the question was asking them for in **Question 7**. Most got the correct answer with respect to the blood vessel Q. Some answered as if they were answering for blood vessel P. Although they linked artery to higher blood pressure, they must take care to answer the question that was asked.

Question 8

Many candidates correctly identified the correct answer **C**, but some incorrectly put **B**. Possibly they did not read the question and put the value for glucose during respiration.

Question 10

There may be some evidence of misconception. Most students correctly identified the position of the auxin in the root, but they failed to correctly identify the effect of auxin on cell elongation.

Question 11

Most candidates realised the importance of having the anthers outside the flower in wind pollinated plants. Unfortunately, they could not decide about the size of the flower or the presence of nectaries. If candidates had remembered that nectaries are there to attract pollinating insects, then that would have enabled them to access this mark.

General comments: Chemistry

Candidates performed very well on **Question 21**.

Question 22 and **Question 25** proved most difficult for the candidates.

Comments on specific questions

Question 19

More able candidates chose the incorrect **A** rather than the correct answer, **B**. They knew that calcium ions, rather than chloride ions, would be found at the negative electrode during the electrolysis of molten calcium chloride. However, they confused the formation of calcium atoms from calcium ions with the formation of calcium ions from calcium atoms. As a result, this question did not discriminate between candidates of different abilities very well.

Question 21

Candidates knew well the effect of temperature on the rate of the reaction between dilute hydrochloric acid and calcium carbonate. Furthermore, they understood the reasons for this effect in terms of colliding particles.

Question 22

There was evidence that many candidates had guessed at the answer. More able candidates tended to choose the incorrect **B** rather than the correct answer, **D**. They did not understand that the reaction between hydrogen and oxygen is a redox reaction, in which hydrogen is oxidised and oxygen is reduced.

Question 25

There was evidence that many candidates had guessed at the answer. More able candidates tended to choose the incorrect **A** and, in particular, **B** rather than the correct answer, **D**. It is possible that they misread this question as 'Which reaction does take place in the blast furnace?' rather than 'Which reaction does **not** take place in the blast furnace?'.

Question 27

Candidates chose the incorrect **A** more often than the correct answer, **D**. They recognised that butene does decolourise bromine, and that C_2H_4 is the formula of an alkene. However, they also thought that ethanol is an alkane and that alkenes are not made by cracking alkanes.

General comments: Physics

In the physics section, only question **34** was found to be particularly difficult.

Comments on specific questions

Question 28

The most common mistakes in this question on speed-time graphs were either to multiply the maximum speed by the time (leading to option **B**), or to do this and then half the value obtained (leading to option **B**).

Question 29

In this question on extension of a spring, many failed to take into account the original length, therefore choosing **D** (from Y = (6 / 2) × 14 = 42 cm).

Question 30

The topic here was energy transfer, and almost half the candidates thought that the kinetic energy would increase, either not noticing or not understanding the effect of a constant speed.

Question 31

A common mistake here was to multiply by the time taken rather than dividing, meaning that candidates chose the incorrect option **D**.

Question 33

Although a large majority of candidates knew that the radiation P was visible light, many of these believed that Q (X-rays) had the lower frequency.

Question 34

Almost half chose option **A** in this question on refraction of waves, knowing that the wavelength in region Y was smaller (as shown in the diagram), but thinking that the speed in this region was greater. Possibly some thought that the correct option would not have the same description in each column.

Question 36

Most knew that the density of the air in a compression is different from that in a rarefaction, but very many confused ‘rarefactions’ with ‘refractions’.

Question 37

Able candidates found this question on electrostatic forces very easy, and it was generally very well answered by all abilities.

Question 38

The popularity of option **D** here indicates that many are aware of the effect of length on electrical resistance, but not so certain about the effect of cross-sectional area.

Question 39

In this question on electrical power, a large number of candidates divided the voltmeter reading by the current, leading to the incorrect option **B**.

Question 40

Almost one third of candidates seemed to confuse series and parallel circuits, choosing option **A**, which indicated all currents being equal.

COMBINED SCIENCE

Paper 0653/31
Core Theory

Key messages

- Use the correct spellings for scientific terms.
- Read the stem of the question carefully.
- Do not include symbols in a word equation.
- Take care with handwriting, particularly when writing scientific terms.

General comments

There was a wide range of scripts submitted by candidates. Some candidates showed a good knowledge of all aspects of the syllabus and displayed competent examination technique. Other candidates were less familiar with the syllabus. These candidates could easily have gained more credit for questions testing recall and definition if they were more familiar with the syllabus content.

Although this is a theory examination, candidates should make sure that they are familiar with the investigations described by the syllabus. In this paper, knowledge of the tests for food substances, the reactivity series, electrolysis and electrical circuits would have helped some candidates gain more credit.

The handwriting of most candidates was clear and legible. Scripts submitted by a few candidates contained some areas of illegible writing which meant that the intended response could not be interpreted. These candidates should review their work to check that their scripts can be read.

There was no evidence that candidates ran out of time. Generally, responses were confined to the answer lines provided. The space provided on the paper is an indication of the length of response required. Candidates should bear this in mind when writing their answers.

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Comments on specific questions

Question 1

(a) Many candidates successfully linked each food substance with the correct test solution and its positive result. The starch test with iodine was the best-known response, with the protein and reducing sugar tests less well known.

(b) (i) Candidates had to look at the colour of each leaf and predict the relative amounts of starch contained in them. The question was concerned with the necessity for chlorophyll for photosynthesis. Many candidates successfully stated the correct order. The most frequent error was to reverse the order.

(ii) Very few candidates gave the correct explanation for the results, that chlorophyll in the leaf was necessary for photosynthesis, which produced starch. There were several misconceptions shown by candidates in this question. Some candidates stated that the colouration of the leaves was due to the presence of starch. They concluded that the pale-yellow colour of **R** indicated more starch than either of the leaves which were coloured green. Other candidates incorrectly thought that the leaves in Fig. 1.1 had already been tested for starch and tried to interpret the results using this information. Not many candidates knew the correct term for chlorophyll, referring to it as ‘green stuff’.

(c) Candidates generally knew that carbon dioxide enters the leaves, and water enters the roots. More detail in terms of the structures involved, and diffusion as the method of exchange were needed to gain full credit. Therefore, the *stomata* in the leaf, and *root hair cells* were the terms required.

(d) (i) For this question candidates had to state that respiration takes place all the time, not only at night. There were several unclear responses to this. Candidates had to indicate that respiration takes place during both day and night. Therefore, statements such as 'Respiration takes place during the day' did not give enough information. Incorrect responses included 'Photosynthesis occurs during the day, and respiration only at night' and 'Light is needed for respiration'.

(ii) This question was challenging to candidates of all abilities. The question required candidates to state the uses of the energy released by seeds for their own use. Therefore, responses of the type that would benefit other organisms, for example a food source, were not acceptable.

Question 2

(a) (i) In this question candidates had to place the metals in order of reactivity, so knowledge of the reactivity series was essential. Some candidates did this successfully. Others knew that calcium was the most reactive metal and copper was the least reactive metal but reversed the reactivity of iron and zinc.

(ii) Knowledge that the acidity of the solution reduces as the acid reacts was important for this question. Many candidates gained credit in this response by saying that the pH increases. Responses which indicated that the solution became alkaline were not awarded credit.

(b) (i) Many candidates correctly identified the gas as hydrogen. Incorrect responses included chlorine and carbon dioxide.

(ii) Filtration was the correct method of separation needed, and candidates across the ability range gave this response. Incorrect responses included the use of tongs to pick out the solid. The solid is a powder, and would be impossible to remove in this way.

(iii) Many candidates described an acceptable way of obtaining the solid magnesium chloride. Unacceptable responses included filtration and electrolysis.

(c) (i) Candidates needed to interpret the numbers on the symbol. Many candidates succeeded in doing this correctly. The main cause of error was to state the relative atomic mass as 12, and the atomic number as 25. Others incorrectly added the two numbers to give 37.

(ii) For this question the atomic number had to be subtracted from the relative atomic mass to give the answer 13. Many did not do this and gave 12 as their response.

(d) (i) By far the most important physical property of aluminium for its use in power cables is aluminium's ability to conduct electricity. Most candidates stated this in their responses.

(ii) The strength of the aluminium alloy compared to the metal alone was the important property for aeroplane construction. Many candidates gave this correct response.

Question 3

(a) (i) Many candidates drew two opposite vertical forces, knowing that for the load to be stationary the forces had to be balanced. Incorrect responses included diagrams with only one vertical force acting, or a pair of horizontal forces acting on the load.

(ii) Several candidates stated that the airship moves at a constant speed. Others stated that the airship will be stationary. Candidates are reminded that objects with balanced forces move at a constant speed if they are already moving or will remain stationary if they are not moving.

(iii) Most candidates wrote 'newton', the correct response. Incorrect responses included joules or pascals. Candidates should take care when spelling scientific terms. In this case some candidates wrote 'neutron' which was not acceptable, since it is a different scientific term.

(b) (i) The majority of candidates successfully read the speed from the graph.

(ii) The differing speeds of the airship were identified successfully by most candidates.

(c) (i) Many of the more able candidates calculated the volume of the cube successfully to obtain the answer **0.125 (m^3)**. Less able candidates found this challenging with many including the density in their calculations.

(ii) In this question the equation mass = density × volume had to be used to obtain the correct answer of **875 (kg)**. Incorrectly calculated values for volume were carried forward to this question without penalty. Many candidates obtained both marks, but several were unfamiliar with the equation.

Question 4

(a) It was important for candidates to read the stem of the question carefully so that they knew which flask was testing the expired air. The main point of the question was to predict whether the limewater went milky first in flask **A** or flask **B**. Candidates who knew that expired air contains more carbon dioxide than inspired air correctly predicted that the limewater turns milky first in flask **B**.

Many candidates answered the question correctly. When explaining the result for flask **A**, the inspired air, many candidates referred to the inspired air as 'oxygen', making statements such as 'Oxygen does not react with limewater'. Candidates are reminded that other gases are present in inspired air, as shown in Table 4.1.

(b) Most candidates completed the table successfully to gain full credit.

(c) (i) The term 'hormone' was known by many candidates across the full range of ability. Incorrect responses included 'substance' and 'enzyme'. The word 'chemical' was considered to be too vague to be given credit.

(ii) The effects of an increase in adrenaline in the bloodstream were generally well known.

(iii) Very few candidates could describe the role that the liver plays in removing adrenaline from the bloodstream. Most responses were vague statements, such as 'they are calming down', 'the race is over'.

Question 5

(a) (i) Many candidates were familiar with the fractionating column used in fractional distillation and named the process correctly. The word 'distillation' on its own was not accepted.

(ii) Some candidates responded correctly with 'physical change.' There was a wide range of incorrect answers ranging from 'chemical change' to 'no change'. Candidates are reminded that changes of state, as in this refinery process, are physical changes.

(iii) Candidates across the whole ability range found this question challenging. The most important consideration was whether the components had combined chemically. In the definition of the mixture it was not sufficient to say 'two or more chemicals added together'. Further explanation was required to explain that there was no bonding between the components of the mixture. In the case of the compound, it was important to say that the chemical bond was between two or more different elements.

(b) (i) Many able candidates correctly described a covalent bond as the sharing of electrons between atoms. Incorrect responses included descriptions of loss and gain of electrons as in an ionic bond.

(ii) Very few candidates suggested a correct chemical test for water. Many incorrect responses included universal indicator and litmus paper. Neither of these tests are specific enough to work with water and nothing else.

