COMBINED SCIENCE

Paper 0653/11
Core Multiple Choice

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

General comments: Biology

Candidates found **Question 6** and **Question 9** the most difficult. Candidates had the least difficulty with **Question 2**.

Comments on specific questions

Question 1

Candidates found this question difficult with option **B**, nutrition, proving to be a strong distractor.

Question 3

The stronger candidates were distracted by option **C**, indicating that many thought statement 2 about enzymes was incorrect.

Question 4

Candidates found this question difficult. All three distractors were selected almost equally suggesting that many candidates had not learnt the outcomes of the food tests.

Question 5

Candidates also found this question difficult. The strongest distractor for all candidates was option **D**, carbon dioxide and water. This suggests that candidates are confusing respiration and photosynthesis.

Question 6

Candidates seemed very unsure about transpiration and there was evidence to suggest that many were guessing which part of the leaf water evaporates from.

Question 7

Many candidates answered this question correctly. Option **B** proved the strongest distractor suggesting some confusion about which valves open and close when blood leaves the heart.

Question 9

Candidates found this question about hormones quite difficult. Many candidates incorrectly thought that hormones are produced by target organs.

Question 10

Candidates were distracted by option **A** which suggests some confusion about the role of petals.

Question 11

Many candidates answered this question correctly. Option **A**, the ovaries, was the strongest distractor amongst the weaker candidates.

Question 13

Candidates found this question relatively easy. Option **B**, flooding of river valleys, was the strongest distractor.

General comments: Chemistry

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

Comments on specific questions

Question 16

The incorrect **A** and **B** were chosen by candidates more often than the correct answer **D**. Candidates did not understand well enough that covalent bonds are formed between non-metallic elements by sharing electrons.

Question 17

There was evidence of guessing by a large number of candidates. They did not know well enough the products of the electrolysis of molten lead(II) bromide at each electrode.

Question 22

There was evidence of guessing by a large number of candidates. They did not understand well enough the presence of sulfate ions in sulfuric acid and the use of acidified barium nitrate solution in the test for sulfate ions.

Question 24

The incorrect **A** was chosen more often than the correct answer **C**. Candidates did not understand well enough that an alloy is a mixture, not a compound, containing two metallic elements.

Question 25

Many candidates thought that tubes 3 and 4 contained potassium and sodium, not realising that these metals do not sink but float on water.

General comments: Physics

Candidates found **Question 31**, **Question 32**, **Question 35** and especially **Question 34**, particularly taxing.

Comments on specific questions

Question 28

Although it was generally well answered, in this question on average speed a common error was to consider only the final home to Cambridge part of the journey, leading to the incorrect choice of option **C**.

Question 29

Slightly more than half the candidates believed that mass is measured in newtons and weight in kilogrammes.

Question 31

A very large proportion of candidates knew that the greatest amount of work would involve the greater distance, but many opted for the smaller force, perhaps in the belief that it would be more difficult for a smaller force to do work.

Question 32

Although the name of the process of evaporation was well known, it was widely believed that its effect was to increase the temperature of the liquid rather than decrease it.

Question 33

There appeared to be much guessing in response to this question on convection.

Question 34

This question on waves was very badly answered. Almost half of the candidates chose option **C**, which contained the values shown in the diagram, not processing these numbers at all.

Question 35

More than a third of candidates thought that the process indicated in the diagram was partial internal refraction, not reflection. Although some refraction was shown, this was not inside the glass, so was not an internal process.

COMBINED SCIENCE

Paper 0653/12
Core Multiple Choice

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

General comments: Biology

Question 1 was the easiest question on the paper. **Question 3**, **Question 5** and **Question 10** were the most difficult among the Biology questions.

Comments on specific questions

Question 2

Some candidates were distracted by option **D** and had clearly multiplied the length by the magnification instead of dividing it.

Question 3

Many candidates incorrectly selected option **A**. This is a common misconception – enzymes are denatured at high temperatures but not killed.

Question 4

Candidates found this question difficult. All three distractors were selected almost equally suggesting that many candidates had not learnt the outcomes of the food tests.

Question 5

Candidates also found this question difficult. The strongest distractor for all candidates was option **D**, carbon dioxide and water. This suggests that candidates are confusing respiration and photosynthesis.

Question 6

This question did not discriminate well between candidates. Candidates seemed very unsure about transpiration and options **A** and **D** were both strong distractors.

Question 7

Candidates found this question quite difficult. Option **B** proved the strongest distractor suggesting some confusion about which valves open and close when blood leaves the heart.

Question 8

Many candidates answered this question correctly. Options **C** and **D** proved equally strong distractors.

Question 9

Candidates found this question about geotropism quite difficult. Many candidates did not realise that a geotropism involves growth, movement and sensitivity.

Question 10

Candidates also found this question difficult. Few identified that light is not required for germination.

Question 11

Option **A**, the ovaries, was a strong distractor for some candidates.

General comments: Chemistry

Candidates performed very well on **Question 16** and **Question 23**.

Question 20 and **Question 21** proved most difficult for the candidates.

Comments on specific questions

Question 15

There was evidence of guessing by a large number of candidates. They did not understand well enough that when carbon dioxide is bubbled through limewater and when molten lead bromide is electrolysed chemical changes, not physical changes, happen.

Question 16

Candidates understood very well the relationship between the particles in an atom, atomic number and mass number.

Question 20

The incorrect **C** was chosen more often than the correct answer **B**. Candidates did understand that when iron rusts it is oxidised, but they did not understand well enough that when methane burns in air it is oxidised, and that when copper oxide reacts with carbon it is reduced.

Question 21

The incorrect **A** was chosen more often than the correct answer **D**. Candidates did not understand well enough the method used to obtain pure crystals from a reaction mixture, involving both the removal of excess solid metal oxide from the reaction mixture followed by crystallisation from the pure salt solution.

Question 22

An equal number of candidates chose the incorrect **B** and the correct answer **C**. They did not know well enough the test for nitrate ions, and that ammonia gas is produced in this test.

Question 23

Candidates understood very well the relationship between the position of an element in the Periodic Table and the metallic / non-metallic nature of the element.

Question 24

The incorrect **A** was chosen more often than the correct answer **C**. Candidates did not understand well enough that an alloy is a mixture, not a compound, containing two metallic elements.

General comments: Physics

In the physics section, candidates found **Question 29** and **Question 35** particularly taxing.

Comments on specific questions

Question 28

Although it was generally well answered, in this question on average speed a common error was to consider only the final home to Cambridge part of the journey, leading to the incorrect choice of option **C**.

Question 29

Slightly more than half the candidates believed that mass is measured in newtons and weight in kilogrammes.

Question 31

A large proportion of candidates failed to notice here that the car was travelling on a horizontal road, so had constant gravitational energy.

Question 32

The topic of this question was thermal expansion. Possibly as a result of misreading the question, a common choice was option **D**, which involved heating the wrong tube. Another reason might be that these candidates were unaware that one tube could be cooled instead of the other being heated.

Question 35

This question on critical angle was found to be very difficult by many, with all three incorrect options being more popular than the correct one.

Question 40

The most common misconception here was that connecting the second lamp in parallel with the first identical one would result in the first one being brighter than the second, possibly because it was closer to the battery.

COMBINED SCIENCE

Paper 0653/13
Core Multiple Choice

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

General comments: Biology

Candidates performed very well on **Question 1** and **Question 12**. **Question 4** proved the most taxing.

Comments on specific questions

Question 3

Many of the candidates incorrectly selected option **A**. This is a common misconception – enzymes are denatured at high temperatures but not killed.

Question 4

Candidates found this question very difficult. All three distractors were selected almost equally suggesting that many candidates had not learnt the outcomes of the food tests.

Question 5

This question discriminated well between candidates. Some candidates selected option **D**, carbon dioxide and water. This suggests that some candidates are confusing respiration and photosynthesis.

Question 6

Candidates seemed very unsure about transpiration and options **A** and **C** were both strong distractors.

Question 7

Many candidates answered this question correctly. Option **B** proved the strongest distractor suggesting some confusion about which valves open and close when blood leaves the heart.

Question 8

Many candidates also answered this question correctly. Option **C**, the reverse result to the correct answer, proved the strongest distractor.

Question 9

Candidates found this question about geotropism quite difficult. Many candidates did not realise that a geotropism involves growth, movement and sensitivity.

Question 10

Candidates also found this question difficult. Few identified that light is not required for germination.

Question 11

Many candidates answered this question correctly. Option **A**, the ovaries, was the strongest distractor amongst the weaker candidates.

General comments: Chemistry

Candidates performed very well on **Question 16**, **Question 18** and **Question 23**.

Question 24 and **Question 26** proved most difficult for the candidates.

Comments on specific questions

Question 14

The incorrect **A** was chosen more often than the correct answer **D**. Candidates did not understand well enough that in chromatography the spot is placed above the level of the water.

Question 15

Candidates did not understand well enough that when carbon dioxide is bubbled through limewater and when molten lead bromide is electrolysed chemical changes, not physical changes, happen.

Question 20

The incorrect **C** was chosen more often than the correct answer **B**. Candidates did understand that when iron rusts it is oxidised, but they did not understand well enough that when methane burns in air it is oxidised, and that when copper oxide reacts with carbon it is reduced.

Question 21

The incorrect **A** was chosen more often than the correct answer **D**. Candidates did not understand well enough the method used to obtain pure crystals from a reaction mixture, involving both the removal of excess solid metal oxide from the reaction mixture followed by crystallisation.

Question 22

There was evidence of guessing by a large number of candidates. They did not know well enough the test for nitrate ions, and that ammonia gas is produced in this test.

Question 24

The incorrect **A** and **B** were chosen more often than the correct answer **C**. Candidates did not understand well enough that an alloy is a mixture containing two metallic elements.

Question 25

The incorrect **D** was chosen more often than the correct answer **B**. Candidates did not understand well enough the ability of carbon to reduce copper oxide.

Question 26

The incorrect **B** and **C** were chosen more often than the correct answer **A**. Candidates did not know well enough the composition of clean air.

General comments: Physics

The most difficult questions in the physics section were found to be **Question 32**, **Question 33**, **Question 39**, **Question 40** and, especially, **Question 35**.

Comments on specific questions

Question 29

Here a large proportion of candidates believed that mass is measured in newtons and weight in kilogrammes.

Question 32

The topic of this question was thermal expansion. Possibly as a result of misreading the question, a very common choice was option **D**, which involved heating the wrong tube. Another reason might be that these candidates were unaware that one tube could be cooled instead of the other being heated.

Question 33

In this question on transfer of energy thermally it was very widely believed that convection was the process involved, despite the person's hands being at the side of the fire, and the fire being outdoors.

Question 35

This question on critical angle was found to be very difficult by many, with all three incorrect options being much more popular than the correct one.

Question 39

Despite a circuit used to determine resistance being a very standard question topic, there appears to have been much guessing. Option **A**, with both meters in series, was particularly popular with candidates who otherwise scored quite well overall.

Question 40

The most common misconception here was that connecting the second lamp in parallel with the first identical one would result in the first one becoming brighter.

COMBINED SCIENCE

Paper 0653/21
Extended Multiple Choice

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

General comments: Biology

Candidates performed very well on **Question 4** and **Question 12**. **Question 8** gave the candidates the most difficulty.