(iii) Many candidates correctly stated the term 'exothermic'. Incorrect responses included 'endothermic' and combustion.

Question 6

(a) Knowledge of the electromagnetic spectrum and the uses of some of its waves were needed to answer this question. Some candidates correctly identified the missing waves from the spectrum, though not always in the correct order. Many candidates did not enter any responses for the types of radiation. This prevented them from scoring the mark for the uses of the missing radiations.

(b) (i) Only the best candidates obtained the mark with the term *convection*. Incorrect responses included conduction, exothermic and combustion. Candidates are reminded that convection is the method of thermal energy transfer through gases.

(ii) Candidates across the ability range found this question challenging. Several candidates wrote that the hot air cools but did not follow this up with the rest of the explanation. There were many vague responses which did not obtain credit such as 'to stop the balloon falling to the ground'.

(iii) The two energy changes required by the question were given by many candidates. Incorrect responses included 'heat energy' and 'exothermic energy' for the first response, and 'more' energy for the second response.

(iv) The correct answer, radiation, was given by a handful of candidates who understood that thermal energy can be transferred in all directions by infra-red radiation. There were many responses that were too vague such as 'the people were right underneath the burner'.

Question 7

(a) (i) The vast majority of candidates correctly identified the green plants as the producers. Most also gave all three herbivores in the food web.

(ii) There was only one complete food chain in the food web which consisted of three organisms. Candidates should be aware that complete food chains begins with a producer, the green plants, and ends with the top carnivore, the owl. Many candidates chose any sequence of three organisms from the food web, which did not always start with the green plants. These partial food chains did not gain credit.

(b) There were two possible predictions for this question and as long as the explanations were valid both predictions could gain full credit. A decrease in the number of snails due to increased predation, or an increase due to a greater food supply were both acceptable as explanations, as long as the increase or decrease in population was specified. Many candidates scored well in this response.

Question 8

(a) (i) The knowledge that copper chloride consists of charged particles assisted the candidates to identify the ionic bond in the compound. Frequently seen incorrect responses included covalent bond, chemical bond and metallic bond.

(ii) Candidates had to use the information provided about the ions contained in copper chloride to produce the formula, $CuCl_2$. Many did this successfully. Candidates are reminded that the symbol for copper, Cu, must have the upper-case and lower-case letters written correctly. The number two coming after the chloride ions should be a subscript.

(iii) The cathode was successfully identified by many candidates. Incorrect responses included 'anode', 'copper' and 'right.

(iv) Several candidates correctly identified the chlorine gas produced. The most frequently-seen incorrect answer was hydrogen. Some candidates wrote 'chloride' as their response. Candidates should be aware that it is the element chlorine forming at the anode, and not the chloride ion.

(b) (i) Most candidates correctly expressed the role of a catalyst as speeding up the rate of a chemical reaction. Having learned the term *catalyst* in Biology in the context of enzymes, some candidates described a catalyst as a protein. While enzymes are catalysts made from protein, not all catalysts are enzymes, so the mark could not be awarded.

(ii) The transition metals were known by the higher-scoring candidates. Some candidates wrote a list of the names of transition metals, omitting the term 'transition', so they did not obtain the mark.

(c) (i) Three items of the word equation were given in the stem of the question so it was just the carbon dioxide or carbon monoxide that had to be provided by the candidate as one of the products. Many candidates across the ability range wrote a correct word equation. 'Carbon oxide' was seen frequently as the product and this was not given credit. Candidates are reminded to read the stem of the question carefully, and to know that atoms cannot appear in the products if they were absent from the reactants. Candidates should also take care not to use symbols in a word equation.

(ii) Most candidates found this question challenging. The word 'redox' refers to a combination of oxidation and reduction in the same reaction, and many candidates failed to explain this adequately.

Question 9

(a) (i) Some of the three electrical symbols were known by most candidates. Many drew a correct symbol for the switch. Fewer drew correct symbols for the variable resistor and the fuse.

(ii) The candidates had to use the information supplied to create an electrical circuit. Several candidates drew a parallel circuit as requested. Incorrect symbols were carried forward without penalty.

(b) (i) The majority of candidates found this question challenging. They treated the resistors as a series arrangement and added up the values, obtaining 100 Ω instead of choosing the correct answer. The correct combined resistance must be less than either resistance, in this case **24 Ω**.

(ii) The value of combined resistance stated in **(i)** had to be used in the Ohm's Law formula. The calculation was current = voltage / resistance and this produced the correct value of **10 A**. Many candidates succeeded in doing this calculation. Any incorrect value for resistance given in **(i)** was carried forward without penalty.

COMBINED SCIENCE

Paper 0653/32
Core Theory

Key messages

Read the stem of the question carefully.
Do not include symbols in a word equation.
Take care with handwriting, particularly when writing scientific terms.
In combustion reactions one of the reactants is always oxygen

General comments

There was a wide range of scripts submitted by candidates. Some candidates showed a good knowledge of all aspects of the syllabus and displayed competent examination technique. Other candidates could have gained more credit for questions testing recall and definition if they had been more familiar with the syllabus content.

The handwriting of most candidates was clear and legible. Scripts submitted by a few candidates contained some areas of illegible writing which meant that the intended response could not be interpreted. These candidates should review their work to check that their scripts can be read.

There was no evidence that candidates ran out of time. Generally, responses were confined to the answer lines provided. The space provided on the paper is an indication of the length of response required. Candidates should bear this in mind when writing their answers.

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Comments on specific questions

Question 1

(a) Candidates responded well to this question about the general functions of the digestive system. The most frequent error was confusing the functions of the small intestine, digestion and absorption, and the stomach, digestion only.

(b) The majority of candidates correctly responded that the large sugar component of the drink is harmful for teeth. Very few responses included correct explanations of the sugar encouraging the growth of bacteria and the consequences of this in the mouth. An incorrect response widely seen was the sugar making the teeth sticky as the cause of tooth decay.

(c) The vast majority of candidates responded with two correct ways in which they could care for their teeth.

Question 2

(a) (i) Very few candidates suggested a correct chemical test for water. Many incorrect responses included testing with universal indicator and litmus paper. Neither of these were specific enough to work with water and nothing else.

(ii) The knowledge of limewater as the test for carbon dioxide was known by many candidates.

(b) Combustion as a general reaction with oxygen was known by the better candidates. This enabled them to apply their knowledge to the combustion of hexane. Candidates are reminded that a word equation should not include symbols.

(c) The knowledge that methane is the main constituent of natural gas was not known by many candidates. Incorrect responses included hydrogen, carbon dioxide and nitrogen.

(d) (i) Many candidates correctly identified the bond as covalent. Ionic bond and chemical bond were widely seen as incorrect answers.

(ii) Correct drawings were seen across the ability range. Errors seen included the inclusion of a double bond between the two carbon atoms, and attempts to draw dot-and-cross diagrams.

(iii) Candidates needed to know that relative atomic mass of an atom is the sum of the protons and neutrons. Several candidates mistook the relative atomic mass in the question for the atomic number. Others mistook the relative atomic mass for the neutron number.

Question 3

(a) (i) Many candidates drew two opposite vertical forces, knowing that for the load to be stationary the forces had to be balanced. Incorrect responses included diagrams with only one vertical force acting, or a pair of horizontal forces acting on the load.

(ii) The gravitational force acting on the mass of the load, or the weight, was correctly identified by candidates across the ability range. Among the incorrect responses given were air resistance, push or pull, magnetic force.

(b) Many candidates successfully rearranged the $\text{speed} = \frac{\text{distance}}{\text{time}}$ formula to do this calculation. The majority of errors arose because the equation had been rearranged incorrectly and calculated the $\text{distance} \cdot \text{speed}$ instead of $\frac{\text{distance}}{\text{speed}}$. The correct answer was **333 s**.

(c) In this question the mass of the load was calculated by the formula $\text{mass} = \text{density} \cdot \text{volume}$, a rearrangement of the more familiar $\text{density} = \frac{\text{mass}}{\text{volume}}$. Many candidates calculated the mass successfully. Incorrect rearrangements of the equation caused the majority of errors. The correct answer was **5125 kg**.

(d) (i) Candidates across the ability range gave watts as the correct unit. Incorrect responses included joules, weight, and newtons.

(ii) Most candidates found this question challenging. The question was seeking the understanding that a machine with a greater power can do the same amount of work in a shorter time. Explanations had to make it clear that the amount of work being done by the cranes was the same.

Question 4

(a) (i) Candidates responded well to this question, pointing out that one parent only is required, and that the offspring must be genetically identical since there was no mixing of genes taking place.

(ii) The presence of flowers was the obvious answer to show that the plant is capable of sexual reproduction too. This was observed by several candidates. Incorrect responses included slight differences in the offspring, which although present, were not evidence that the offspring had differences in their genetic makeup.

(b) There were three correct conditions for germination. Very few candidates ticked all three correct boxes. The most widely incorrect answer was 'light'. Candidates should be aware that germination of seeds usually takes place underground, where there is no light present. It is essential that their environment is warm. This condition was the one most frequently omitted.

(c) Those candidates who were familiar with the syllabus had no difficulty with providing the correct definition of an enzyme. Many candidates repeated information given in the stem, that it causes the starch to break down, but omitted to say it is a protein, or that it acts as a catalyst.

(d)(i) The able and middle-scoring candidates were able to complete the word equation for respiration. Some of the errors included candidates' giving the photosynthesis equation, or a confusion of the four chemicals, placing them in the wrong boxes.

(ii) This question was challenging to candidates of all abilities. The question required candidates to state the uses of the energy released by seeds for their own use. Therefore, responses of the type that would benefit other organisms, for example a food source, were not acceptable.

Question 5

(a)(i) A few candidates understood what was happening in this experiment. It was beneficial for candidates if they had done the experiment. Many students thought that the cotton wool was to prevent the evolved gas, rather than acid splashes from escaping the flask. Consequently, a large number of candidates decided that here was no change in the mass of the flask and its contents. A widespread misconception was shown when candidates said that the mass increased because a gas was being produced.

(ii) Knowledge about the factors affecting the rate of reaction was needed for this question, and many of the higher-scoring candidates chose the options on the mark scheme. Responses which were not credited were adding less magnesium powder, or less acid.

(iii) The candidates had to use their knowledge of the reactivity series for this response. Knowledge that calcium is more reactive than magnesium was the key to gaining the marks. Many of the middle-scoring and higher-scoring candidates did this successfully.

(b)(i) Many candidates successfully identified electricity as the energy source for electrolysis.

(ii) The knowledge that magnesium chloride consists of charged particles assisted the candidates to identify the ionic bond. Frequently seen incorrect responses included covalent bond, chemical bond and metallic bond.

(iii) Candidates had to use the information provided about the ions contained in magnesium chloride to produce the formula, $MgCl_2$. Many did this successfully. Candidates are reminded that the symbol for magnesium, Mg, must have the upper-case and lower-case letters written correctly. The number two coming after the chloride ions should be a subscript.

(iv) Many candidates successfully identified reduction, the process by which oxygen is removed from magnesium oxide. Incorrect responses included combustion, oxidation and exothermic.

Question 6

(a) Knowledge of the electromagnetic spectrum and the uses of some of its waves were needed to answer this question correctly. Many candidates correctly identified X-rays as the missing wave from the spectrum. The uses of the different types of radiation were known by many candidates. The most frequent error was the confusion of the function of radio waves for television transmission with the function of microwaves for satellite transmission.

(b)(i) Conduction as the method of heat transfer through solids was correctly given by higher-scoring candidates. Many incorrectly stated 'convection' as the method of heat transfer. Candidates are reminded that the method of heat transfer through the glass is by conduction since it is a solid.

(ii) The slow heating of the air inside the bottle is an indication that the thermal energy has not been transferred easily across the glass of the bottle, thereby indicating that glass is a bad conductor. A few candidates explained this well. Most candidates did not give enough detail in their answers, for example, saying it was hard to heat glass.

(iii) This question proved challenging to most candidates. The balloon fills with warm air because the air inside the bottle expands and the outward pressure caused by this causes the balloon to inflate. Many candidates' explanations acknowledged that the air inside the bottle becomes warm but lacked detail about how this causes the balloon to inflate.

Question 7

(a) The vast majority of candidates stated that July is the month for the greatest rate of photosynthesis.

(b) Candidates had to predict that some light would be able to reach the small plants on the woodland floor during the months of March and April. Many did so successfully and related the light availability to the rate of photosynthesis in these small plants.

(c) (i) Two effects of deforestation were correctly identified by most candidates. The loss of a habitat and the loss of a food supply were the most widely-chosen effects.

(ii) Many candidates successfully responded to this question with explanations of loss of soil stability. There were many answers which were too vague to obtain credit. Examples of these responses are 'the soil becomes infertile' and 'the soil becomes weak'.

Question 8

(a) (i) The trend across the period from metallic to non-metallic was correctly answered by the more able candidates. Incorrect responses included naming the group or the element at each end of the period, rather than describing a trend.

(ii) Many candidates correctly named Group I as their response and therefore achieved the mark. Other candidates identified the group incorrectly or tried to name a metal. Neither of these responses were acceptable.

(iii) The transition metals were known by the higher-scoring candidates. Some candidates wrote a list of the names of transition metals, omitting the term 'transition', so they did not obtain the mark.

(b) Very few candidates achieved full marks on this question about displacement reactions of the halogens. Knowledge of the trend of reactivity down the halogen group was essential for this question, and also the fact that the element will displace a less reactive element from its salt. Most candidates found this question challenging.

(c) Many candidates knew that chlorine kills bacteria to purify water, therefore gaining the mark. Credit was not awarded for vague statements such as 'it cleans the water'.

(d) (i) The correct explanation of exothermic was given by some candidates. Other candidates were not awarded the mark although they said that energy is given out during the reaction they failed to say that it is heat or thermal energy that is given out.

(ii) The answers on the mark scheme show examples of sodium compounds which candidates could have used during their course to make sodium chloride safely. Some candidates gave one of these compounds as an example in their answers. Many candidates incorrectly wrote sodium, which would be highly dangerous.

Question 9

(a) (i) Many candidates drew an accurate diagram of the circuit. Some of the lower-scoring candidates did not know the correct symbol for the ammeter. Candidates are reminded that the connecting wire does not pass through the symbol for the ammeter.

(ii) Some candidates correctly added the voltmeter to the circuit so that it measured the potential difference across the motor. Other candidates placed the voltmeter in the circuit in series, or in parallel across the wrong component. The addition of the voltmeter to the circuit was omitted by many candidates.

(b) (i) The application of Ohm's Law was successfully done by many candidates. The correct form of the equation was $\text{current} = \frac{\text{voltage}}{\text{resistance}}$, or $I = V / R$. The correct answer for this was **0.3 A**. Incorrect responses arose from using the formula incorrectly, or not using the formula at all.

(ii) Many candidates could explain that the reading for current on the meter increases because of the increased potential difference across the motor.

(c) (i) The law of reflection of light was not widely known across the range of candidates. Some responses said that the reflected ray was equal to the incident ray, without mentioning any angles, so these responses did not gain credit. Other responses were too vague, for example 'all angles are equal'.

(ii) Although many candidates could not relate the law of reflection of light as required for **(c)(i)**, they could apply the law in the repositioning of the mirror. It was important that the mirror was positioned so that there was a noticeable angle of incidence that matched the angle of reflection, and the reflected ray was capable of entering the eye.

COMBINED SCIENCE

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Core Theory

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(a)(i) A few candidates understood what was happening in this experiment. It was beneficial for candidates if they had done the experiment. Many students thought that the cotton wool was to prevent the evolved gas, rather than acid splashes from escaping the flask. Consequently, a large number of candidates decided that here was no change in the mass of the flask and its contents. A widespread misconception was shown when candidates said that the mass increased because a gas was being produced.

(ii) Knowledge about the factors affecting the rate of reaction was needed for this question, and many of the higher-scoring candidates chose the options on the mark scheme. Responses which were not credited were adding less magnesium powder, or less acid.

(iii) The candidates had to use their knowledge of the reactivity series for this response. Knowledge that calcium is more reactive than magnesium was the key to gaining the marks. Many of the middle-scoring and higher-scoring candidates did this successfully.

(b)(i) Many candidates successfully identified electricity as the energy source for electrolysis.

(ii) The knowledge that magnesium chloride consists of charged particles assisted the candidates to identify the ionic bond. Frequently seen incorrect responses included covalent bond, chemical bond and metallic bond.

(iii) Candidates had to use the information provided about the ions contained in magnesium chloride to produce the formula, $MgCl_2$. Many did this successfully. Candidates are reminded that the symbol for magnesium, Mg, must have the upper-case and lower-case letters written correctly. The number two coming after the chloride ions should be a subscript.

(iv) Many candidates successfully identified reduction, the process by which oxygen is removed from magnesium oxide. Incorrect responses included combustion, oxidation and exothermic.

Question 6

(a) Knowledge of the electromagnetic spectrum and the uses of some of its waves were needed to answer this question correctly. Many candidates correctly identified X-rays as the missing wave from the spectrum. The uses of the different types of radiation were known by many candidates. The most frequent error was the confusion of the function of radio waves for television transmission with the function of microwaves for satellite transmission.

(b)(i) Conduction as the method of heat transfer through solids was correctly given by higher-scoring candidates. Many incorrectly stated 'convection' as the method of heat transfer. Candidates are reminded that the method of heat transfer through the glass is by conduction since it is a solid.

(ii) The slow heating of the air inside the bottle is an indication that the thermal energy has not been transferred easily across the glass of the bottle, thereby indicating that glass is a bad conductor. A few candidates explained this well. Most candidates did not give enough detail in their answers, for example, saying it was hard to heat glass.

(iii) This question proved challenging to most candidates. The balloon fills with warm air because the air inside the bottle expands and the outward pressure caused by this causes the balloon to inflate. Many candidates' explanations acknowledged that the air inside the bottle becomes warm but lacked detail about how this causes the balloon to inflate.

Question 7

(a) The vast majority of candidates stated that July is the month for the greatest rate of photosynthesis.

(b) Candidates had to predict that some light would be able to reach the small plants on the woodland floor during the months of March and April. Many did so successfully and related the light availability to the rate of photosynthesis in these small plants.

(c) (i) Two effects of deforestation were correctly identified by most candidates. The loss of a habitat and the loss of a food supply were the most widely-chosen effects.

(ii) Many candidates successfully responded to this question with explanations of loss of soil stability. There were many answers which were too vague to obtain credit. Examples of these responses are 'the soil becomes infertile' and 'the soil becomes weak'.

Question 8

(a) (i) The trend across the period from metallic to non-metallic was correctly answered by the more able candidates. Incorrect responses included naming the group or the element at each end of the period, rather than describing a trend.

(ii) Many candidates correctly named Group I as their response and therefore achieved the mark. Other candidates identified the group incorrectly or tried to name a metal. Neither of these responses were acceptable.

(iii) The transition metals were known by the higher-scoring candidates. Some candidates wrote a list of the names of transition metals, omitting the term 'transition', so they did not obtain the mark.

(b) Very few candidates achieved full marks on this question about displacement reactions of the halogens. Knowledge of the trend of reactivity down the halogen group was essential for this question, and also the fact that the element will displace a less reactive element from its salt. Most candidates found this question challenging.

(c) Many candidates knew that chlorine kills bacteria to purify water, therefore gaining the mark. Credit was not awarded for vague statements such as 'it cleans the water'.

(d) (i) The correct explanation of exothermic was given by some candidates. Other candidates were not awarded the mark although they said that energy is given out during the reaction they failed to say that it is heat or thermal energy that is given out.

(ii) The answers on the mark scheme show examples of sodium compounds which candidates could have used during their course to make sodium chloride safely. Some candidates gave one of these compounds as an example in their answers. Many candidates incorrectly wrote sodium, which would be highly dangerous.

Question 9

(a) (i) Many candidates drew an accurate diagram of the circuit. Some of the lower-scoring candidates did not know the correct symbol for the ammeter. Candidates are reminded that the connecting wire does not pass through the symbol for the ammeter.

(ii) Some candidates correctly added the voltmeter to the circuit so that it measured the potential difference across the motor. Other candidates placed the voltmeter in the circuit in series, or in parallel across the wrong component. The addition of the voltmeter to the circuit was omitted by many candidates.

(b) (i) The application of Ohm's Law was successfully done by many candidates. The correct form of the equation was $\text{current} = \frac{\text{voltage}}{\text{resistance}}$, or $I = V / R$. The correct answer for this was **0.3 A**. Incorrect responses arose from using the formula incorrectly, or not using the formula at all.

(ii) Many candidates could explain that the reading for current on the meter increases because of the increased potential difference across the motor.

(c) (i) The law of reflection of light was not widely known across the range of candidates. Some responses said that the reflected ray was equal to the incident ray, without mentioning any angles, so these responses did not gain credit. Other responses were too vague, for example 'all angles are equal'.

(ii) Although many candidates could not relate the law of reflection of light as required for **(c)(i)**, they could apply the law in the repositioning of the mirror. It was important that the mirror was positioned so that there was a noticeable angle of incidence that matched the angle of reflection, and the reflected ray was capable of entering the eye.

COMBINED SCIENCE

Paper 0653/41
Extended Theory

Key messages

Those candidates who scored well on this paper:

- Had prepared thoroughly for the examination, paying particular attention to the details of the knowledge and definitions that might be tested as set out in the syllabus.
- Read the questions carefully and understood the importance of key words for example *muscle* in **Question 1(d)(ii)**.
- Ensured that their handwriting was legible enough to allow the Examiner to award as many marks as possible.
- Ensured that they included working and relationships in questions involving calculations and that this was set out clearly enough for partial credit to be awarded where possible.

General comments

Candidates often showed that they had prepared well for most sections of the syllabus and were familiar with the examination techniques required for success. In some cases, low scores were likely the result of inadequate preparation rather than any lack of ability. Evidence for this includes the observation that full credit for answers to advanced questions were seen from candidates right across the final mark range. Further evidence comes from the fact that incorrect answers were often expressed very well and suggested that the candidate probably understood the concept being tested but had not practised how to express answers with the necessary clarity or detail. Candidates' responses to the three Science disciplines were broadly balanced with neither Biology, Chemistry nor Physics standing out as any more problematic. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. There was no evidence that candidates were under any undue time pressure to complete the examination.

Comments on specific questions

Question 1

(a) The majority of candidates gained at least partial credit and many scored full marks. A number of candidates incorrectly thought that they were required to select only one element for each of the chemicals, and so their table contained only four ticks.

(b) Most candidates gained a mark by describing the need to consume more fibre. Credit was not given for references to a balanced diet or lists of food types that either should or should not be consumed. Only a minority of candidates explained their answer by describing how fibre would assist in the movement of food waste through the gut. Although it is understandable why a candidate might use a phrase such as *to make it easier to go to the bathroom*, they should be advised that biological detail is needed in a science examination.