Comments on specific questions

Question 1

Many candidates answered this question correctly with option **B**, nutrition, proving to be a strong distractor.

Question 2

Most candidates also answered this question correctly. There was some confusion about the role of the cell wall and the cell membrane amongst the weaker candidates.

Question 3

This question discriminated very well between candidates. The weaker candidates were distracted by option **C**, indicating that many thought statement 2 about enzymes was incorrect.

Question 6

This question discriminated well between candidates. The weaker candidates were distracted by option **A** suggested they think that glucose is taken up through the roots.

Question 7

Many candidates answered this question correctly. Option **B** proved the strongest distractor suggesting some confusion about which valves open and close when blood leaves the heart.

Question 8

Candidates found this question more difficult. Many incorrectly selected option **B**, carbon dioxide, as the answer.

Question 9

Many candidates answered this question correctly. Option **D**, where the limewater in both tubes goes cloudy, proved the strongest distractor.

Question 11

This question worked well. Option **A** was the strongest distractor for the weaker candidates suggesting some uncertainty about the waste products passed from fetus to mother.

Question 13

Candidates found this question relatively easy. Option **A**, acid rain, was the strongest distractor.

General comments: Chemistry

Candidates performed very well on **Question 16** and **Question 26**.

Question 23 and **Question 25** proved most difficult for the candidates.

Comments on specific questions

Question 16

Candidates understood well enough how to determine the electronic structure of an atom.

Question 23

The incorrect **B** and **C** were chosen more often than the correct answer **D**. Candidates did not understand well enough the relationship between melting point and physical state at room temperature, and between the number of outer shell electrons and non-metallic character.

Question 24

The incorrect **A** was chosen more often than the correct answer **C**. Candidates did not understand well enough that an alloy is a mixture, not a compound, containing two metallic elements.

Question 25

The incorrect **B** and **C** were chosen more often than the correct answer **A**. Candidates did not understand well enough how to determine the order of reactivity of metals using observations from experiments.

Question 26

Candidates knew well enough the proportions of gases in clean air.

General comments: Physics

The difficult questions in the physics section were found to be **Question 31** and **Question 36**.

Comments on specific questions

Question 29

More than a quarter of the candidates believed that mass is measured in newtons and weight in kilogrammes.

Question 30

This question concerned the extension of two connected springs. A common error was to choose option **B**; this took into account the reduced load, but failed to combine the extensions of the springs.

Question 31

The topic here was energy, and almost half of the stronger candidates gained the mark. A slightly smaller proportion of the weaker ones were able to calculate the kinetic energy, but then failed to realise that this value was also the initial potential energy.

Question 32

Although a very large proportion of candidates knew that the process described was evaporation, it was widely believed that the effect of this was to increase the temperature of the liquid rather than decrease it.

Question 33

A fair number understood the process of convection, but there appeared to be much guessing of the answer by the rest.

Question 35

More than a third of candidates thought that the process indicated in the diagram was partial internal refraction, not reflection. Although some refraction was shown, this was not inside the glass, so was not an internal process.

Question 36

Many weaker candidates did not appreciate that all electromagnetic waves travel at the same speed in a vacuum.

Question 40

The main error was a belief that the current would be 4.0 A.

COMBINED SCIENCE

Paper 0653/22
Extended Multiple Choice

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

General comments: Biology

Candidates performed very well on **Question 1**, **Question 2** and **Question 3**.

Question 4, **Question 9** and **Question 10** gave the candidates the most difficulty.

Comments on specific questions

Question 4

This question worked well. Many weaker candidates incorrectly selected option **A**. This is a common misconception – enzymes are denatured at high temperatures but not killed.

Question 5

This question discriminated well between candidates. Some candidates were distracted by option **A**, suggesting they think that glucose is taken up through the roots.

Question 6

Candidates found this question quite difficult. Option **B** proved the strongest distractor suggesting some confusion about which valves open and close when blood leaves the heart.

Question 7

Many candidates answered this question correctly. Option **D**, where the limewater in both tubes goes cloudy, proved the strongest distractor.

Question 8

This question discriminated well between candidates. A significant number of candidates were distracted by options **A** and **B**, suggesting some uncertainty about the role of mucus.

Question 9

Candidates found this question about auxins difficult. Many candidates selected option **B** – this is where the auxin is made but not where the greatest concentration would be after three days.

Question 10

Only a small proportion of candidates selected the correct answer, suggesting some misconceptions about the movement of substances over the placenta.

Question 11

Many of the candidates knew that white blood cells are affected by HIV.

Question 13

Candidates found this question relatively easy. Option **A**, acid rain, was the strongest distractor.

General comments: Chemistry

Candidates performed very well on **Question 17**, **Question 20** and **Question 26**.

Question 27 proved most difficult for the candidates.

Comments on specific questions

Question 14

Candidates understood well enough how to use chromatography to separate a mixture of colours, but some did not realise that the coloured spot must start above the water level.

Question 16

Candidates understood well enough how to determine the electronic structures of atoms and ions.

Question 17

Candidates understood well enough how to determine the formula of an ionic compound using the charges of the ions it contains.

Question 20

Candidates understood well enough the factors that affect the rate of a chemical reaction.

Question 26

Candidates knew well enough the proportions of gases in clean air.

Question 27

Candidates did not understand well enough that the strength of covalent bonds between atoms does not affect the boiling point of a compound.

General comments: Physics

The difficult questions in the physics section were found to be **Question 35**, **Question 40** and **Question 33**.

Comments on specific questions

Question 30

This question concerned the extension of two connected springs. A common error was to choose option **B**; this took into account the reduced load, but failed to combine the extensions of the springs.

Question 31

The topic here was energy, and a large proportion of the stronger candidates gained the mark. A considerable number of candidates were able to calculate the kinetic energy, but then failed to realise that this value was also the initial potential energy.

Question 33

In this question on thermal radiation, the incorrect option **B** was far more popular than any other, even for able candidates. They were apparently not aware that the same type of surface is both a better absorber and a better emitter.

Question 35

Many candidates seemed to resort to guessing the answer to this question on critical angle.

Question 40

Strong candidates performed well in this electrical question, but other candidates had to guess here again.

COMBINED SCIENCE

Paper 0653/23
Extended Multiple Choice

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

General comments: Biology

Candidates performed very well on **Question 1**and **Question 4**.

Question 3, **Question 6** and **Question 9** gave the candidates the most difficulty.

Comments on specific questions

Question 2

Most candidates answered this question correctly although some were unsure of the role of the cell membrane.

Question 3

Many of the stronger candidates selected amylase activity as the label for X.

Question 5

Many candidates answered this question correctly. Option **A** was the strongest distractor.

Question 6

Some candidates were distracted by option **A**, suggesting they think that glucose is taken up through the roots.

Question 7

Many candidates answered this question correctly. Option **B** proved the strongest distractor suggesting some confusion about which valves open and close when blood leaves the heart.

Question 8

Many candidates answered this question correctly. Option **D**, where the limewater in both tubes goes cloudy, proved the strongest distractor.

Question 9

Candidates found this question quite difficult, although it did discriminate well between them. Some candidates were distracted by option **C**, nicotine.

Question 10

Most candidates knew the flower was pollinated by insects but fewer were able to correctly identify part Q as the stigma.

Question 11

The majority of candidates knew that white blood cells are affected by HIV.

Question 13

Candidates found this question quite difficult. Option **A**, acid rain, was the strongest distractor for the weaker candidates.

General comments: Chemistry

Candidates performed very well on **Question 17** and **Question 19**.

Question 15, **Question 16**, **Question 22**, **Question 24** and **Question 27** proved most difficult for the candidates.

Comments on specific questions

Question 15

The incorrect **C** was chosen more often than the correct answer, **A**. Candidates did not understand well enough that simple ions and noble gases have the same electronic structures.

Question 16

The incorrect **A** was chosen more often than the correct answer, **D**. Candidates did not understand well enough the multiple bonding in a molecule of nitrogen.

Question 17

Candidates understood well enough how to determine the formula of an ionic compound using the charges of the ions it contains.

Question 19

Candidates understood well enough exothermic reactions.

Question 20

Candidates knew well enough the apparatus that is needed to investigate the rate of a reaction.

Question 22

Candidates did not understand well enough how to make a salt in a chemical reaction.

Question 24

The incorrect **A** was chosen more often than the correct answer, **C**. Candidates did not understand well enough that an alloy is a mixture, not a compound, containing two metallic elements.

Question 27

The incorrect **B** was chosen more often than the correct answer, **C**. Candidates did not know well enough the effect that ethene, an alkene, has on bromine.

General comments: Physics

Several questions in the physics section were found to be very difficult, particularly **Questions 31**, **33**, **38** and **39**.

Comments on specific questions

Question 29

Here a significant number of candidates believed that mass is measured in newtons and weight in kilogrammes.

Question 30

This question concerned the extension of two connected springs. A common error for candidates was to choose option **B**; this took into account the reduced load, but failed to combine the extensions of the springs.

Question 31

The topic here was energy, and there was evidence of widespread guessing.

Question 33

A large majority of candidates of all abilities believed that both a melting solid and a boiling liquid would increase in temperature.

Question 35

There was much confusion about convection among all but the most able.

Question 36

The topic here was the electromagnetic spectrum; most knew the position of X-rays, but many confused visible light with microwaves.

Question 38

Guessing also showed in the responses to this question about factors affecting resistance.

Question 39

The popularity of option **C** here shows that many candidates failed to take account of both the unit of current and the unit of time, simply multiplying together the three values given.

COMBINED SCIENCE

Paper 0653/31
Paper 3 (Core)

Key Messages

- Attempt **all** questions.
- Read the information provided in the stem of the question carefully.
- Do not attempt to write formulae in a word equation.
- Energy cannot be created or used up, just changed from one form into another.

General Comments

There was a wide range of scripts submitted by candidates, showing some good examples of examination technique. Some candidates had prepared well for the examination, and had mastered all areas of the syllabus. Other candidates would have improved their performance if they were more familiar with the syllabus. Some questions ask for definitions, or direct recall from the syllabus. Candidates who are familiar with the syllabus can obtain these marks relatively easily.

Candidates generally made good use of the available space. There were fewer examples of the question being repeated in the answer. A few candidates would benefit from clearer handwriting. Illegible handwriting of key words to an answer meant that some candidates lost marks unnecessarily.

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

Comments on specific questions

Question 1

(a) Many candidates showed a good understanding about flowering plants in their responses to this question. The most common misconception was to indicate that oxygen is needed for photosynthesis, rather than being produced during the process.

(b) (i) The features of a flower for attracting insects were generally well known, and many candidates took the opportunity to include features such as scent and colour of the petals which are not visible in the diagram. Responses referring to the anthers and stigmas were not credited. Candidates should be aware that attraction of insects enables pollen to be collected from the anthers by the insects' bodies, and later deposited on the stigmas.

(ii) Candidates had to compare the two flowers and comment on the differences of the stamens between them. Many did this successfully. Other candidates compared the stigmas of the two flowers. Candidates are reminded that the stamens, consisting of anther and filament, are the male reproductive organs.

(c) The inability of pollen to fall off the anthers and land on the stigma is shown by flower **2**, and many candidates successfully described this feature. Some candidates responded by describing how flower **1** was more likely to have self-pollination so did not score. Others described the role of insects in the pollination process, though this had been discounted in the stem. Candidates are reminded to read the stem of the question carefully.