(c) This was answered very well by most candidates. The most common mistake was the substitution of *fatty* by *unhealthy*.

(d) (i) Most candidates realised that the stent opens the artery and so allows blood flow to increase. A small number thought that the stent would itself block the artery thereby stopping blood flow.

(ii) The key word in this question was *muscle*. The majority of candidates answered either in terms of benefits to the body as a whole or made very general statements involving blood pressure or the work that the heart needed to do. Only a very small number discussed respiration in heart muscle cells.

Question 2

(a) (i) Large numbers of candidates gained credit by stating that no reaction would occur. Answers such as *because it would be pointless* were not accepted.

(ii) Most candidates were familiar with the reactivity order of the metals in this question.

(b) (i) Many correct answers were seen. Incorrect responses included *sea salt* or sodium chloride suggesting a limited appreciation of the meaning of the term *salt*.

(ii) This proved to be a challenging question for candidates across the mark-range and only a very small number gained full credit. Two of the most common problems included incorrect or missing state symbols and the incorrect formula, MgC*l*.

(iii) It was not expected that candidates should produce drawings of apparatus correct in every detail although some were able to do this. All that was required was a sketch of apparatus that could collect and potentially measure evolved gas. Many were able to do this and gained partial credit. The question asks for additional apparatus. This was intended to prompt candidates to state that some sort of timing device would also be needed. Very few realised this but some drew a stopwatch which was of course accepted.

(c) (i) Candidates are well-served if they are encouraged to learn important definitions. Not all candidates had learned the definition of mass number. Many stated that the mass number of the element in the question is 37. Although this is true it is not a definition. Others suggested that the mass number is the weight of the atom. Others suggested that mass number is the number of electrons added to the number of neutrons. While this gives the correct numerical result, it is not accepted as the definition of mass number.

(ii) Generally, candidates were very familiar with the process of allocating electrons to electron shells and large numbers gained full credit.

Question 3

(a) (i) Candidates from across the mark-range usually knew that they had to draw a vertical arrow pointing away from the ground. The most accurate answer is the arrow located on the supporting rope approximately the same length as the given force arrow and in the opposite direction.

(ii) Candidates generally appreciated the concept of balanced forces. Many read the question carefully where they learned that the airship was moving and so were led to the correct statement that the airship was moving with constant speed (or constant velocity). The most common answers that did not gain credit were that the airship was stationary or that it was in constant motion.

(b) (i) The great majority of candidates answered this correctly.

(ii) Many candidates had been well-prepared for calculations of this type and gained full credit. Partial credit was awarded to candidates who showed that they knew that an area under the graph in the question had to be calculated. even if they could not work through to the final answer of **210 (m)**.

(c) Large numbers of candidates worked through to the correct result **56 000 (kg)**. Lower-scoring candidates were generally challenged by this calculation but many scored partial credit for stating the relationship *density = mass ⁄ volume* and/or by correctly calculating the volume of the cube to be 8.0 m^3. Quite a large number of candidates were unfamiliar with how the volume of a cube is calculated.

Question 4

(a) (i) Most candidates identified leaf P but they could not be credited unless they also stated that this leaf contained the most chlorophyll. Chloroplasts was accepted as an alternative for chlorophyll. Answers such as *leaf P is the greenest* were not accepted. Some candidates suggested leaf P *because most photosynthesis is occurring where it is green* which does not answer this particular question.

(ii) This important part of the Biology syllabus is often tested and it was clear that some candidates had been very well prepared. Answers to avoid include *light is converted into glucose* and *light is stored in the plant*. The idea that light is used for photosynthesis was accepted as an alternative to the conversion into chemical energy and this allowed a large number of candidates to gain partial credit.

(b) (i) Some candidates wrote perfectly correct equations for photosynthesis while some others suggested the equivalent equation for respiration. Some candidates towards the lower end of the mark range seemed unfamiliar with the form that an equation should take, and sometimes wrote incorrect combinations of words, formulae and energy terms. No credit was available for correct word equations.

(ii) Only a small number of candidates gained full credit here. Some were able to describe the role of phloem vessels in transporting glucose to the roots but did not mention that glucose would be made in the leaves. Some candidates suggested that photosynthesis was occurring in the roots or that the roots drew glucose in from the soil.

Question 5

(a) (i) Candidates are well-served if they are encouraged to learn important definitions. Not all candidates had learned the definition of a hydrocarbon. The most common reasons for loss of credit were to omit the idea that *only* hydrogen and carbon make up hydrocarbons or to suggest that the constituents are carbon and water (or in some cases *hydro*).

(ii) Many correct structural diagrams of ethene were seen from candidates across the mark-range. However, since a dot-and-cross diagram was required these could not be credited. Partial credit was gained where a candidate correctly showed two shared pairs between the carbon atoms or four shared pairs between each hydrogen atom and carbon. The detailed form of the diagram was unimportant provided the shared electrons were clearly and correctly located.

(iii) The bromine test for double bonds seemed to be unfamiliar to candidates across the whole of the mark-range. The sizeable number of blank responses and the wide variety of incorrect ideas suggest that these candidates had not observed the test either in the laboratory or on video. The candidates who had been well-prepared ensured full credit by using the term *colourless* or *decolorised* rather than *clear* when describing the result for the unsaturated hydrocarbon.

(b) (i) This was answered very well by the majority of candidates who either used the term *global warming* or described a consequence of it, often *climate change*. Very few lost credit for the unqualified suggestions that *carbon dioxide is a greenhouse gas* or that *it causes the greenhouse effect*. Each time this question is asked, a small number of candidates will suggest answers such as *carbon dioxide replaces oxygen and so we may suffocate*.

(ii) Very many candidates knew what exothermic meant and some gave perfect answers. The most common reasons for loss of credit included not specifying that it is thermal (heat) energy that is released and, more commonly, not identifying that chemical energy is converted to thermal energy during the reaction.

Question 6

(a) Many candidates gained full credit. Some candidates at the lower end of the mark range included answers such as *sound* or *natural light* in the diagram of the regions of the electromagnetic spectrum. There was no particular pattern in mistaken links although the most common mistake was a link between television transmission and microwaves.

(b) (i) Large numbers of candidates recognised convection. A frequently-seen mistake concerned answers that described the origin of the thermal energy. Suggestions included *the burning of the fuel, exothermic reactions* and *kinetic energy.*

(ii) Some candidates wrote very clear descriptions of the decreased density when gases are heated which causes them to rise. Many candidates lost credit by talking about the balloon rather than the gases inside it. The better candidates avoided suggestions such as *heating the balloon lowers its density*. Another reason for the loss of credit was the discussion of the decreased density of hot particles rather than the hot gases.

(iii) Candidates nearer the higher end of the total mark range gained full credit by describing the increased molecular speed and separation and decreased intermolecular forces. Many other candidates suggested answers involving density which were appropriate for part **(ii)**. The more successful candidates wrote answers that used comparative terms. For example they stated that gas particles move faster when heated rather than simply stating that hot particles move at high speed.

Question 7

(a) (i) Candidates generally were very familiar with this type of question and many fully correct answers were seen. Some may not have understood the significance of the term complete food chain which requires them to select a chain starting with green plants and ending with hawk. Partial credit was awarded if their suggested chain contained four organisms which were a valid section from the web and which had the flow of energy shown correctly. Some lower-scoring candidates suggested organisms that did not occur in the given web. These could not be rewarded even if they were a valid food chain. The great majority of candidates showed energy flowing in the correct direction in their food chains.

(ii) This question was also answered very well. A list of organisms meant that credit was not awarded even if cat and hawk were in the list.

(b) (i) Many candidates suggested *respiration, heat, movement, faeces and urine, not all the cat eaten*. These losses come into effect once the cat is eaten and so apply to the hawk. Many candidates discussed the so-called 10% rule. Candidates should appreciate that the 10% should be thought of as energy which finally becomes biomass, in this case, in the body of the hawk. This means that suggestions such as *the cat uses energy trying to escape the hawk* is not an answer to this question. Many candidates chose two from respiration, heat and movement as ways that energy is lost from the chain. In this case these were considered to be different expressions of the same way that energy is lost and so counted as only one way.

(ii) It was clear that many candidates understood that energy shortage was the reason why the number of trophic levels is limited. They often found it challenging to express their ideas but any reasonable attempt to do so gained the available mark. Some suggested answers such as *because there are not enough larger predators to eat those in the fourth level.* A misconception that some candidates had was that the organisms beyond the fifth level would be the decomposers.

Question 8

(a) (i) Many candidates knew that the sodium bromide needed to be converted into a liquid form. Since this is an electrolysis in the syllabus it was hoped that candidates would remember that lead bromide has to be melted since it is insoluble. However, recall of solubility tables is not required and so answers referring to formation of an aqueous solution were, on this occasion, accepted. Less precise answers such as *add water* were not accepted.

(ii) Many candidates were able to discuss the need for ionic mobility and so gained the mark. Any reasonable implication of the idea was accepted although credit was not given for references to mobile atoms or mobile elements.

(b) (i) Not many candidates were familiar with the term *blast furnace*. No alternatives were accepted. A wide variety of incorrect suggestions were seen including fractional distillation and cracking.

(ii) Many fully correct answers were seen mainly from candidates towards the higher end of the total mark range. A common reason for loss of credit was the omission of the relative reactivity of iron

from the answer. Candidates needed to realise that they had to make statements about the relative reactivities of both metals with respect to carbon. Vague, undeveloped statements such as *calcium is above carbon* could not be rewarded.

(c) (i) Some candidates recognised the transition metals but a variety of incorrect suggestions were also seen, including alkali metals and halogens.

(ii) Most candidates recognised the noble gases.

Question 9

(a) (i) The great majority of candidates gained one mark for their drawing of a switch. Very few were familiar with the other two circuit symbols and so full credit was rarely awarded. The least well-known was the fuse for which the symbol for a fixed resistor was often suggested. The symbol for a thermistor was sometimes given for the variable resistor.

(ii) Most candidates correctly stated that the type of circuit would be parallel.

(iii) Some perfectly correct and neatly drawn circuits were seen from better candidates. A very common reason for loss of credit was omission or misplacement of the fuse. Whatever symbols for a fuse and variable resistor had been suggested in part **(i)** were accepted in the circuit diagram. Most candidates gained at least partial credit for drawing two heater symbols in parallel with the power supply.

(b) A small number of fully correct answers were seen from higher scoring candidates. Candidates who found this question very challenging but who tried to keep their attempts at working well-organised often gained partial credit for individually correct segments of working. Simply stating the key relationship $P = IV$ could have secured at least one mark. Many candidates gained a mark for calculating the total power requirement as 2.5 (kW). Candidates who worked through to show that the maximum current that would be drawn was **10.4 (10.42 or 10.416) A** gained full credit

COMBINED SCIENCE

Paper 0653/42
Extended Theory

Key messages

Those candidates who scored well on this paper:
- had prepared thoroughly for the examination, paying particular attention to the details of the knowledge and definitions that might be tested as set out in the syllabus
- read the questions carefully and understood the importance of key words for example *safely* in **Question 8(d)(ii)**
- ensured that their handwriting was legible enough to allow the examiner to award as many marks as possible
- ensured that they included working and relationships in questions involving calculations and that this was set out clearly enough for partial credit to be awarded where possible.

General comments

Candidates often showed that they had prepared well for most sections of the syllabus and were familiar with the examination techniques required for success. In some cases, low scores were likely the result of inadequate preparation rather than any lack of ability. Evidence for this includes the observation that full credit for answers to advanced questions were seen from candidates right across the final mark range. Further evidence comes from the fact that incorrect answers were often expressed very well and suggested that the candidate probably understood the concept being tested but had not practised how to express answers with the necessary clarity or detail. Candidates' responses to the three Science disciplines were broadly balanced with neither Biology, Chemistry nor Physics standing out as any more problematic. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. There was no evidence that candidates were under any undue time pressure to complete the examination.

Comments on specific questions

Question 1

(a) (i) This phenomenon was familiar to many candidates. Gravitropism was also accepted. The most common mistakes were phototropism and germination.

(ii) A large number of reasonable suggestions were seen which, if correct, would explain why the plumule bends to grow upwards. Full credit was given for the ideas that auxin concentrates on the lower side of the plumule and that auxin encourages cell elongation on the lower side. Candidates needed to be careful in their choice of words and needed to avoid the suggestion that auxin stimulates growth in terms of cell division. Partial credit was awarded whenever possible even if the candidate answered in terms of a phototropic response.

(iii) The idea that auxin has the opposite effect in the root, causing retardation of cell elongation was not very familiar. Many candidates suggested that auxin accumulates on the upper surface of the root causing elongation or extra growth.

(b) (i) Many candidates scored one mark for their description of the shape of the root hair cell. The second mark was not awarded very often since candidates had to refer to increased **rate** of water uptake. Most candidates simply made statements such as *so more water is absorbed* which does not necessarily say anything about rate. Any statements that applied to the root rather than root hair cell did not gain credit. The main examples that were seen of this were the ideas that *the long root hair is able to penetrate a long way into the soil* and *that the long root hair anchors the plant into the soil.*

(ii) Many candidates were familiar with the correct way to explain this phenomenon in terms of the concentration of water, the water concentration gradient or the water potential, and many did this very well. Some candidates discussed transpiration pull but on its own this was not accepted. Some others suggested *because it has a semi-permeable membrane* which is not the answer to this particular question.

(c) The majority of candidates from across the mark-range gained the credit for xylem. The most common mistake was phloem.

Question 2

(a) (i) The question requires a chemical test for water and so those describing the measurement of boiling point could not gain credit. The test involving either anhydrous copper sulfate or cobalt chloride was familiar only to candidates towards the higher end of the total mark range. Some candidates lost credit for specifying copper sulfate solution as the test reagent.

(ii) This proved challenging for many candidates across the mark-range and only a relatively small number gained full credit. Two common reasons for loss of credit were incorrect or missing state symbols and omission of water from the product side.

(b) (i) Many correct structural diagrams of ethene were seen from candidates across the mark-range. However, since a dot-and-cross diagram was required these could not be credited. Partial credit was gained where a candidate correctly showed two shared pairs between the carbon atoms or four shared pairs between each hydrogen atom and carbon. The detailed form of the diagram was unimportant provided the shared electrons were clearly and correctly located.

(ii) Most candidates gained this mark. Those who did not either suggested ionic or left the answer line blank.

(c) Most candidates were familiar with the form of an electronic structure and large numbers gained the mark. Since this was testing the way that electronic structures are presented and only one mark was available, candidates who described the structure in a sentence did not gain credit even if they had made correct statements. A minority of candidates towards the lower end of the mark range substituted atomic structure for electronic structure and gave the numbers of protons, neutrons and electrons in the carbon atom.

Question 3

(a) Only relatively small numbers of candidates recognised component **C** as a fuse, and invariably suggested it was a resistor. This tended to compromise their explanations of the reasons why component **C** was included in the circuit. However, these candidates often made relevant statements and so partial credit was often given. Candidates should be encouraged to think about the reasons for a fuse in terms of current and not potential difference. Many candidates lost credit for referring to protection of the circuit from the voltage rather than from high current.

(b) (i) The equation for Ohm's Law and its use were very familiar to candidates across the mark-range. Full credit for the final answer **15 (Ω)** was very often awarded.

(ii) This calculation was completed very well by many candidates, who set out their working in an organised way and worked through to the final answer **0.5 (A)**. Where working was clear, partial credit was awarded if the relationship $P = V \times I$ could be seen and if the total power consumption was stated to be 120 W. A common mistake occurred in the formula when candidates suggested power was given by either I/V or V/I. In some cases, candidates wrote down more than one formula. These candidates are in danger of losing credit for doing this.

(c) It is possible that some candidates did not read the question carefully enough and assumed that all they had to do was to show how the student could see the lamp. A sizeable number made this mistake. Better candidates drew a neat ray diagram and made their angles of incidence and reflection look approximately equal.

Question 4

(a) The majority of candidates correctly identified trachea, bronchus and bronchiole. Every one of the other parts of the body were suggested with varying frequency, the most common one being oesophagus.

(b) This question was answered quite well by candidates from across the mark-range. The fact that mucus production would increase was very often stated and many candidates correctly suggested that the cilia would be damaged or paralysed. It appeared that the detailed role of cilia was less well known and so full credit tended to be awarded only to candidates nearer the higher end of the total mark range. Candidates should be advised to avoid suggesting that cilia are *killed*. This idea does not gain credit.

(c) The connection between the reduced rate of gaseous exchange and the reduced surface area of the alveoli caused by emphysema was familiar to many candidates. Many candidates stated that the rate of exchange decreases but offered no explanation or just guessed.

(d) (i) Candidates at the high end of the mark range had prepared very well for this question and referred to the coronary arteries rather than simply arteries or blood vessels, and described that these are narrowed or blocked by fat or plaque. Cholesterol was also accepted on this occasion. Not specifying coronary artery remained a common reason for loss of credit. Generally, though, understanding of the term *coronary heart disease* was not correct and many candidates did not gain any credit. Many descriptions of *blackened heart* or the heart *having to work too hard and so we get a heart attack* were all too often seen.

(ii) The majority of candidates gained full credit. Answers that lacked detail such as *poor diet, unbalanced diet* or carelessly worded answers such as *eat more fat* could not be accepted.

Question 5

(a) (i) Most candidates thought that the mass of the conical flask and its contents would decrease. Better answers included an explanation that referred to the evolution of gas and that the gas would escape from the flask. Candidates could still gain full credit even if they named an incorrect gas. Some of the incorrect explanations revealed misconceptions. Some thought that the mass decreases because the magnesium dissolves or the acid becomes diluted. It was apparent that many candidates were unfamiliar with cotton wool and were distracted by its presence in the neck of the conical flask. Some of these candidates argued, with a degree of logic, that the mass would not change because the cotton wool would prevent the gas from leaving the flask. Answers like this gained partial credit.

(ii) This aspect of reaction rate theory is frequently tested and many candidates were well-prepared for it. Some good answers were seen that referred to increased molecular speed and increased collision frequency. The phrase *there will be more collisions* does not gain credit, but other ways of securing the mark include *there will be increased chances of collision* and *there will be increased numbers of effective/reactive/fruitful collisions.* Although the concept of activation energy was not required for this examination, correct statements concerning the concept are credited.

(b) (i) Candidates tended to gain the mark for cathode. Many suggested anode and others gave a material from which the electrode might be made, e.g. copper or carbon.

(ii) Candidates had to be able to distinguish electron transfer processes occurring in ionic bonding from those occurring in ionic discharge. Lower-scoring candidates often confused these processes and described what occurs when chlorine bonds with magnesium.

(iii) Most candidates had learned the chemical formula, $MgCl_2$.

(iv) Redox was accepted in addition to reduction. Invented terms such as *deoxidation* were not accepted. A wide variety of suggestions were seen from candidates towards the lower end of the mark range which suggested they were not at all familiar with processes involved in redox reactions.

Question 6

(a) (i) Most candidates gained the mark for X-rays.

(ii) The most frequently seen correct link was from detecting intruders to infra-red.

(b) Correct answers were seen from candidates throughout the mark-range. Some candidates probably understood the concept being tested but expressed their ideas in ways that could not be credited. Examples include *all waves travel in a vacuum / infra-red comes from the sun and that's in space / infra-red works because it's nothing but light.*

(c) (i) Many candidates correctly described glass as a poor conductor of heat. Some candidates lost credit for answers such as *it's a glass bottle* and *the heat has to get through the glass first*. Others re-phrased the information in the question when they suggested things like *it takes a long time for the heat to penetrate the glass.*

(ii) Some excellent answers were seen mainly from higher-scoring candidates. Unfortunately, many candidates saw this as an example of convection rather than gas expansion due to heating. This often made it difficult to find enough ideas relevant to the context of the question for many marks to be awarded. However, references to increased molecular speed were frequently seen and so partial credit could be given. Correct statements concerning increased gas pressure were allowed as an alternative to the point about increased gas volume.

Question 7

(a) (i) The idea that the sun is the source of energy driving the carbon cycle was relatively unfamiliar. The most common suggestions included *green plants, decomposers* and *fossil fuels.*

(ii) Only a minority of candidates gained this mark. Most candidates suggested *decomposition* or *decay*.

(iii) Candidates towards the higher end of the total mark range tended to gain the mark for identifying process 1, 2 and 4. Candidates very often omitted process 1 suggesting that they do not associate respiration with organisms other than highly visible plants and animals.

(b) (i) Most candidates gained this mark.

(ii) Large numbers of candidates gained the credit for discussion of reduced photosynthesis which means less carbon dioxide being removed from the atmosphere. There was almost no reference to processes continuing to add carbon dioxide. Some candidates became distracted into discussion of environmental issues not all of which had anything to do with carbon dioxide.

(c) Most candidates showed awareness of the connection between sulfur dioxide and acid rain. Many gained full credit and the only mark lost by some good candidates was the result of omitting to state that acid rain is caused when sulfur dioxide reacts with water in the atmosphere. Full credit was lost by candidates who gave a list of environmental issues in which sulfur dioxide might be involved. Candidates discussing breathing issues caused by sulfur dioxide gas gained credit.

Question 8

(a) (i) Candidates usually knew that the group number is the same as the number of outer shell electrons. Their answers needed to state this clearly and so imprecise answers such as *the group number increases when the outer shell electrons increase* did not gain the mark.

(ii) This was generally well-answered. Candidates found many ways to express the idea and all gained credit.

(b) (i) Most candidates' estimates of the melting point of rubidium fell within the limits that candidates should have deduced from the data in the question.

(ii) The majority of candidates gained this mark.

(c) The role of chlorine in water treatment was generally well-known, and candidates usually knew that they had to state that chlorine kills bacteria. The term *germs* is not accepted but microorganisms or viruses were, as was the statement that chlorine sterilises the water.

(d) (i) Very many candidates knew what exothermic meant and some gave perfect answers. The most common reasons for loss of credit included not specifying that it is thermal energy (heat) that is released and, more commonly, not identifying that chemical energy is converted to thermal energy during the reaction.

(ii) The key word in the question is *safely*. Candidates are well-served if they are aware of the danger of adding an alkali metal to acid and so sodium, which was suggested by many candidates, was not accepted. The most popular correct answers were sodium hydroxide, sodium carbonate and sodium oxide.

Question 9

(a) (i) Candidates from across the mark-range usually knew that they had to draw a pair of vertical arrows pointing in opposite directions. The most accurate answer has the arrow representing tension located on the supporting rope and the arrow representing weight vertically below it and approximately the same length.

(ii) Most candidates gained this mark. Candidates should be advised that the preferred answer to this question is *weight*.

(b) (i) The great majority of candidates answered this correctly.

(ii) Many candidates had been well-prepared for calculations of this type and gained full credit. Partial credit was awarded to candidates who showed that they knew that an area under the graph in the question had to be calculated, even if they could not work through to the final answer of **100 (m)**.