Question 2

(a) (i) Most candidates successfully named the covalent bond.

(ii) Many candidates successfully responded that non-metals form covalent bonds. Incorrect answers included *hydrocarbons*, *carbon and hydrogen* and *gases*.

(b) (i) The word equation was successfully given by many of the higher-scoring candidates who knew that combustion reactions use oxygen as a reactant, and produce carbon dioxide and water. Candidates should read the stem carefully and just provide the words of the chemicals involved, not the formulae.

(ii) Candidates found this question challenging. Correct responses had to refer to energy changes, and many did not refer to the thermal energy produced when methane is burned.

(c) (i) The correct answer of natural gas was given by many candidates. Incorrect responses included the products of refineries, such as petrol.

(ii) Two further fossil fuels, as stated in the syllabus, were known by many candidates across the ability range.

(d) (i) Fractional distillation was correctly identified by many candidates. Candidates are reminded that this is a special kind of distillation, so *distillation* on its own did not score.

(ii) The portability of bottled refinery gas makes it suitable for cooking and heating where there is no other fuel source, for example when camping. Many candidates were able to give one of these uses.

Question 3

(a) (i) Most candidates could identify the four forces acting on the surf board.

(ii) Many candidates found this question challenging and provided many incorrect reasons explaining why they thought the forces should be different. Forces **A** and **C** must be the same, otherwise they would not be balanced, and there would be net movement, either upwards or downwards.

(iii) It was widely understood by candidates that the driving force must be increased to provide the unbalanced forces needed for acceleration.

(b) The stronger answers showed a successful conversion of the units to give the correct answer. Both the distance and the time units had to be converted. Incorrect responses included many who converted kilometres to metres, but did not change the hours to seconds correctly.

(c) (i) The correct answers of force and distance were correctly given by many candidates. The most common incorrect answer was *time*, needed in power calculations, but not required to calculate the work done.

(ii) Most candidates successfully responded by stating kinetic energy. Incorrect responses included *renewable* and *wind* energy.

(iii) Candidates had to suggest where the kinetic energy had gone. Many of those candidates who knew that the energy had to be transformed into another form stated incorrectly that the energy had changed into potential energy. There were many misconceptions about energy stated in responses. These included *the energy was all used up* and *kinetic energy stops*.

Question 4

(a) The majority of candidates successfully defined *herbivore* and *carnivore*. A common misconception was shown by candidates who included plants in the carnivore's diet, and animals in the herbivore's diet. Some candidates used the term *organism* instead of 'animal' in their definitions of carnivores. Candidates should be aware that the term *organism* includes plants.

(b) (i) Most candidates correctly stated light as one of the conditions needed for photosynthesis. Fewer mentioned the need for enough carbon dioxide to be present. Although not on the syllabus, those candidates who stated temperature were awarded credit.

(ii) There were several alternative food chains available from the food web. Most candidates knew the structure of a food web, and selected organisms from the diagram. A few candidates invented their own food chains using different organisms. Careful reading of the stem was required here to avoid this. Candidates should be aware that a food chain starts with a producer, and ends with the top consumer, in this case the seagull. Several candidates omitted the producer at the start of their food chain. Others omitted the top consumer.

(iii) This question was answered successfully by a large range of candidates who understood the interdependence of the organisms shown in the food web.

Question 5

(a) (i) The gas carbon dioxide was correctly stated by many candidates. Incorrect responses included the gases hydrogen and nitrogen. Some candidates correctly named the salt, copper sulfate. Incorrect names for the salt included copper nitrate, copper chloride and just copper. Candidates are reminded that the name of the salt produced in this type of reaction depends on the acid used, in this case a sulfate produced from sulfuric acid.

(ii) This question required an indication of the direction of change of the pH number of the reaction mixture. The reaction of an acid with a metal carbonate is an example of a neutralisation reaction, so the pH should increase. Incorrect responses included a pH number instead of a trend, or the change from acid to alkali pH values.

(b) Many candidates gave good explanations in response to this question, indicating that one or more of the reactants had run out. Some incorrect responses stated that there was no more gas being produced, or that the reaction was over. Candidates should be careful not to repeat information in the question in another form.

(c) Candidates had to use their knowledge about rate of reaction to suggest a change to speed up the reaction. Many candidates successfully did this by suggesting the use of heat to increase the temperature of the reactants. Some candidates did not appreciate that the decreased time required a faster rate of reaction, so some responses indicated methods of slowing down the reaction. There were many responses which suggested incorrectly that the amounts of reactants should be changed. Careful reading of the stem shows that these responses were not allowed.

(d) (i) Many candidates used the formula correctly to find the number of elements and the number of atoms contained in sulphuric acid.

(ii) Only a few candidates recalled the test for sulfate ions correctly. Incorrect responses included the use of limewater, or aqueous sodium hydroxide.

Question 6

(a) (i) Thermal energy transfer by radiation was the key to this question. Several candidates correctly stated that energy was transferred by radiation. Fewer mentioned infra-red radiation, the part of the electromagnetic spectrum for transferring thermal energy. The most common incorrect answer for thermal energy transfer was *by ultra violet rays.* The response *by rays from the Sun*, written by many candidates, did not show enough knowledge about thermal energy transfer by radiation.

(ii) Most candidates correctly described the large difference in temperatures between the man's feet and the colder water. Fewer responses described the thermal energy transfer from the man's feet to the water, which would have gained more credit.

(iii) An understanding of the molecular process of evaporation was required to complete the sentences of this question. The key point to understand was that the molecules at the surface of a liquid have a range of kinetic energies, and the more energetic molecules are able to escape, leaving the remaining molecules with less overall kinetic energy, therefore cooling the liquid. Candidates found this question challenging, though many did state that the remaining water on the man's feet was at a lower temperature, therefore obtaining some credit.

(b) (i) Candidates had to apply their knowledge of refraction in this question. The ray would be refracted away from the normal since it was coming from a more dense to a less dense medium. Many candidates successfully drew a possible ray and therefore identified where the fish might be. Candidates are reminded that the refracted ray should be continuous, even though it is refracted, to gain credit.

(ii) Candidates across the ability range stated refraction as the correct answer. Scientific terms should be spelled as accurately as possible. The spelling of the term *refraction* has similarities to the term *reflection*. Therefore, the spellings *reflaction* or *refrection* were not acceptable.

(c) Many candidates wrote microwaves in their correct place in the electromagnetic spectrum. Candidates are advised to write microwaves in one of the empty spaces of the electromagnetic spectrum, even if they are unsure of the exact position. Several candidates did not attempt this question.

Question 7

(a) Many candidates successfully supplied the two missing nutrient groups needed for this question. A common mistake was to supply the names of two foods, which could be added to the list given in the table. Candidates should be aware of the difference between the nutrients needed for a balanced diet, such as fat, carbohydrate and protein, and examples of foods which contain these nutrients.

(b) Stronger answers showed successful calculations of the amount of energy supplied by the eggs. These candidates used the information in the table, and in the stem of the question, to calculate the energy provided by 100 grams of eggs. Some weaker answers added the kilojoules of energy in one gram of fat, carbohydrate and protein, without taking into account the number of grams of each nutrient in the eggs.

(c) (i) The syllabus and the question both require the word equation for respiration, so candidates should only provide words in their answers. There is a danger that formulae may be written incorrectly, and marks lost when candidates could have successfully given the answer in words.

(ii) The transport of oxygen in the red blood cells was known by candidates across the range of ability. Fewer candidates mentioned the role of haemoglobin in this process. Incorrect responses included descriptions of the path taken by oxygenated blood, and of uptake of oxygen at the lungs.

(d) Many candidates had a good knowledge of the regions of the alimentary canal where chemical digestion takes place. The most frequent incorrect answer given was the *large intestine*. Other candidates wrote *salivary glands* and *pancreas*. Though both of these produce enzymes, the enzymes are secreted from the gland into the areas of the alimentary canal where chemical digestion takes place.

Question 8

(a) (i) Some candidates knew that the collection of metals referred to in the question is the transition elements. Many others incorrectly responded with a list of metals near copper in the periodic table.

(ii) Few candidates identified copper oxide as the substance being reduced in this question. Candidates should be aware that the removal of oxygen is the definition of reduction required by the syllabus. Therefore, copper oxide is being reduced to copper.

(iii) The focus of this question was to identify which properties of metals are important for the particular application described. In this case the ductility, the ability of the metal to form wires, was the considered one of the most important properties. The high melting point was also accepted with

this property being a safety feature when electric cables are in danger of overheating. Other features, though correct, were not accepted as the most important for the purpose. These included the property of copper being a good conductor of heat, and any consideration of cost.

(iv) In this question, the most important property was the unreactive nature of copper when compared with iron. Many candidates gained credit for their responses, which included the tendency of iron to rust.

(v) Many candidates successfully explained that alloys often make metals harder. This property makes the coins more durable, therefore lasting longer.

(b) Knowledge of the reactivity series of metals was needed for the correct response to this question. Most candidates identified magnesium as the most reactive metal. Some candidates incorrectly gave carbon dioxide as the gas produced. Candidates should bear in mind the elements in the reactants when naming the products of a reaction.

Question 9

(a) (i) Most candidates correctly wrote the names of two metals which conduct electricity.

(ii) The examples of poor conductors stated by successful candidates were common materials such as glass and plastic. Candidates who did not score chose elements such as gold and silver, which they knew are unreactive, but being metals, they are good conductors of electricity.

(iii) The term *insulator*, required for the mark, was known by some candidates. Many gave the term ‘non-conductors’, others ‘non-metals’.

(b) Explaining the presence of a resistor in the circuit was challenging for most candidates. The idea needed for the mark was to limit the current to protect the circuit, and some candidates explained this well. Others compared the resistor to a variable resistor, and indicated that the current could be varied. Some candidates used phrases such as ‘to limit the electricity’ without mentioning current and these responses did not gain credit.

(c) (i) The addition of the voltmeter to the circuit was done successfully by many candidates. Other responses lost credit because although their voltmeter was drawn in parallel to the circuit, it was not across the correct component. Candidates are reminded that there is no wire running through the centre of the voltmeter.

(ii) Most candidates successfully did the Ohm’s Law calculation, and provided the correct unit. The most common errors resulted from the incorrect recollection of the formula. Some candidates did not know the correct unit for resistance, the ohm (Ω).

COMBINED SCIENCE

Paper 0653/32
Core Theory

Key Messages

- Attempt **all** questions.
- Read the information provided in the stem of the question carefully.
- Do not attempt to write formulae in a word equation.
- Use a ruler for drawing straight lines in diagrams.

General Comments

There was a wide range of scripts submitted by candidates, showing some good examples of examination technique. Some candidates had prepared well for the examination, and had mastered all areas of the syllabus. Other candidates would have improved their performance if they were more familiar with the syllabus. Some questions ask for definitions, or direct recall from the syllabus. Candidates who are familiar with the syllabus can obtain these marks relatively easily.

Candidates generally made good use of the available space. There were fewer examples of the question being repeated in the answer. A few candidates would benefit from clearer handwriting. Illegible handwriting of key words to an answer meant that some candidates lost marks unnecessarily.