(iii) Many candidates worked through to the correct result **13 300 (kg)**. Numbers of significant figures were not marked strictly which allowed more candidates to gain full credit. Partial credit was awarded if candidates stated the relationship *power = work ÷ time.*

(c) Many candidates set out perfectly correct and well-organised calculations working through to the final answer **5125 (kg)**. Partial credit was awarded to candidates who were able to state the relationship *density = mass ÷ volume* and/or convert the volume from dm^3 to m^3.

COMBINED SCIENCE

Paper 0653/43
Extended Theory

Key messages

Those candidates who scored well on this paper:

- Had prepared thoroughly for the examination, paying particular attention to the details of the knowledge and definitions that might be tested as set out in the syllabus.
- Read the questions carefully and understood the importance of phrases such as *Use the information in the diagram to…* .
- Ensured that their handwriting was legible enough to allow the Examiner to award as many marks as possible.
- Ensured that they included working and relationships in questions involving calculations and that this was set out clearly enough for partial credit to be awarded where possible.

General comments

The general performance of candidates sitting this paper showed a marked improvement in comparison with previous years. Candidates often showed that they had prepared well for most sections of the syllabus and were familiar with the examination techniques required for success. In some cases, low scores were likely the result of inadequate preparation rather than any lack of ability. Evidence for this includes the observation that full credit for answers to advanced questions were seen from candidates right across the final mark range. Further evidence comes from the fact that incorrect answers were often expressed very well and suggested that the candidate probably understood the concept being tested but had not learned the best way of expressing their ideas. Candidates' responses to the three Science disciplines were broadly balanced with neither Biology, Chemistry nor Physics standing out as any more problematic. Candidates would be well-served to be encouraged to read through all parts of a multi-part question before starting their answers. This could help to avoid the wrong emphasis in earlier parts of the question. An example of this is in **Questions 7(b)(i)** and **(ii)**, where some candidates had already answered part **(ii)** in their answers to part **(i)** but who did not score the marks for part **(ii)**. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. There was no evidence that candidates were under any undue time pressure to complete the examination.

Comments on specific questions

Question 1

(a) (i) Some candidates wrote perfectly correct equations for photosynthesis and some others suggested the equivalent equation for respiration or hydrocarbon combustion. Some candidates towards the lower end of the mark range seemed to be unfamiliar with the form that an equation should take, and sometimes wrote incorrect combinations of words, formulae and energy terms.

(ii) Many **candidates** realised that trapped air would cause the duckweed to float although they tended to miss the point that floating would ensure good light absorption. Only a minority of candidates gained full credit. The most common misconception was that the trapped air would allow the plant to continue photosynthesising while fully submerged. This is evidence that these candidates may not have read the question introduction carefully enough or that they did not realise that the introduction contained important and relevant information to help them to answer the question.

(b) (i) In part **(i)** of this question candidates needed to focus on describing the results of the experiment. Many included conclusions about the effect of nitrate ions which is the subject of part **(ii)**. Candidates also needed to understand the instruction to *Use the information in Fig. 1.2.* Rather than simply making statements about the final numbers of plants in the two dishes, candidates needed to compare the starting numbers of plants with the final numbers of plants and describe the difference in the *increase*. Any wording that suggested they had attempted to do this gained credit.

(ii) Many candidates found that they had to repeat wording they had already included in part **(i)**. Only a minority of candidates gained the mark here. Many candidates simply made a statement that nitrate ions help with growth for example, *nitrate makes duckweed grow better.* The mark was only given if the wording suggested that nitrate increases the rate of reproduction.

(c) (i) Most candidates answered this question correctly.

(ii) A small number of candidates towards the higher end of the mark range were familiar with processes involved in eutrophication and gained full credit. Partial credit was often gained by candidates who made sensible suggestions about oxygen depletion. Very few referred to valid reasons why oxygen would become depleted, a common misconception being that since underwater plants died they would not be replacing oxygen by photosynthesis.

Question 2

(a) (i) Many candidates were familiar with electrolysis and gained full or partial credit. Common mistakes included labelling the polarity symbol on the low voltage supply rather than the anode itself and reversing the metal and non-metal ions.

(ii) The wording in the question tried to lead candidates away from simple ideas about the direction in which the ions move. Of the candidates that gained credit most correctly described electrons loss and gain but did not make it clear that electrons were gained from an electrode and lost to an electrode.

(b) This proved to be a very challenging question and most candidates did not realise that an alternative form of electrolysis was required. Most looked for completely different methods that might produce sodium.

(c) Only a small number of candidates gained these marks. Coal is not accepted in part **(i)** although carbon is an acceptable alternative to coke. The large number of guesses seen in both parts of **(c)** suggested that most candidates were unfamiliar with iron-making in the blast furnace.

Question 3

(a) (i) The majority of candidates completed the force diagram correctly and showed the vertical force above the drone and acting from a position on or near the drone.

(ii) Most candidates stated that the drone falls when the rotors stop. Full credit required that candidates also described the falling motion as an acceleration.

(iii) The idea that the drone falls as the result of forces becoming unbalanced was familiar to most candidates. They did not have to use the term *unbalanced* and any wording that implied the idea gained the mark, for example *the drone falls because the only force acting is its weight.*

(b) (i) Many candidates were familiar with this type of calculation and many from across the full range of total marks gained full credit, working through to the result **2500 J**. In this question a separate mark was allocated to stating the correct unit and the most common mistake was to suggest newtons.

(ii) Candidates towards the higher end of the total mark range tended to gain full credit provided they specified that the first energy type is *chemical*. The term *potential* alone is accepted when it refers to (*gravitational) potential energy* but is not an alternative for *chemical (potential) energy.* Other candidates appeared to be far less familiar with deducing energy transformation sequences and many guesses and blank spaces were seen.

(c) (i) Many candidates throughout the mark range correctly identified radio waves as electromagnetic. One mistake often seen was to name another part of the electromagnetic spectrum.

(ii) Those candidates familiar with this type of calculation gained full credit by application of the formula and correctly manipulating the data which had been given in standard form. The final answer is **8.6 (m)**. In general, candidates need to be aware of significant figures although in this case the answer 8.57 (m) was accepted but the answer 8.5 (m) was not.

Question 4

(a) Candidates generally found it challenging to recognise, name and state the function of the stigma and the anther. Many candidates gained one or two of the available marks and often it was for recognition of the anthers. A variety of suggested names were seen for both stigma and anthers and although many candidates had learned the roles of these parts of the flower they were often assigned to the incorrect structure.

(b) Most candidates answered this question correctly. A few candidates gave the answer *because they are wind-pollinated*. While an answer like this could mean that the candidate understands the context, they should be aware that they are leaving too much for the Examiner to assume.

(c) Candidates are often asked to give a definition of important terms and ideas. While these parts of the syllabus may be very familiar they are often not so easy to describe. Candidates are well-served if they are encouraged to learn important definitions. This question is a typical example where a candidates' everyday knowledge may obscure the scientific definition required in an examination. Many answers to this question referred to mothers and fathers which in the context of plant biology is unlikely to score full marks. References to zygote were not seen and very few candidates discussed the fusion of contributing cells from male and female.

Question 5

(a) (i) Candidates often showed familiarity with atomic structure. They needed to pay attention to the wording of the question where it asks them to *Use Fig. 5.1 to…*The diagram gives the number of electrons and unless candidates related this to the number of protons they could not score the mark.

(ii) Nearly all candidates answered this question correctly. An error carried forward from part **(i)** was allowed.

(b) (i) Most candidates knew how to interpret the chemical symbol and gained full credit. The two most common mistakes were to suggest that the number of neutrons was seventeen and to take 35.5 from the Periodic Table as the mass number.

(ii) Although the term ion had been emboldened in the question, the majority of candidates who were familiar with this type of atom diagram drew the electronic structure of a chlorine atom.

(iii) Nearly all candidates answered this question well and could explain that the Periodic Table contains only elements. Candidates found many ways to express the ideas and most of these could be accepted. An example of an answer that could not be accepted is *because it is a compound*. In the context of the wording of the question, the ambiguity of this answer could not be given the benefit of the doubt.

(c) In general, candidates were very unfamiliar with the test for chloride ions and only a very small number gained any credit. Common suggestions included the test for chlorine or the use of litmus paper in an acid/base context. Candidates are well-served if they can observe these tests either in the laboratory or alternatively via the internet.

Question 6

(a) The majority of candidates realised that they needed to draw a line that started at –5 °C and which climbed to a higher temperature as time passed. Full credit was gained by those who realised that their line needed to meet the given line and then follow it. It was not required that candidates should show a short horizontal section corresponding to the melting of the ice.

(b) (i) Most candidates from across the full mark-range recognised convection.

(ii) Candidates generally found it challenging to explain why convection occurs. Some simply found new ways to restate the information given in the question and so did not gain credit. An explanation in terms of liquid density differences was given by higher-scoring candidates.

Question 7

(a) (i) The most common mistake was the labelling of the trachea.

(ii) The two common mistakes were to label either the alveoli or a bronchus.

(b) (i) Candidates needed to read and understand the question which asks them to describe features of an alveolus **visible** in the diagram. This question is frequently asked and those candidates who avoid discussing the mechanism of gaseous exchange are more likely to gain credit. Thus, a description of a short diffusion distance gains credit but a discussion of oxygen diffusing from high to low concentration does not. Those reading ahead would see that this idea is tested in the following question. Candidates needed to take care to describe the alveolus **wall** as being one cell thick rather than using phrases such as *the alveolus is one cell thick*.

(ii) Candidates in the upper part of the mark-range tended to gain the credit for a discussion of oxygen concentration gradient. Many other candidates answered in terms of the need for oxygen in the body or gave answers more suited to part **(i)** of this question.

(c) This question was answered well by candidates from across the mark-range. The role of mucus was better understood than that of cilia. Candidates should be advised that term *germs* is not usually accepted as an alternative for pathogens or bacteria.

(d) Candidates usually gained credit for knowing that blood at higher pressure from the left ventricle had to reach greater distances. Only a minority went on to explain that lower pressure blood from the right ventricle needed only to reach the lungs. Several answers did not gain credit because they left too much for the Examiner to assume, for example *for the blood to get to the foot and back* is not linked to either a ventricle or a blood pressure.

Question 8

(a) (i) There were not really any alternatives to the expected answers, coal and natural gas although methane was allowed. Some candidates suggested fractions from oil refining and others apparently had not realised that petroleum and crude oil refer to the same material. The term *carbon* was often suggested, but this term is not an acceptable alternative to either of the allowed answers. Candidates would be well-served to be reminded that the popular use of the term carbon in an environmental context is not an acceptable answer in a Science examination.

(ii) Many candidates gained the mark. Cracking was often suggested and the unqualified term *distillation* is not accepted as an alternative.

(b) (i) Candidates near the upper end of the mark-range were often able to balance the equation and others gained partial credit for knowing the products of combustion. The question was very challenging for candidates in the lower half of the mark-range.

(ii) Most candidates answered this question correctly. Carelessly written or misplaced subscripts sometimes led to loss of the mark. The response $H_{14}C_6$ was accepted.

(iii) Most candidates near the higher end of the total mark range identified hexane and gained credit for explaining that the greater molecular size is linked to higher boiling point. They needed to be very careful in their explanations of increased intermolecular forces of attraction. References to the need to *break stronger bonds* are ambiguous and do not usually gain credit. There was much evidence that candidates probably understood the explanations in terms of increased intermolecular forces and corresponding higher energy demand to cause a change of state, but were not able to express their ideas in a way that gained credit. Most other candidates found this a challenging question.

(c) (i) Some candidates recognised cracking. A wide range of incorrect suggestions were also seen and these included fractional distillation, combustion and reduction.

(ii) Many correct structural diagrams of ethene were seen from candidates across the mark-range. However, since a dot-and-cross diagram was required these could not be credited. Partial credit was gained where a candidate correctly showed two shared pairs between the carbon atoms or four shared pairs between each hydrogen atom and carbon. The detailed form of the diagram was unimportant provided the shared electrons were clearly and correctly located.

Question 9

(a) Many candidates answered this question well and drew neat, accurate circuit diagrams. Candidates generally drew parallel circuits of some kind and most gained at least partial credit for this.

(b) A small number of fully correct answers were seen from higher scoring candidates. Candidates who found this question very challenging but who tried to keep their attempts at working well-organised often gained partial credit for individually correct segments of working. Simply stating the key relationship $P = IV$ could have secured at least one mark. Candidates who worked through to show that the maximum current that would be drawn was **10.4 (10.42 or 10.416) A** gained full credit

(c) Candidates who had learned the frequency range of normal human hearing had no difficulty in gaining full credit and many did. Some candidates made mistakes with units and confused kHz and Hz. Some candidates gained partial credit for suggesting a suitable frequency for the alarm. They went on to discuss in general terms the deterioration in hearing with aging rather than explaining the basis of their actual value.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

Best-fit lines do not necessarily pass through every point and should have an approximately equal distribution of points to either side of the line.

General comments

It was very rare for a candidate not to finish the paper. The standard of writing was high.

Comments on specific questions

Question 1

All candidates recorded a full set of results and most recorded them to the nearest cm^3 as instructed. Plotting of points on the graph was generally carried out accurately. Many curves were forced through the points and there were a few inappropriate straight lines. The reading from the graph was usually well done. Nearly all candidates gave an appropriate safety precaution but not all provided a suitable reason for their stated precaution.

In part **(e)** it was rare to see more than one mark scored. Most candidates stated what should be kept constant and appreciated that the concentration had to be varied. Many did not specify how many concentration readings would be needed and even fewer suggested values of concentration.

Question 2

This experiment required great care in description of solutions and precipitates. Many candidates still do not know that a solid formed when two solutions are added together should be described as a precipitate. It was easier to describe the colours of the precipitates if the test-tubes were placed side by side. Many correct colours were recorded. The effect of excess ammonia solution was seen by most candidates. The term 'clear solution' should be avoided because all solutions should be clear. It is better to describe a solution by its colour or lack of colour.

Correct answers for **(a)(ii)** were rarely seen emphasising that candidates do not appreciate why dilute nitric acid is often used in the tests for chloride and sulfate.

The reactions in part **(b)** worked better than expected with many candidates scoring both marks in **(i)** and identifying iodine in **(ii)**. About half of candidates recognised this reaction as redox or displacement.

Identification of the halides was often correct.

Question 3

It was rare not to see l_0 recorded to the nearest millimetre. Candidates are getting better at explaining how to view scales perpendicularly. A small number a candidates correctly suggested laying the spring alongside the ruler.

Most candidates scored all three marks in part **(b)**.

Generally graphs were plotted well using sensible scales. Some candidate still use awkward scales which usually lead to poor plotting and almost always lead to errors when reading intercepts or calculating gradients. Best-fit straight lines were sometimes wrongly forced through the origin.

Most candidates appreciated that line **D** should start from the same intercept on the l axis and have a larger gradient. A few candidates either showed a smaller gradient or the same gradient.

COMBINED SCIENCE

Paper 0653/52
Practical Test

Key messages

Drawings should not be sketched and should use most of the box provided for the drawing.

General comments

It was very rare for a candidate not to finish the paper. The standard of writing was high.

Comments on specific questions

Question 1

Many drawings were too small. At least half of the box provided should be used for drawings. Details of the centre of the banana was generally well done even when the outer line was poorly drawn. Most candidates scored all three marks for the measurements. A small number of candidates gave the measurements in centimetres. Magnification was usually correct. Sometimes the answer was given as a percentage or as a ratio. Percentage was allowed.

In part **(b)** Fehlings test gave an observable colour and most candidates recognised this as the test for reducing sugars including glucose. Some candidates wrongly concluded the presence of sugars or carbohydrates.

The observation for a positive fat test in **(c)** was well known. A significant number of responses wrongly included a precipitate. Judging by the answers to the Chemistry question it is clear that many candidates do not understand what a precipitate is.

Question 2

The copper(I) oxide turned black in part **(a)** for nearly all candidates. The reaction in part **(b)(i)** worked well. A common loss of one mark was for confusing the filtrate with the residue and vice versa. Occasionally the blue precipitate in **(b)(ii)** was incorrectly described as green or as a milkiness. Candidates still do not seem to realise that a solid formed from the addition of two liquids should be described as a precipitate.

The displacement reaction in **(b)(iii)** worked very well. The description of what happened to the solution and to the solid was not well done and many candidates simply gave a colour change for the overall mixture.

Copper was the most common conclusion in part **(c)(i)**. Iron represented the one incorrect metal that was seen. Most candidates were able to support their conclusion with ‘blue’ evidence. Relatively few were able to provide a worthy second piece of evidence.

The reagents for **(c)(ii)** were well known and of course appeared on the Notes for Qualitative Analysis on the back page of the question paper. Some candidates suggested the use of both silver nitrate and barium nitrate for which they scored a mark. The second mark was then only awarded if the candidates explained how both acids reacted with each of the two reagents.

Question 3

Most candidates recorded d_2 to the nearest millimetre in **(a)(i)** and gained the first mark but often they were very inconsistent with this down the table for which there was no penalty. Consequently both marks in **(a)(ii)** were usually awarded.

Calculation of *a* and *b* was well done with very few errors. Graph plotting was much better than in previous years. Common errors seen were the mis-plotting due to the poor choice of awkward scales and not incorporating the origin (0,0). Many drew very good best-fit straight lines. An approximately equal distribution of points to either side of the line was expected. Some candidates forced their lines through the origin.

Intercepts were read accurately although those who forced their lines through the origin chose not to give zero as an answer. In **3(d)** calculations were good. Most candidates used an appropriate number of significant figures in their answers although this was made easy by the calculation in this part.

Part **(e)** was well answered with most candidates choosing the difficulty in balancing the rule or the lack of uniformity of the loads.

COMBINED SCIENCE

Paper 0653/53
Practical Test

Key messages

Drawings should not be sketched and should use most of the box provided for the drawing.

General comments

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Comments on specific questions

Question 1

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Calculation of *a* and *b* was well done with very few errors. Graph plotting was much better than in previous years. Common errors seen were the mis-plotting due to the poor choice of awkward scales and not incorporating the origin (0,0). Many drew very good best-fit straight lines. An approximately equal distribution of points to either side of the line was expected. Some candidates forced their lines through the origin.

Intercepts were read accurately although those who forced their lines through the origin chose not to give zero as an answer. In **3(d)** calculations were good. Most candidates used an appropriate number of significant figures in their answers although this was made easy by the calculation in this part.

Part **(e)** was well answered with most candidates choosing the difficulty in balancing the rule or the lack of uniformity of the loads.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key messages

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

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was good. The standard of graph drawing was generally high although candidates need to remember that axes need to be linear and covering at least half of the grid. Candidates must read the questions carefully so that they answer what is being asked by the question. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results. Candidates need to ensure that they have good knowledge of identification tests for ions and that they have practised drawing diagrams of apparatus.

Comments on specific questions

Question 1 – Enzyme catalysed reactions

(a) (i) Almost all candidates gained credit for plotting the points. They needed to include the units on the axes labels to be awarded further credit.

(ii) Many candidates gained credit. A clear single line was required; some lines were feathery, very thick or had multiple lines. A small number of candidates connected the points using a ruler.

(b) (i) Whilst most candidates could read the value from their graph correctly to gain credit they also needed to draw the lines on the graph to show how they had arrived at their answer.

(ii) Few candidates gained credit as they described the change in volume of mixture rather than the rate of reaction.

(c) Whilst most candidates could name a safety precaution fewer explained why it should be taken.

(d) Many candidates repeated the experiment as described in **(a)** and so did not gain credit. Control variables scored the most highly. Few cited the number or range of temperatures to be used. Very few appreciated that the graph to be drawn would be different to that in **(a)**.

Question 2 – Identification of Solutions

(a) (i) Many candidates gained credit. Incorrect responses included H as it is a colourless solution and J because it forms a cream precipitate.

(ii) Candidates found this challenging. Many discussed different reactions without reference to the observations in the table.

(iii) Few candidates gained credit. Few appreciated that the identity of the solutions was already known and so carbonate did not need to be eliminated or thought that the silver nitrate was already acidic.

(b) (i) Candidates found it challenging to use the observations in the table to explain their usually correct choice of solutions.

(ii) Safety precautions were well known. Common responses which were not awarded credit included lab coats, tying hair back and standing up.

(iii) Candidates found this challenging. Some repeated the original test and many omitted this question. Stronger candidates gained credit.

(c) (i) Many candidates gained credit, and the most common response was measuring cylinder. Common responses which were not awarded credit included beaker and measuring tube.

(ii) Few candidates gained credit. Many thought it was a control, or that it was omitted in order to find the volume needed without the indicator or to increase accuracy.

(iii) Candidates found this challenging.

Question 3 – Length of a Spring

(a) (i) The vast majority of candidates measured the spring correctly. A few candidates gave 2.8.

(ii) Stronger candidates gained credit. Common non-creditworthy responses included keeping the spring vertical or still or not measuring the loops on the ends.

(b) The majority of candidates gained at least partial credit with many gaining full credit.

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

(ii) The line was drawn well by many candidates. Some thought that the line should go through the origin.

(iii) Many candidates read the intercept correctly. Those that did not start the axes at 0,0 as requested usually did not have an intercept to read. Some candidates attempted an intercept value from a non-linear scale or estimated a value from a line extending out of the grid.

(d) Candidates found this challenging. Stronger candidates were able to assess their values whilst discussing an experimental accuracy value of around 10 per cent.

(e) Candidates found this challenging. The most common line started to the left of the original but had a less steep gradient and so crossed the original or went vertically upwards usually to the right of the original.

Question 4 – Cells

(a) (i) Most candidates gained partial credit with many gaining full credit. Some had feathery outlines and some drew more than one cell. Some drew a plant cell with a cell wall, or had a rectangular or circular cell.

(ii) The majority of candidates correctly labelled the nucleus. Some drew label lines which did not touch the nucleus.

(b) (i) Whilst many candidates measured the cell correctly some recorded the measurement in cm.

(ii) Candidates needed to draw the line on their cell in order to gain credit for the measurement.

(iii) Many calculated the magnification correctly. A significant number inverted the calculation of subtracted the values. Many candidates rounded their calculator value incorrectly.

(c) The fat test was quite well known. Some candidates omitted the water, or described the observation as a milky solution or a white precipitate. Biuret was seen a few times.

Question 5 – Salt preparation

(a) Almost all candidates gained partial credit with some gaining full credit. ABED and ABDE were the most common incorrect responses as many found positioning the filtering step difficult.

(b) Many candidates gained credit. The most common incorrect responses included: when the reaction stops and when it stops changing colour.

(c) Candidates found the diagram very challenging. There were many filter papers with no funnel, or filter paper drawn with holes. The substances also needed to be labelled.

(d) (i) Stronger candidates gained credit. Many thought it was to make more copper sulfate or to complete the reaction.