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

Comments on specific questions

Question 1

(a) This question was answered well, and many candidates scored most of the available marks. The most frequently-chosen incorrect response was *Enzymes are used up during reactions*. Candidates are reminded that one of the features of a catalyst is that it remains unchanged at the end of the reaction.

(b) The idea of large food molecules being broken down into small molecules for absorption was described well in stronger answers. Correct responses described these changes in the size of the molecules. Candidates who just referred to breaking down food did not score because this response could refer to mechanical digestion, and did not focus on the food molecules.

(c) Most candidates correctly identified starch as one of the larger molecules consisting of many glucose molecules joined together. Fewer candidates gave glycogen as their second response. Candidates should be aware that the glycogen molecule, found in animals, is made up from glucose molecules.

(d) (i) The Benedict's test for reducing sugar was well known by many candidates. Some of those who did not score described the test for starch using iodine.

(ii) The stronger answers correctly stated that at 80 °C all activity of the enzyme is lost. This is due to the enzyme molecules being destroyed, or denatured. Weaker responses incorrectly described the rate of reaction increasing due to the higher temperature, a conclusion which disregarded the effect of high temperatures on the protein molecules.

(e) Many candidates correctly identified light and chlorophyll as the conditions necessary for photosynthesis. The stem of the question describes the raw materials for photosynthesis. Careful reading by the candidates shows that raw materials are not the conditions required by the question. Many candidates incorrectly chose water as one of the conditions. Though not on the syllabus, a *suitable temperature* was given credit as one of the conditions, but just *temperature* was not a detailed enough response.

Question 2

(a) (i) Many candidates correctly interpreted the information to produce the list of the three Group I metals in the order of reactivity. Many candidates wrote the names of metals which are not in Group I, and may have confused the information with the reactivity series. Candidates are reminded to read the stem of the question carefully.

(ii) The production of hydrogen when Group I metals react with water was widely known by many candidates. The most frequent incorrect answer stated that carbon dioxide was produced. Candidates should consider the elements present in the reactants before answering the question.

(iii) Some candidates knew that if red litmus turns blue, then blue litmus would remain unchanged. Many candidates correctly wrote that the red litmus turns blue, but then stated that the blue litmus turns red. Candidates would be helped by the knowledge that litmus is always blue in alkaline solutions, red in acidic solutions, and the colour of the litmus paper used at the start is not important.

(b) (i) Knowledge of the reactivity series of metals was important for this question, and many of the candidates successfully gave magnesium as their answer.

(ii) The unreactive nature of copper was correctly identified by many candidates who wrote copper as the metal that did not react at all.

(iii) The high reactivity of Group I metals is the most important fact to help in answering this question. Some candidates used their knowledge of the characteristics of the group to state that the addition of Group I metals is far too dangerous to do. Other candidates, who understood that the Group I metals were the same metals as shown in **(a)(i)**, could speculate that the reaction with acids would be much more violent with water.

(c) (i) The candidates had to make a judgement about which particular property was most appropriate for the function described. In this case, it was the tendency of iron to rust, and for the alloy not to rust which was the most important when in contact with food. Other properties, such as strength of the alloys, were not judged to be the most important in this question.

(ii) In this example of using a copper alloy for coins, the strength of the alloy was important to improve the durability of the coins. Many candidates correctly explained this. The lack of rusting of the alloy was not considered important here because copper metal is also unreactive.

Question 3

(a) (i) Most candidates correctly identified the four forces acting on the aircraft.

(ii) The higher scoring candidates knew that for an object to keep at the same height the forces must be balanced. Candidates who stated incorrectly that the forces are different did not appreciate that any difference in value of the two forces would make them unbalanced and the plane would move either upwards or downwards.

(iii) The knowledge that unbalanced forces would result in changes to the speed or height of the aircraft was essential for this question. Candidates across the ability range understood this and answered the question successfully.

(b) (i) The stronger answers successfully converted the units to give the correct answer. Both the distance and the time units had to be converted. Incorrect responses included many who converted kilometres to metres, but did not change the hours to seconds correctly.

(ii) A clear calculation was essential for this question which was successfully tackled by candidates across the full range. They approached this calculation in different ways, including the most straightforward division of the distance by the speed, 2700/600.

(c) The stem of the question indicated that changes in kinetic energy and gravitational potential energy should be described. Many candidates found this challenging. Candidates had to state that both the kinetic energy and the gravitational potential energy had decreased. Some candidates gave their answers in terms of the forces that had changed. Others made incorrect statements about energy. These statements included *energy is used up*, *less kinetic energy is taking place* and *energy slows down*.

(d) Most candidates successfully drew the appropriate graph, with lines showing acceleration, constant speed, and deceleration. Credit was lost when some candidates did not finish their graphs at 0. Other candidates lost marks where the line intended to show constant speed had a noticeable gradient, or was carelessly drawn showing a wavy line indicating a varying speed. The use of a ruler is essential in this diagram.

Question 4

(a) (i) A simple description of valve **A** closing and valve **B** opening was what was required in this question. Some candidates answered this correctly. Others described parts of the heart cycle without reference to the heart valves, so did not score. Candidates should be aware of the passive action of heart valves. They do not contract to pump blood themselves. They respond to the pressure of blood inside the chambers of the heart to open or close accordingly.

(ii) The need for the blood to travel in one direction through the heart was the important point here. If candidates are unfamiliar with the need to have valves **A** and **B** in the heart, they could use their knowledge of the function of valves in the veins. Valves prevent backflow of blood, thereby ensuring that the blood flows in one direction.

(b) (i) A specific example of a situation where adrenaline is rapidly secreted was needed to score in this question. Therefore, general statements such as *any fight or flight situation* were not acceptable. Since a sudden increase in adrenaline was asked for, just *exercising* on its own was not accepted, but the beginning of a race, when the adrenaline secretion increases, was acceptable.

(ii) Very few candidates knew that adrenaline is broken down by the liver and therefore made inactive. Candidates should be familiar with the contents of the syllabus as part of their preparation for this examination.

(c) Most candidates correctly described the role of the red blood cells in transporting oxygen around the body. Fewer were familiar with the plasma, the liquid component which transports dissolved substances and cells around the body. Many candidates incorrectly described the function of platelets, the small cell fragments involved in clotting of the blood.

Question 5

(a) (i) Fractional distillation was correctly identified by many candidates. Candidates are reminded that this is a special kind of distillation, so *distillation* on its own did not score.

(ii) The important point to be made in answers to this question was that no new substance is made during fractional distillation, so the process does not involve a chemical change. The separation is done purely on boiling point, a physical property of the compounds in the mixture.

(iii) The portability of bottled refinery gas makes it suitable for cooking and heating where there is no other fuel source, for example when camping. Many candidates were able to give one of these uses.

(b) (i) Several candidates knew methane, the main component of natural gas. Frequent incorrect answers were *carbon hydroxide* or *carbon hydrogen*, presumably attempts to state hydrocarbon.

(ii) Many candidates used the formula correctly to find the number of elements and the number of atoms contained in methane.

(iii) This question was answered well by candidates of all abilities who added their responses to the given diagram to produce the correct formula. Incorrect formulae included hydrogen atoms with two or more bonds, or a carbon atom connected to the four hydrogen atoms in a line.

(c) The stem of the question named two out of the three fossil fuels mentioned in the syllabus. The candidates therefore had to supply coal as the third one. Many candidates did this and scored credit. Incorrect responses included the naming of fuels resulting from the fractional distillation, for example diesel and kerosene.

Question 6

(a) (i) Candidates found this question challenging. The mention of thermal energy transfer from the air inside the aircraft led some candidates to think about convection. Correct responses showed understanding that energy was being transferred from the air inside the aircraft through the solid material making up the wall of the aircraft. Therefore the method of heat transfer was conduction.

(ii) Those candidates who realised that the question was about insulating against heat loss gained credit in this question. Some responses were advising the shape of the aircraft to be more streamlined. This would reduce air resistance and save heat energy lost by friction with the air, not thermal energy transferred through the walls of the aircraft.

(b) (i) Candidates who read the stem of the question carefully knew that the exhaust from the engine was in gaseous form. Therefore, the arrangement of molecules in diagram **Z** was the correct response to this question.

(ii) Those candidates who understood the description of the exhaust gases in **(b)(i)** knew what the white trails might be made of carbon dioxide and water. Very few candidates referred to the very cold temperature of -55 °C outside the plane. This temperature changes the water in the trails to ice, so this was a more accurate answer to explain the white trails. Incorrect responses included *smoke*, and *unburned fuel*.

(c) Many candidates wrote microwaves and radio waves in their correct places in the electromagnetic spectrum and therefore gained full credit. Candidates are advised to write microwaves and radio waves in empty spaces of the electromagnetic spectrum, even if they are unsure of the exact position. There were some scripts with no response to this question.

(d) Some candidates successfully stated that a low frequency sound has a low pitch, and a loud sound has a high amplitude. Incorrect answers included those with the low and high responses the wrong way around.

Question 7

(a) (i) Generally, the stronger responses successfully stated that the supply of oxygen is needed by the fish for respiration, the release of energy in their cells. There were many answers that were too vague and therefore did not score. Examples of these answers are *all living things breathe in oxygen*, *living things need oxygen to stay alive*, and *the fish need oxygen to survive*. Candidates should be aware that after the oxygen enters the bodies of the fish, it is used for respiration. This process releases the energy that the fish needs to survive or stay alive.

(ii) Diffusion was the answer needed here. Although in a different context from diffusion into and out of cells, or gaseous exchange at the lungs, the stem of the question describes the difference in concentration of oxygen between the air and the water. Many candidates correctly applied their knowledge of diffusion to a new situation and gained credit.

(iii) The majority of candidates identified either the water plants or the algae as another source of oxygen for the fish. The production of oxygen as a waste product of photosynthesis was the reasoning behind the candidates' correct answers. Any candidates who stated small animals were not awarded credit, since these would take oxygen from the water, similar to the fish.

(b) (i) The feeding relationships described by the stem had to be placed in a food web, some of which was provided. Stronger responses showed this done correctly, and so gained full credit. Many other answers showed the arrows drawn in the wrong direction. Candidates should be aware that the arrows represent the flow of chemical energy, so the arrow head should point towards the animal eating the organism, not towards the organism being eaten.

(ii) Most candidates could successfully name the small animals as the herbivores because they feed on the algae, which are plants. Candidates who wrote *fish* were not awarded credit because they feed on the small animals too. Most candidates named either the water plants or the algae as producers and both answers were acceptable.

Question 8

(a) (i) Most candidates successfully stated that process **J** is filtration.

(ii) The knowledge that bacteria are killed by chlorination was known by most candidates. Others who made vague statements such as *to clean the water*, *to purify the water*, or *to kill germs* were not awarded credit.

(iii) The chemical test for chlorine gas was not widely known and many candidates did not attempt to answer this question. Some candidates incorrectly described the test for chloride ions. Candidates are reminded that the test for chlorine is one of the tests for gases stated on the syllabus.

(b) (i) Many candidates successfully translated the stem of the question into the word equation. They correctly identified the product, hydrogen chloride, and the two reactants, chlorine and hydrogen. Candidates are strongly advised to write just words in their answers, and not attempt formulae. There was evidence of candidates writing formulae incorrectly and losing the mark when candidates could have successfully given the answer in words.

(ii) Many candidates correctly identified the bond between non-metals as a covalent bond. Incorrect responses included *ionic* and *metallic bonding*, and where covalent bonding was given, the description of sharing electrons was frequently absent.

(iii) The description of the molecule of hydrogen chloride gave information about the formula, containing one atom of hydrogen and one atom of chlorine. Many candidates used this information to state the formula of hydrogen chloride successfully. Candidates are advised to take care with writing formulae. The symbol for the hydrogen atom is H, upper case, and the symbol for chlorine is *Cl*, with the second letter being lower case. A few candidates did not gain credit because they wrote these symbols incorrectly.

(c) (i) Correct answers stated that the anode, the positive electrode, is the place where chlorine is produced during electrolysis. Many candidates succeeded in naming it. Incorrect responses included *cathode*, the negative electrode.

(ii) Having identified the anode where the chlorine is produced, many candidates could name the metal copper which is formed at the other electrode. Incorrect responses for this question included *hydrogen* and *cathode*.

(iii) Very few candidates across the whole ability range correctly identified the electrolyte, aqueous copper chloride. Incorrect responses included *water*.

Question 9

(a) The majority of candidates successfully drew a series circuit containing the correct number of components. The symbol for the variable resistor was not widely known. Some indicated that it was present in the circuit by drawing just a box or a diagonal line through the box. Candidates are reminded that the symbol for a variable resistor has an arrow going diagonally across the symbol, not just a line.

(b) Many candidates successfully used Ohm's Law to calculate the total resistance of the circuit and so gained credit. Very few knew to divide the resistance by two to find the resistance of one lamp. The bulbs were identical, so the total resistance was the sum of the resistance of both lamps, making the resistance of one lamp 2Ω, half of this total resistance.

(c) The reduction of the resistance in the circuit has the effect of increasing the current, and therefore the brightness of the bulb increases. Many candidates understood that the brightness of the bulbs increases, but did not offer an explanation in terms of an increase in current. Vague statements, such as *more electricity*, were not accepted.

COMBINED SCIENCE

Paper 0653/33
Core Theory

Key Messages

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General Comments

There was a wide range of scripts submitted by candidates, showing some good examples of examination technique. Some candidates had prepared well for the examination, and had mastered all areas of the syllabus. Other candidates would have improved their performance if they were more familiar with the syllabus. Some questions ask for definitions, or direct recall from the syllabus. Candidates who are familiar with the syllabus can obtain these marks relatively easily.

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Comments on specific questions

Question 1

(a) This question was answered well, and many candidates scored most of the available marks. The most frequently-chosen incorrect response was *Enzymes are used up during reactions*. Candidates are reminded that one of the features of a catalyst is that it remains unchanged at the end of the reaction.

(b) The idea of large food molecules being broken down into small molecules for absorption was described well in stronger answers. Correct responses described these changes in the size of the molecules. Candidates who just referred to breaking down food did not score because this response could refer to mechanical digestion, and did not focus on the food molecules.

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Question 2

(a) (i) Many candidates correctly interpreted the information to produce the list of the three Group I metals in the order of reactivity. Many candidates wrote the names of metals which are not in Group I, and may have confused the information with the reactivity series. Candidates are reminded to read the stem of the question carefully.

(ii) The production of hydrogen when Group I metals react with water was widely known by many candidates. The most frequent incorrect answer stated that carbon dioxide was produced. Candidates should consider the elements present in the reactants before answering the question.

(iii) Some candidates knew that if red litmus turns blue, then blue litmus would remain unchanged. Many candidates correctly wrote that the red litmus turns blue, but then stated that the blue litmus turns red. Candidates would be helped by the knowledge that litmus is always blue in alkaline solutions, red in acidic solutions, and the colour of the litmus paper used at the start is not important.

(b) (i) Knowledge of the reactivity series of metals was important for this question, and many of the candidates successfully gave magnesium as their answer.

(ii) The unreactive nature of copper was correctly identified by many candidates who wrote copper as the metal that did not react at all.

(iii) The high reactivity of Group I metals is the most important fact to help in answering this question. Some candidates used their knowledge of the characteristics of the group to state that the addition of Group I metals is far too dangerous to do. Other candidates, who understood that the Group I metals were the same metals as shown in **(a)(i)**, could speculate that the reaction with acids would be much more violent with water.

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(ii) In this example of using a copper alloy for coins, the strength of the alloy was important to improve the durability of the coins. Many candidates correctly explained this. The lack of rusting of the alloy was not considered important here because copper metal is also unreactive.

Question 3

(a) (i) Most candidates correctly identified the four forces acting on the aircraft.

(ii) The higher scoring candidates knew that for an object to keep at the same height the forces must be balanced. Candidates who stated incorrectly that the forces are different did not appreciate that any difference in value of the two forces would make them unbalanced and the plane would move either upwards or downwards.

(iii) The knowledge that unbalanced forces would result in changes to the speed or height of the aircraft was essential for this question. Candidates across the ability range understood this and answered the question successfully.

(b) (i) The stronger answers successfully converted the units to give the correct answer. Both the distance and the time units had to be converted. Incorrect responses included many who converted kilometres to metres, but did not change the hours to seconds correctly.

(ii) A clear calculation was essential for this question which was successfully tackled by candidates across the full range. They approached this calculation in different ways, including the most straightforward division of the distance by the speed, 2700/600.

(c) The stem of the question indicated that changes in kinetic energy and gravitational potential energy should be described. Many candidates found this challenging. Candidates had to state that both the kinetic energy and the gravitational potential energy had decreased. Some candidates gave their answers in terms of the forces that had changed. Others made incorrect statements about energy. These statements included *energy is used up*, *less kinetic energy is taking place* and *energy slows down*.

(d) Most candidates successfully drew the appropriate graph, with lines showing acceleration, constant speed, and deceleration. Credit was lost when some candidates did not finish their graphs at 0. Other candidates lost marks where the line intended to show constant speed had a noticeable gradient, or was carelessly drawn showing a wavy line indicating a varying speed. The use of a ruler is essential in this diagram.

Question 4

(a) (i) A simple description of valve **A** closing and valve **B** opening was what was required in this question. Some candidates answered this correctly. Others described parts of the heart cycle without reference to the heart valves, so did not score. Candidates should be aware of the passive action of heart valves. They do not contract to pump blood themselves. They respond to the pressure of blood inside the chambers of the heart to open or close accordingly.

(ii) The need for the blood to travel in one direction through the heart was the important point here. If candidates are unfamiliar with the need to have valves **A** and **B** in the heart, they could use their knowledge of the function of valves in the veins. Valves prevent backflow of blood, thereby ensuring that the blood flows in one direction.

(b) (i) A specific example of a situation where adrenaline is rapidly secreted was needed to score in this question. Therefore, general statements such as *any fight or flight situation* were not acceptable. Since a sudden increase in adrenaline was asked for, just *exercising* on its own was not accepted, but the beginning of a race, when the adrenaline secretion increases, was acceptable.

(ii) Very few candidates knew that adrenaline is broken down by the liver and therefore made inactive. Candidates should be familiar with the contents of the syllabus as part of their preparation for this examination.

(c) Most candidates correctly described the role of the red blood cells in transporting oxygen around the body. Fewer were familiar with the plasma, the liquid component which transports dissolved substances and cells around the body. Many candidates incorrectly described the function of platelets, the small cell fragments involved in clotting of the blood.

Question 5

(a) (i) Fractional distillation was correctly identified by many candidates. Candidates are reminded that this is a special kind of distillation, so *distillation* on its own did not score.

(ii) The important point to be made in answers to this question was that no new substance is made during fractional distillation, so the process does not involve a chemical change. The separation is done purely on boiling point, a physical property of the compounds in the mixture.

(iii) The portability of bottled refinery gas makes it suitable for cooking and heating where there is no other fuel source, for example when camping. Many candidates were able to give one of these uses.

(b) (i) Several candidates knew methane, the main component of natural gas. Frequent incorrect answers were *carbon hydroxide* or *carbon hydrogen*, presumably attempts to state hydrocarbon.

(ii) Many candidates used the formula correctly to find the number of elements and the number of atoms contained in methane.

(iii) This question was answered well by candidates of all abilities who added their responses to the given diagram to produce the correct formula. Incorrect formulae included hydrogen atoms with two or more bonds, or a carbon atom connected to the four hydrogen atoms in a line.

(c) The stem of the question named two out of the three fossil fuels mentioned in the syllabus. The candidates therefore had to supply coal as the third one. Many candidates did this and scored credit. Incorrect responses included the naming of fuels resulting from the fractional distillation, for example diesel and kerosene.

Question 6

(a) (i) Candidates found this question challenging. The mention of thermal energy transfer from the air inside the aircraft led some candidates to think about convection. Correct responses showed understanding that energy was being transferred from the air inside the aircraft through the solid material making up the wall of the aircraft. Therefore the method of heat transfer was conduction.

(ii) Those candidates who realised that the question was about insulating against heat loss gained credit in this question. Some responses were advising the shape of the aircraft to be more streamlined. This would reduce air resistance and save heat energy lost by friction with the air, not thermal energy transferred through the walls of the aircraft.

(b) (i) Candidates who read the stem of the question carefully knew that the exhaust from the engine was in gaseous form. Therefore, the arrangement of molecules in diagram **Z** was the correct response to this question.

(ii) Those candidates who understood the description of the exhaust gases in **(b)(i)** knew what the white trails might be made of carbon dioxide and water. Very few candidates referred to the very cold temperature of -55 °C outside the plane. This temperature changes the water in the trails to ice, so this was a more accurate answer to explain the white trails. Incorrect responses included *smoke*, and *unburned fuel*.

(c) Many candidates wrote microwaves and radio waves in their correct places in the electromagnetic spectrum and therefore gained full credit. Candidates are advised to write microwaves and radio waves in empty spaces of the electromagnetic spectrum, even if they are unsure of the exact position. There were some scripts with no response to this question.

(d) Some candidates successfully stated that a low frequency sound has a low pitch, and a loud sound has a high amplitude. Incorrect answers included those with the low and high responses the wrong way around.

Question 7

(a) (i) Generally, the stronger responses successfully stated that the supply of oxygen is needed by the fish for respiration, the release of energy in their cells. There were many answers that were too vague and therefore did not score. Examples of these answers are *all living things breathe in oxygen*, *living things need oxygen to stay alive*, and *the fish need oxygen to survive*. Candidates should be aware that after the oxygen enters the bodies of the fish, it is used for respiration. This process releases the energy that the fish needs to survive or stay alive.

(ii) Diffusion was the answer needed here. Although in a different context from diffusion into and out of cells, or gaseous exchange at the lungs, the stem of the question describes the difference in concentration of oxygen between the air and the water. Many candidates correctly applied their knowledge of diffusion to a new situation and gained credit.

(iii) The majority of candidates identified either the water plants or the algae as another source of oxygen for the fish. The production of oxygen as a waste product of photosynthesis was the reasoning behind the candidates' correct answers. Any candidates who stated small animals were not awarded credit, since these would take oxygen from the water, similar to the fish.

(b) (i) The feeding relationships described by the stem had to be placed in a food web, some of which was provided. Stronger responses showed this done correctly, and so gained full credit. Many other answers showed the arrows drawn in the wrong direction. Candidates should be aware that the arrows represent the flow of chemical energy, so the arrow head should point towards the animal eating the organism, not towards the organism being eaten.