(ii) Candidates found this very challenging. Many thought it was to help with filtration.

(e) Candidates should ensure that they know the test for copper(II) ions. Dark blue precipitate and blue solution were common incorrect responses. Few included observations for both a small amount and an excess of the reagent.

Question 6 – Energy efficiency

(a) The circuit diagram was often completed correctly. A significant number drew lines through the meters or drew the voltmeter in series.

(b) (i) Current was usually read correctly, voltage was often 2.4. Few candidates gave time to 2 significant figures, most copied the reading and a small number gave 742.

(ii) Most candidates multiplied the values correctly.

(iii) Stronger candidates calculated the kinetic energy correctly but many forgot to include *m* in their calculation or did not square *t*.

(iv) Stronger candidates calculated the efficiency correctly but many omitted to multiply by 100 or inverted the division.

(c) Many candidates stated that energy was ‘lost’, but did not explain how.

(d) Candidates found this challenging. Many described more circuits or repetition, but did not then average the results. Some used invented apparatus, used more accurate stop clocks or used more people to measure.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

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

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of an excellent standard, calculations were well executed and food tests were quite well known. The standard of graph drawing was generally high, although candidates need to remember to include quantities with units on the axes and to draw smooth curves or straight lines with a single line. Candidates need to ensure that they have good knowledge of identification tests for ions. They must read the questions carefully so that they answer what is being asked by the question. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1 – Drawing skills and food tests

(a) (i) Most candidates gained partial credit and many gained full credit. A few candidates drew feathery outlines, did not enlarge the drawing or missed the detail in the centre.

(ii) Many candidates measured the diameter of the banana in the figure correctly although some gave their answer in centimetres. Candidates needed to draw the diameter on their drawing to gain credit for the measurement.

(iii) The majority of candidates calculated the magnification correctly. Some inverted the division or subtracted the values. Rounding was sometimes incorrect.

(b) Whilst many candidates appreciated that this was a test for protein some did not realise that the test was negative.

(c) (i) Most candidates appreciated that this was a sugar test but many did not recall that the test is for reducing sugars. Many knew the correct observation. Heating was often omitted.

(ii) Whilst many could state a safety precaution far fewer could explain why it was needed. Common non-creditworthy responses included lab coat, tying hair back and standing up.

Question 2 – Identification of ions

(a) (i) The test for copper(II) ions was quite well known. Dark blue precipitate and blue solution were common incorrect responses.

(ii) The tests for chloride ions and sulfate ions were not well known. Indicators, sodium hydroxide and ammonia solution were common incorrect responses. Some candidates put a dash, which is not acceptable for "no reaction".

(b) The diagram was well known but the labels were often missing or reversed.

(c) (i) Many candidates gained credit. Non-creditworthy responses included: endothermic, diffusion, neutralisation, reduction, oxidation.

(ii) Few candidates identified the powder correctly. Common incorrect responses included: magnesium, magnesium oxide, magnesium chloride, copper oxide, copper sulfate, cobalt chloride.

(d) Many candidates gained credit. Answers such as it is heated are too vague to be creditworthy.

Question 3 – Mass of a metre rule

(a) (i) Many candidates gained credit but a significant number gave the measurement of one edge or the other, i.e. 88.3 or 87.3.

(ii) Candidates found this very challenging. Many repeated the stem and some omitted the question. Common responses included: at eye level, measure it and using a ruler.

(b) Most candidates calculated the two distances correctly.

(c) (i) Whilst the graph was generally well executed, many did not start the axes at 0,0. Some had non-linear scales or scales which did not cover at least half of the grid. Units were often omitted from the labels on the axes. Some reversed the axes.

(ii) The line was drawn well by many candidates. Some thought that the line should go through the origin.

(iii) Many candidates read the intercept correctly. Those that did not start the axes at 0,0 as requested usually did not have an intercept to read. Some candidates attempted an intercept value from a non-linear scale or estimated a value from a line extending out of the grid.

(d) Most candidates multiplied the values correctly.

(e) Few candidates gained credit. Non-creditworthy responses included: the ruler was not balanced, parallax error on the readings, rounding of values and pivot not being in the centre.

Question 4 – Photosynthesis

(a) Many candidates placed the plant in the dark but some did not include a time. A significant number thought the plant should be boiled in alcohol to destarch it.

(b) Most candidates gained partial credit usually for the correct observation and often for ethanol. Fewer candidates boiled the leaf in water. Very few candidates used a hot water bath.

(c) Candidates found this challenging. Many said to remove the starch. Some discussed fair testing, testing for chlorophyll, to see if starch is needed for photosynthesis and control experiments.

(d) Many candidates gained partial credit for the positive result, stronger candidates gained full credit. The most common error was to label the areas white and green.

Question 5 – Rate of Reaction

(a) Most candidates gained credit. A small number gave the reading on the balance.

(b) (i) Many candidates subtracted the values correctly. Some added all of the values in the column.

(ii) Candidates found this challenging. Some thought the values included the mass of the flask, that not all of the calcium carbonate had reacted, carbon dioxide was lost from the flask or that the values had been rounded to 2 decimal places.

(c) Few candidates gained credit. Many thought that the cotton wool kept the carbon dioxide gas in the flask or that it did not allow oxygen into the flask.

(d) (i) Many candidates plotted the points correctly.

(ii) Many candidates gained credit. Some of the curves were feathery and some had multiple lines.

(e) (i) Stronger candidates gained partial credit for the line but fewer appreciated that twice the amount of acid would result in twice the mass of carbon dioxide being lost.

(ii) Many candidates gained partial credit for the line being steeper and stronger candidates gained full credit.

Question 6 – Speed

(a) (i) Most candidates recorded the times correctly. A small number copied the times into the table.

(ii) Most candidates calculated the average correctly.

(iii) Candidates found this challenging and gave reasons why some of the times may be inaccurate rather than all of them.

(iv) Many candidates gained credit. Non-creditworthy answers included: to get an average or to reduce errors.

(v) Many candidates described the relationship correctly. The most common error was to describe the relationship between height and time.

(b) (i) Many candidates did not appreciate that their answer should account for the time being too large and so many gave reasons such as pressing the button too early or too late without specifying at the start or at the end.

(ii) Very few candidates gained credit. Most included the anomalous result in their calculation rather than ignoring it.

(c) Most candidates gained partial credit with many gaining full credit. A significant number controlled the mass of the ball.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key messages

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

General comments

Candidates from some centres demonstrated good understanding of practical knowledge. The reading of instruments was of an excellent standard but candidates need to consider the number of significant figures required by the readings. Diagrams of apparatus are improving, but care should be taken with drawing connections between the pieces. Undertaking practical prior to the examination helps the candidates to state observations and to interpret and evaluate experimental methods, techniques and results.

Comments on specific questions

Question 1 – Photosynthesis

(a) (i) The majority of candidates recorded the temperature for T_1 correctly but most candidates gave 26 as their answer for T_2.

(ii) Many candidates gave a correct statement but a significant number stated that the number of bubbles would increase without reference to whether this was for an increase or a decrease in temperature. Stronger candidates explained their statement, but many repeated their statement using different wording or included the temperature reference as their explanation.

(iii) Stronger candidates gained credit. Many candidates discussed the lamp. Other common non-creditworthy responses included: type of pondweed, volume of water and temperature.

(b) Most candidates appreciated that the number of bubbles would be less but many gave decreasing temperature as their reason.

(c) (i) The test was quite well known. The most common incorrect responses included relighting a lighted splint, lighting a burnt splint or a lighted splint burning with a larger flame.

(ii) Some candidates found this challenging. Many repeated the stem of the question; speed, effectiveness and efficiency were common responses.

(iii) Many candidates appreciated that the collection vessel needed to be graduated but did not include water in the beaker. There were also many test-tubes, downwards delivery into a measuring cylinder and apparatus which was not airtight.

Question 2 – Rate of reaction

(a) (i) Candidates found this challenging. Many did not use a conical flask or collected the gas in a test-tube or by downwards delivery into a measuring cylinder. Candidates should ensure that the connections which they draw between pieces of apparatus are possible. Some used the apparatus used in question 1. Few candidates labelled the delivery tube.

(ii) The majority of candidates gained credit. Some candidates discussed the formation of a white precipitate.

(b) (i) Most candidates gained full credit.

(ii) Many candidates gained credit. Some drew very thick or feathery lines or joined the points using a ruler.

(iii) Whilst most candidates gave a value commensurate with their line, many did not draw the lines on their graph to show how they obtained their given value.

(c) Many candidates drew a line with a steeper gradient but fewer appreciated that the line should plateau at the same value as the line in **(a)(ii)**. Some candidates drew a less steep line usually plateauing at a smaller volume.

Question 3 – Series and parallel circuits

(a) (i) Many candidates read the scales correctly. Common incorrect responses included 0.19 and 1.8.

(ii) Most candidates multiplied their values in **(a)(i)** correctly.

(iii) Candidates found this very challenging. Incorrect responses included restoring or resetting readings, making sure the earlier reading did not add on to the reading, for accuracy and for safety.

(b) (i) Whilst most candidates multiplied the values correctly, fewer recorded their answers to two significant figures.

(ii) Many candidates added the values correctly although many multiplied the values.

(c) Few candidates gave an observation as their answer. Many discussed a difference in power or current.

(d) Candidates found this very challenging. Some quoted V = IR but did not use the figures and many used R = IV. Of those who discussed current, few also considered potential difference.

Question 4 – Breathing

(a) Candidates found this very challenging. Few considered maximum volume in their answer. Many described the difference in water levels without reference to the practical details.

(b) (i) Most candidates chose the correct sample and discussed the levels of oxygen or carbon dioxide but few explained the reason for this difference. A common non-creditworthy response was “oxygen is breathed in and carbon dioxide is breathed out”.

(ii) The test was quite well known. Weaker candidates used burning splints, litmus or plants.

(c) This was well known. It was common for candidates to either halve or give the same value for the volume of air in each breath.

(d) Most candidates gained at least partial credit usually for measuring pulse rate before and after exercise. Few discussed measuring a pulse for a stated time. Stronger candidates discussed either a large sample size or repetition but few included averaging.

Question 5 – Electrolysis

(a) Most candidates gained at least partial credit. Some thought the inert electrodes were the + and – signs and the aqueous copper chloride the copper coating on the cathode.

(b) (i) Some candidates recalled this test but sometimes did not include bleaching. Many thought electrolysis, and all common gas tests were seen. Some gave the test for chloride ions.

(ii) Stronger candidates gave one of the two observations with fewer giving both. The most common non-creditworthy response was blue solution. White precipitate was quite common.

(c) (i) This was well answered.

(ii) Many candidates calculated the mass correctly.

(iii) Many candidates gained credit for the relationship but fewer included the use of data in their answer.

Question 6 – Specific heat capacity

(a) Many candidates used the correct symbol for a voltmeter, although many had a line running through it, but connected it in series. Some drew it in the power supply.

(b) (i) Stronger candidates gained credit. Some discussed the temperature being higher near the coil but did not discuss equalising the temperature through the water.

(ii) Stronger candidates gained credit. Many thought the power was still switched on.

(c) Many candidates multiplied the values correctly. A common response was 1800.

(d) Rearranging the equation proved to be challenging. All permutations of the numbers were seen.

(e) (i) Candidates found this very challenging. Not enough information in the experiment, values too high or low or misreading meters were all common responses.

(ii) Few candidates gained credit. Removing the heater and stirring were common responses.

(f) Candidates found this very challenging. Answers explaining that the heater was not hot enough, and that 72 °C is below 100 °C were seen quite often.