(ii) Most candidates could successfully name the small animals as the herbivores because they feed on the algae, which are plants. Candidates who wrote *fish* were not awarded credit because they feed on the small animals too. Most candidates named either the water plants or the algae as producers and both answers were acceptable.

Question 8

(a) (i) Most candidates successfully stated that process **J** is filtration.

(ii) The knowledge that bacteria are killed by chlorination was known by most candidates. Others who made vague statements such as *to clean the water*, *to purify the water*, or *to kill germs* were not awarded credit.

(iii) The chemical test for chlorine gas was not widely known and many candidates did not attempt to answer this question. Some candidates incorrectly described the test for chloride ions. Candidates are reminded that the test for chlorine is one of the tests for gases stated on the syllabus.

(b) (i) Many candidates successfully translated the stem of the question into the word equation. They correctly identified the product, hydrogen chloride, and the two reactants, chlorine and hydrogen. Candidates are strongly advised to write just words in their answers, and not attempt formulae. There was evidence of candidates writing formulae incorrectly and losing the mark when candidates could have successfully given the answer in words.

(ii) Many candidates correctly identified the bond between non-metals as a covalent bond. Incorrect responses included *ionic* and *metallic bonding*, and where covalent bonding was given, the description of sharing electrons was frequently absent.

(iii) The description of the molecule of hydrogen chloride gave information about the formula, containing one atom of hydrogen and one atom of chlorine. Many candidates used this information to state the formula of hydrogen chloride successfully. Candidates are advised to take care with writing formulae. The symbol for the hydrogen atom is H, upper case, and the symbol for chlorine is *Cl*, with the second letter being lower case. A few candidates did not gain credit because they wrote these symbols incorrectly.

(c) (i) Correct answers stated that the anode, the positive electrode, is the place where chlorine is produced during electrolysis. Many candidates succeeded in naming it. Incorrect responses included *cathode*, the negative electrode.

(ii) Having identified the anode where the chlorine is produced, many candidates could name the metal copper which is formed at the other electrode. Incorrect responses for this question included *hydrogen* and *cathode*.

(iii) Very few candidates across the whole ability range correctly identified the electrolyte, aqueous copper chloride. Incorrect responses included *water*.

Question 9

(a) The majority of candidates successfully drew a series circuit containing the correct number of components. The symbol for the variable resistor was not widely known. Some indicated that it was present in the circuit by drawing just a box or a diagonal line through the box. Candidates are reminded that the symbol for a variable resistor has an arrow going diagonally across the symbol, not just a line.

(b) Many candidates successfully used Ohm's Law to calculate the total resistance of the circuit and so gained credit. Very few knew to divide the resistance by two to find the resistance of one lamp. The bulbs were identical, so the total resistance was the sum of the resistance of both lamps, making the resistance of one lamp 2Ω, half of this total resistance.

(c) The reduction of the resistance in the circuit has the effect of increasing the current, and therefore the brightness of the bulb increases. Many candidates understood that the brightness of the bulbs increases, but did not offer an explanation in terms of an increase in current. Vague statements, such as *more electricity*, were not accepted.

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 that might be tested as set out in the syllabus
- read the questions carefully and used the number of marks for each question as a guide to the detail required in their answers
- 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

Many candidates showed mastery of all sections of the syllabus and were well-prepared in terms of examination technique. In some cases low scores were likely to be the result of unfamiliarity with both the syllabus and the techniques needed to do well in this type of examination rather than any lack of ability. In some other cases the very low scores obtained suggest that these candidates may have benefited from entry to the core paper with its reduced demand in content and depth.

Candidates' responses to the three Science disciplines were broadly balanced with neither Biology, Chemistry nor Physics standing out as any more problematic. However, it is worth highlighting that in this examination some aspects of Biology including the mechanism of formation of acid rain and its consequences for plant germination emerged as relatively unfamiliar. Candidates also found it challenging to express answers concerning energy losses through food chains although they very often appeared to be familiar with the ideas involved. Candidates would have done better if they had learned some textbook ways of explaining energy losses along food chains and also learned to use the term trophic level. Similarly in Chemistry, some candidates found it challenging to answer questions about electrolysis. In Physics, candidates often confused the relationship between speed, frequency and wavelength.

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 great majority of candidates gained at least partial credit for their choices and large numbers from across the total mark range gained full credit. The production of haploid pollen was one of the most likely choices to be missed.

(b) (i) In answering this question, candidates had to make a clear connection between the structures of the anthers and stigmas and the consequences of these structural features for wind pollination. Candidates needed not only to state that *anthers hang outside the flower* but also that this made it easier for the wind to carry pollen away. Similarly for the stigma a reference to surface area or stickiness had to be followed by the idea that this increases the likelihood of pollen attaching itself to the stigma. Some candidates reversed the roles of anther and stigma for which no credit was available.

(ii) Candidates needed to refer to the increased probability that pollination would occur. Only a minority suggested or implied this. The idea that pollination would be easier was not accepted as a good enough alternative since this idea really applies to the action of pollination onto an individual stigma. This question was about the general efficiency of pollination of a crop as a whole. Some sensible suggestions were seen from candidates but if these did not include a direct reference to pollination no credit was available.

(c) (i) Full credit here was for a reference to the main compounds released from the burning of fossil fuels that cause acid rain and the fact that these compounds react chemically with water in the atmosphere. The expected compounds are sulfur dioxide or nitrogen oxides and candidates needed to make a clear statement about the way these gases combine with water. Many candidates discussed this environmental issue in terms of carbon dioxide which did not gain a mark. References to clouds were also not credited. Common mistakes included the idea that combustion of fossil fuel creates sulfuric acid which rises into the atmosphere, condenses and then falls again as acid rain. Examples of some of the vague or possibly careless references to combustion products included *sulfur, nitrogen* and *phosphorus*.

(ii) Only a minority of candidates referred to the denaturation of enzymes. Some discussed harmful effects on soil but only in a very general way that lacked any scientific reasons for the harmful effect on plant growth. The majority of candidates made a general comment that acidity is either bad for plants, is harmful for plants or kills plants, this lack of scientific detail causing loss of credit.

Question 2

(a) (i) The term *covalent* was familiar to large numbers of candidates. The most common mistakes included *ionic* and *double*.

(ii) Dot-and-cross diagrams showing shared electrons in covalent molecules are usually very familiar, and large numbers of candidates from across the mark range gained full credit. Candidates should be advised to learn these diagrams for all of the examples specified in the bonding section of the syllabus.

(b) (i) The identity of the products of combustion of hydrocarbon fuels is very frequently tested and many candidates had learned them. The question asked for names of the products and candidates should be advised to write names rather than chemical formulae when asked. For very common compounds like water and carbon dioxide, chemical formulae are usually accepted but these must be correct in every detail. Common incorrect suggestions included oxygen and hydrogen.

(ii) Only one mark was available and candidates did not gain the credit unless they specified the release of thermal energy (heat) when methane reacts. Suggestions that did not quite say enough to gain credit included the ideas that *methane burns easily, methane contains lots of chemical energy, methane gives out heat.* The suggestion that *methane creates energy* is never accepted.

(c) (i) The composition of natural gas tended to be more familiar to candidates towards the higher end of the mark range. A very wide variety of suggestions were seen, other fossil fuels being the more reasonable incorrect answers.

(ii) In many cases, candidates had suggested one of the acceptable responses to this question as their answer to **(c)(i)**. This caused them to lose the credit here as well since they reasonably assumed that the same answer would not occur twice. Since only one mark was available two correct fuels had to be given here. Candidates should be advised that the term *fossil fuel* does not include the fractions from the fractional distillation of petroleum and that the terms *petrol* and *petroleum* do not mean the same thing. In both this question and in **(c)(i)** there was evidence that some candidates were unfamiliar with the term *fossil fuel*.

Question 3

(a) (i) The majority of candidates gained the mark for recognising frictional force and upthrust.

(ii) It is usually the case in questions of this type that the mark is awarded for reasoning and not, in this example, for stating that force **C** has the same numerical value as force **A**. However, candidates must make this initial statement before the reasoning is marked. Candidates could either state or imply that the windsurfer shows no vertical motion or that the forces **A** and **C** are balanced. The term *equal* was not accepted as an alternative for the term *balanced,* although *equal and opposite* did gain credit.

(b) Candidates needed to make sure that all of the information about the movement of the windsurfer was included on their speed-time graph. Full credit was gained by those candidates who, included a horizontal section to show constant speed after the acceleration, drew a curved line to show the acceleration and whose graphs started at a speed of 2 m/s rising to 4.5 m/s after a time of 10 seconds. Candidates very often drew the correct general form of the graph but only a minority gained full credit. The most common mistakes included showing the acceleration as a linear increase, starting the acceleration section at the origin and not including the constant speed section after 10 minutes.

(c) (i) The calculation of kinetic energy using the relationship $\frac{1}{2}mv^2$ is frequently examined and many candidates were very well prepared for it. It is often the case that partial credit may be given for a calculation even though candidates do not arrive at the correct final answer. Partial credit might be given for a clear statement of a relationship or mathematical formula that is relevant to the calculation. Partial credit may also be awarded for a correct logical step in the calculation. For this reason candidates should set out their working in a clear and well-organised manner to make it more likely that correct statements worthy of partial credit are recognisable. Responses to this question produced all possible marks with many candidates gaining full credit. Two of the more common mistakes were that candidates stated the correct formula but then did not take the square of the velocity, and candidates did not include the square of velocity in the formula.

(ii) The comments in **(c)(i)** about well-organised working are particularly important in answering this question which is less familiar than simply calculating kinetic energy. Relatively few candidates worked through to the correct final answer but large numbers gained partial credit for recognising that the final calculation would require 90 kJ to be converted to joules, or for showing that the distance moved is 150 m or for stating that the formula to be used is
force = energy transferred ÷ distance moved.

Question 4

(a) (i) Many candidates gained partial credit for references to chlorophyll and the trapping of light. The additional points that light energy is converted into chemical energy which is stored in molecules such as glucose or starch was rarely stated. Candidates should be advised to avoid statements such as *light is turned into glucose*. Partial credit was given to candidates who gave a sensible statement that included the term *photosynthesis*.

(ii) Candidates could only be expected to recognise the flagellum and its connection to the need for movement. Eyespot and the need for animals to have sight were suggested by many candidates and of course gained credit. The reason for the flagellum or eyespot being animal features had to be answered in a positive sense so suggestions such as *plants don't move* or *plants don't have eyes* did not gain full credit. Quite a few candidates suggested features not shown in the diagram of the euglena and some others suggested cell membrane or nucleus. Some candidates suggested that plant cells do not contain a nucleus, cytoplasm or a cell membrane.

(b) (i) This food chain was identified by the great majority of candidates and only a small number lost credit for forgetting that the chain had to include the crab, for drawing the feeding relationship arrows in reverse or for drawing a non-linear arrangement.

(ii) The main challenge faced by candidates answering this question was to find a way of expressing correct ideas clearly enough. The key ideas that candidates needed to show they understood were that the route from phytoplankton through fish involved a greater number of energy transfers than the route through mussels, and that there is energy loss through each transfer. Full credit would be gained if candidates could go on to use the term *trophic level* or describe ways in which energy is lost through a trophic level. Most candidates identified the shorter route through mussels. Only a minority of candidates used the term trophic level or discussed ways that energy is lost.

Question 5

(a) (i) The question asked for the change in pH and so candidates needed to state that it increases. Candidates who stated things like *acid to neutral* were answering a different question and so did not gain credit. A variety of answers for the reaction type in addition to those in the published mark scheme were seen and accepted. The most appropriate answer is *neutralisation* and this was given by large numbers of candidates.

(ii) The correct symbol equation was frequently seen in higher scoring scripts. The idea that acids react with carbonates to produce a salt, carbon dioxide and water is something candidates are expected to know and partial credit was available for stating that two of the products would be CO_2 and H_2O. Weaker scripts contained guesses based on the available elements from the product side.

(b) Candidates who had experience of this procedure had no difficulty in answering the question and often gave far more detail than needed for the two marks available. Many rather confused answers were seen particularly involving the filtration stage where this was included. Candidates needed to ensure that filtration was to remove excess copper carbonate and not to separate the already formed copper sulfate. Large numbers of candidates gained at least partial credit for explaining that excess water has to be evaporated.

(c) This question was challenging in that candidates had to realise that they were required to answer questions about reaction rate by interpreting a graph showing product gas volume plotted against time. Hardly any candidates referred to the gradient of the graph but many gained partial credit by stating that the horizontal section showed that the reaction had stopped which was accepted as an alternative to the idea of the rate becoming zero. Many candidates answered in terms only of the changing gas volume and others thought that the horizontal section of the graph showed that the rate of reaction had reached a constant (non-zero) value.

(d) (i) Candidates generally were far more successful in answering this question and full or partial credit was gained by candidates across the mark range. Candidates needed to pause and think about this question since similar questions in the past have asked candidates to predict the graph when the amount of products would not change. Many candidates lost credit by drawing their lines to meet the horizontal section of the given line.

(ii) Scripts towards the higher end of the mark range contained **c**orrect references to decreased collision frequency or other acceptable statements. Candidates need to be aware that if the temperature does not change then they should avoid suggesting that particle energy or speed would change.

Question 6

(a) (i) The idea that white surfaces are reflective was very familiar and most candidates gained at least partial credit. The second mark was for giving a description other than *light* of what was being reflected so that the man's back would not increase in temperature so much. Very few candidates referred either to radiation or infra-red.

(ii) Many candidates gained partial credit for discussing the temperature difference between the water and the man's feet. A small number of candidates gained full credit for an explanation in terms of energy transfer.

(iii) The majority of candidates gained partial credit for writing *temperature* in the third space. Both the first and second spaces had to be completed correctly for the second mark. The question asks for an answer in terms of the movement of molecules and so candidates needed to state faster molecules rather than warmer molecules in the first space. Only a minority gained full credit.

(b) Some candidates were familiar with this example of real and apparent depth but the great majority were not. Large numbers of candidates did not seem familiar with the correct form of ray diagrams. Very few added directional arrows to the light rays and some represented rays as sketched or broken lines drawn without the use of a ruler. A sizeable minority marked the position of **X** clearly but did not draw any light rays. Credit could not be given for answers like this even if **X** was in an approximately correct position. The most important knowledge tested here was the general form of the refraction of the ray at the water surface. Many candidates did this correctly enough and gained partial credit.

(c) (i) The majority of candidates had learned the electromagnetic spectrum and gained this mark.

(ii) Most candidates knew that a relationship exists between wave velocity, frequency and wavelength and many knew the correct formula to use in this calculation. The incorrect formula that was most often suggested was frequency = speed × wavelength. Numerical answers calculated using an incorrect formula do not gain credit. Candidates gained credit for any numerically correct form of the answer.

Question 7

(a) Many fully correct calculations were seen from candidates across the total mark range. Partial credit was gained by those candidates who did not scale up the energy total for 200 g rather than 100 g of food. Many candidates who produced well-presented working, as suggested in the report on **Question 3(c)(i)**, gained partial credit in other ways, most notably when the only error was misuse of a calculator following correct working. Common mistakes included scaling up the masses of food rather than the energy values, and including water in the calculation even though it had no energy value.

(b) Most candidates correctly identified egg as the food to select. Full credit was then available for the reason they selected egg which is that egg contains the highest amount of fat. A sizeable minority from all parts of the mark range answered a slightly different question and selected fat as the food and then described the role of fat in coronary heart disease. This did not attract credit in this case.

(c) (i) Candidates have usually learned by heart the balanced equation for respiration. Only one mark was available and so candidates needed to get the equation correct in every detail which many did. Essentially, credit depended on whether candidates had learned the equation, and large numbers of correct answers were seen throughout the mark range.

(ii) The roles of both haemoglobin and red blood cells were generally well-known by candidates throughout the mark range. A common mistake was to describe, often in an accurate and detailed way, how blood is oxygenated and/or transported.

(d) Only a minority of candidates gained full credit but many gained one mark for stating that absorption occurs in the small intestine. Candidates very often correctly identified one or two of the places where chemical digestion occurs but all three were required for the mark. Candidates had to specify **small** intestine in both parts of the question. The most common mistake was to state large intestine in either part of the question although, for the second part, a mark was given if candidates specified that water is absorbed.

Question 8

(a) The majority of candidates had no difficulty gaining this mark. Some appeared to be unfamiliar with the form and in some cases the meaning of the term *electronic structure*. Suggestions included the responses, *13, 27, 40, 3 in outer shell* and *outer shell is not full*.

(b) (i) Candidates may be asked to predict the products of electrolysis of molten binary compounds. Provided they remembered that the anode is the positive electrode, the diagram in this question was very helpful in leading candidates to the answer oxygen. Quite a large number of candidates were unfamiliar with the context of this question and many answers suggested that they were unfamiliar with electrolysis as a whole. Many candidates did gain the mark although those who suggested oxide ions did not. The mark was awarded for the answer O_2 but not for O since candidates had been asked for the name.

(ii) The key ideas required were that aluminium ions gain electrons and that the ions are discharged. Some candidates obtained full credit by writing a correct electrode equation. Many scripts contained confused ideas and suggested that some candidates were unfamiliar with this topic. Electrolysis is frequently examined and the requirements of this question are indicative of the detail required.

(c) (i) Those candidates who had revised the blast furnace had no difficulty answering this question, and candidates from across the mark range gained the mark.

(ii) Answers to this question must be in terms of the relative reactivities of aluminium and carbon. Credit was not given for statements such as *aluminium is too reactive* or *aluminium is more reactive than iron.* An alternative answer that was accepted referred to the impractically high temperature that would be needed in a blast furnace to extract aluminium.

(d) (i) Many candidates recognised that this question was testing the reactivity series and so gained the mark since they either knew that magnesium was more reactive than aluminium or they deduced it. Some candidates' attempts to explain the observation just repeated the information in the question with statements such as *no change is seen because aluminium does not react.* Candidates should be advised to check that their answers are adding new information to that included in the question. Some candidates lost the mark by attempting to compare the reactivity of aluminium with *magnesium sulfate, sulfate* or *sulfur.*

(ii) Candidates who scored the mark for **(d)(i)** invariably gained the mark here. With only one mark available candidates had to make the point about relative reactivity. It was not enough, in this case, simply to state that aluminium displaces copper.

Question 9

(a) Most candidates correctly named two materials that are electrical conductors. The general term *metal* was not accepted.

(b) This question was answered very well. The great majority of candidates followed the instructions and obtained the correct numerical answer. Most of these candidates went on to state the correct unit. The most common incorrect units were J, A and watts.

(c) (i) The mark here was for the reason why the current in wire **Q** is 2A but unless 2A was stated somewhere in the answer no mark could be given. This was answered very well by many candidates who found a variety of ways to explain the current of 2A. A variety of suggestions from 3A to 9A were seen. Common incorrect answers were *5A because the currents in parallel branches are always the same* and *7A because the current is the same everywhere*.

(ii) This proved to be challenging for most candidates and only a minority gained credit. The information about the similarities of the two wires, **P** and **Q**, given in the introduction to **(i)** may have distracted candidates from considering that the resistances of the wires could still be different. Despite the information in **(i)** some candidates still suggested that the length of the wires could be different which could have been ignored if they had gone on to make a relevant comment about resistance.

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 that might be tested as set out in the syllabus
- read the questions carefully and used the number of marks for each question as a guide to the detail required in their answers
- 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
- avoided answers that simply re-stated the question without adding any new information.

General comments

A relatively large number of excellent scripts were seen from candidates who had prepared thoroughly for the examination and who showed sound examination technique. Some of the candidates who produced very low scores were unfamiliar with both the syllabus content and with what was expected of them in an examination of this type. In some other cases the relatively low scores suggest that some candidates may have benefited from entry to the core paper with its reduced demand in content and depth.

Candidates' responses to the three Science disciplines were broadly balanced with neither Biology, Chemistry nor Physics standing out as any more problematic. However, it is worth highlighting that in this examination some aspects of Biology including the way that adrenaline is removed from the body, the mechanism of how auxins cause the phototropic effect, a textbook definition of the term *ecosystem* and the role of bacterial respiration in removing oxygen from eutrophied water emerged as relatively unfamiliar.

In Physics candidates had difficulty recognising the mechanism of thermal energy transfer and then describing it in terms of particle motion.

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 great majority of candidates gained at least partial credit for their choices and large numbers from across the total mark range gained full credit. A commonly missed option was *works best in a narrow pH range* and a common incorrect option was *are used up during reactions.*

(b) The denaturation of enzymes at high temperature was very familiar and large numbers of candidates gained a mark for stating this. Only a minority could describe the idea that the information about rate of production showed that the process displayed an optimum temperature (46 °C). Some lengthy paragraphs were written that reworded the question without adding anything extra. Candidates should be advised to read over their answers and ask themselves whether they have added new, explanatory information.

(c) (i) Candidates throughout the mark range gained the mark here. Some candidates missed the mark because they opted for the general term *carbohydrate*. A common mistake seen from candidates from all parts of the mark range was *amino acid*.

(ii) This mark was not awarded very often. Candidates needed to suggest **large** molecules that contained glucose units and so *sucrose* and *maltose* did not gain credit. Even candidates near the top of the mark range seemed unfamiliar with polymers containing glucose units other than starch. Large numbers of incorrect suggestions were seen and the most common ones included *protein, carbohydrate, starch* and *glucose.*

(iii) Candidates were generally far more successful in this question than in **(ii)**. It is worth noting that throughout the mark range many of the incorrect guesses included suggestions that were not chemical elements.

Question 2

(a) (i) This was generally very familiar and large numbers of candidates gained full credit. Not all candidates realised that the three metals they had to name were alkali metals. The majority of those gaining partial credit reversed the order of lithium and potassium which suggests that they may have seen sodium in water as a demonstration but not the other two.

(ii) This question was answered very well by candidates across the mark range, with many scoring full credit. The term *potential* is not specific enough to be allowed as an alternative for *chemical.* Some candidates missed a mark by suggesting both *heat* and *thermal* as two different forms of energy emerging.

(iii) Most candidates were familiar with the reactivity trend down Group 1 and were able to predict a lower reaction time than potassium. Quite a number did not attempt to answer this question and it could be that they did not realise that they had to use the data in the question to make an estimate. The use of data to make estimates is frequently included in these papers and it is hoped that candidates can be made aware of how to approach questions like this. They should be advised that the allowed range of their estimate is usually very wide and there is no pressure on them to state the 'correct' value.

(b) It was not enough here simply to state, as many did, that Group 1 metals are *too reactive* or that they *react vigorously*. Candidates who were well-prepared for this question knew that they had to emphasise the idea that the reaction is dangerous.

(c) (i) Candidates needed to discuss the lack of reactivity of the iron alloy in comparison with iron. Many of the suggested advantages of the alloy were either not relevant to its use as a saucepan or were not accurate. Some candidates suggested, for example, that an iron saucepan would melt on a cooker.

(ii) This part needed to be answered in comparative terms, so candidates had to say that the alloy would be *stronger* rather than simply *strong*. Any wording that expressed the idea of greater strength or greater durability was accepted.

Question 3

(a) (i) The majority of candidates gained the mark for recognising the frictional force and the lifting force. A common mistake was to suggest that the frictional force was represented by **A**.

(ii) It is usually the case in questions of this type that the mark is awarded for reasoning and not, in this example, for stating that force **B** has the same numerical value as force **D**. However, candidates must make this initial statement before the reasoning is marked. Candidates could either state or imply that the aircraft shows no vertical motion or that the forces **B** and **D** are balanced. The term *equal* was not accepted as an alternative for the term *balanced,* although *equal and opposite* did gain credit.

(iii) This was answered successfully by many candidates. In questions like this there is always a danger that candidates will make suggestions which are not incorrect in everyday terms but which lack correct scientific detail. For this reason candidates needed to state that the **weight** of the aircraft decreases. A few very strong scripts contained excellent answers that described the decreasing force of gravity on a decreasing mass. Credit was not gained for stating that the aircraft *loses mass* or *becomes lighter* or *there is now less fuel.* A common incorrect statement that is often made when this topic is examined is the idea that gravity decreases.

(b) (i) This straightforward calculation of acceleration caused few problems for candidates from across the mark range. Full credit could only be gained if the correct units were stated which in most cases they were.

(ii) Similarly to **(b)(i)** this calculation caused few problems and candidates from across the mark range completed it correctly. Some marks were lost by candidates making arithmetic errors involving orders of magnitude.

Question 4

(a) (i) Most candidates gained the mark.

(ii) To gain full credit, candidates needed to make a clear comparison of the blood pressure in the aorta and pulmonary artery and then explain why the pressure needed to be different in terms of the different destinations of the blood in these vessels. Candidates generally had some knowledge and many gained partial credit. Many would have gained full credit if they had stated clearly that the blood pressure in the aorta was higher than in the pulmonary artery. In this respect, candidates should be advised to make sure they include all the detail even if they think some of it is so obvious that it does not need to be written down.

(b) (i) The details of the causes of coronary heart disease are often tested and candidates should be advised that it is essential to know CHD occurs when the blood supply to the heart muscle is restricted because **coronary arteries** become blocked by deposits of fat, cholesterol or plaque. If candidates learn and use these terms and phrases then they can expect full credit. Many candidates showed incomplete knowledge and so wrote about *arteries being blocked* rather than specifying *coronary arteries*, or they made vague statements such as *fat blocks blood flow*.

(ii) This was very familiar and the majority of candidates gained the mark. Frequently seen answers that sound correct but which were not accepted included *eat a healthy diet, eat a balanced diet* and *avoid eating oily food.* One-word answers such as *exercise* were accepted in this instance although this is another example of candidates assuming that the Examiner will know that they really mean *take more exercise.* Candidates should be advised to avoid brief answers like this.

(c) (i) A wide variety of imaginative responses were seen for this and they all gained the mark. Answers that suggested endurance events were not always accepted unless some aspect of the event that would cause a rapid adrenaline increase was described. Hence referring to the *start of a marathon* might be acceptable but simply stating *running a marathon* was not. The simple answer *a fight or flight situation* was suggested by a small number but this was not accepted since candidates needed to show they could identify an actual example of such a situation.

(ii) This was another question that produced a variety of imaginative responses including *via the urinary system, through perspiration* and simply by *calming down*. Candidates needed to state that adrenaline would be destroyed in the liver rather than simply be removed there.

(d) Many candidates knew the term *auxins* and so gained at least partial credit. Large numbers of candidates tended to discuss the benefits to the plant of bending towards the source of light, but the details of how auxin works to bring this about were not commonly seen. Of those candidates who did try to explain the role of auxins, many made the common mistake of stating that auxins concentrate on the illuminated side of the stem.

Question 5

(a) (i) The great majority of candidates recognised fractional distillation.

(ii) Many candidates throughout the mark range correctly stated the relationships between molecular size and intermolecular forces, and between intermolecular forces and boiling point. Some candidates thought that the term *relationship* required a statement such as *the intermolecular forces are higher than the boiling point.*

(iii) See comment for **(ii)**.

(b) (i) Candidates needed to realise that a question asking for *types* of hydrocarbon should not be answered with the name of a particular compound or a chemical formula. A minority of candidates suggested the correct names of the compounds shown in the question but full credit was not available for this.

(ii) The bromine test for unsaturation was familiar to many candidates. In many of the scripts with low total scores no attempt had been made to answer this question.

(iii) The majority of candidates recognised cracking. Incorrect suggestions included *evaporation, combustion* and *oxidation.*

(c) Most candidates balanced the equation. Where partial credit was given it was usually for correct numbers on the product side.

Question 6

(a) (i) Candidates found this challenging and only a minority gained the mark. Of those who realised that a mechanism of thermal energy transfer was required, large numbers suggested convection. It is possible that they were confused by the context which wanted them to realise that thermal energy would need to transfer through the solid material of the aircraft body.

(ii) The continuation of the context meant that this question was also very challenging for candidates, and only a very small number near the top end gained full credit. Many attempts to answer the question in terms of convection were seen but no provision for continued error was available. Partial credit was gained by any candidate who made a sensible reference to the collision or vibration of molecules or particles.

(b) (i) Many candidates realised that at the elevated temperature of the engine, the products from the combustion of the fuel would be formed as gases. This led them to identify diagram **Z**. Credit was gained by those candidates who described the features visible in the diagram that showed **Z** to represent the gaseous state. Thus credit was gained by candidates describing widely separated particles and was not gained by candidates making statements such as **Z** *because it is a gas*.

(ii) There were several ways that candidates could gain credit here, and success in this question was greater than in **(a)**. Some candidates focused on the difference in molecular speed between the exhaust gas and the water molecules inside the aircraft but they did not always explain that the increased speed of the exhaust gas molecules was the result of higher temperature. Other candidates discussed the temperature difference but did not then go on to explain how this affected molecular speed.

(c) (i) This calculation was done well by large numbers of candidates. Many gained at least partial credit for correctly stating the formula distance = speed × time and then calculating the total distance travelled by the radar signal to be 60 km. Only a minority realised that the answer to the question had to be half of the total they had calculated.

(ii) The inverse relationship between the frequency and wavelength of electromagnetic radiation was familiar to large numbers of candidates who gained at least partial credit if they expressed this clearly enough. Many stated correctly that radar signals would be found at longer wavelengths but credit for this depended on them locating radar signals in the microwave section of the Table in the question. This was not so frequently seen with many stating that radar was the same as radio.

Question 7

(a) Unless candidates have learned standard definitions of ecological terms it is often very difficult to gain full credit in questions like this one. The essential idea that was missing from most candidates' answers was that in an ecosystem, organisms **interact** both with other organisms and with non-living features best summarised as the environment. Although candidates from across the mark range were able to recall relevant vocabulary most did not use it properly to produce an accepted definition of an ecosystem.

(b) Construction of this simple food web presented few problems and most candidates gained full credit.

(c) (i) Most candidates understood the situation described in this question and gained full credit. A common mistake is the suggestion that the excess fertiliser poisons the water.

(ii) The idea that oxygen depletion occurs because of bacterial respiration was seen only in the best scripts. Several other explanations were suggested including the idea that plants that were still alive use up oxygen, or that the oxygen produced by the algae escapes from the surface of the lake. Credit was not given for oxygen removal by respiration unless candidates made it clear they were referring to respiration by bacteria or decomposers.

Question 8

(a) (i) The relationship between group number and outer shell electrons was familiar to the majority of candidates.

(ii) Most candidates recognised that element **X** was a non-metal and most could state a suitable physical property.

(b) (i) The great majority of candidates were able to complete the diagram of the atom of **X**.

(ii) Most candidates completed a correct dot-and-cross diagram of a chlorine molecule. Only one mark was available and so the diagram had to be correct in every detail. Provided the shared pair and all non-bonding electrons were clear then the mark was awarded. Structural or graphic formulae did not gain credit.

(c) (i) Most candidates correctly stated *ionic.* In weaker answers, *covalent, metallic* or *single* were the most common mistakes.

(ii) The electron exchange between sodium and chlorine to form sodium chloride was familiar to many candidates. Even candidates who had suggested the answer *covalent* in **(c)(i)** still gained full or partial credit in this question. Some candidates reversed the electron transfer but there was no provision for a continued error in this case.

(d) The association of a complete outer shell and the chemical stability of the noble gases is always very familiar to candidates and most gained this mark. Some candidates gave answers such as *noble gas atoms don't need to share electrons* but with only one mark available they had to give the reason.

Question 9

(a)(i)(ii) These circuits were drawn correctly and very well by the majority of candidates. Generally, electrical symbols were shown accurately and circuits were drawn carefully often with the aid of a ruler. Credit was lost if wires were shown through the middle of the ammeter or voltmeter but only a minority of candidates did this. Very few candidates were unaware of the difference between a circuit diagram and the drawing of the components shown in the question.

(b) The majority of candidates recognised that they needed to use the formula, power = p.d. × current and arrived at the answer 0.9 W.

(c) (i) Only a minority of candidates stated that adding the second lamp would increase the total resistance hence reducing the current. Many confused power and current and many attempted to answer this question in terms of power sharing or current sharing. This may be suggesting that these candidates did not associate lamps with resistance. Had the question been in terms of resistors then it may be that many more candidates would have gained credit.

(ii) Very few candidates gained any credit for their attempts to answer this question. A small number near the very top of the mark range used the formula $E = V \times I \times t$ and went on to gain full credit. Some candidates in the upper part of the mark range suggested arguments based on the idea that power is shared but did not address the fact that the total power dissipated would be lower. The majority continued with the idea of current sharing as in **(c)(i)**. In many scripts no attempt was made to answer this question.

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 that might be tested as set out in the syllabus
- read the questions carefully and used the number of marks for each question as a guide to the detail required in their answers
- 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

Some candidates showed that they had prepared well for most sections of the syllabus, and were familiar with this type of examination. In some cases low scores were likely the result of unfamiliarity with both the syllabus and the techniques needed to do well in this type of examination rather than any lack of ability. The main evidence for this comes from the observation that full credit for answers to several of the more advanced questions were seen from candidates right across the final mark range.

Candidates' responses to the three Science disciplines were broadly balanced with neither Biology, Chemistry or Physics standing out as any more problematic. However, it is worth highlighting that in this examination some aspects of Biology including the mechanism of the role of auxins in geotropism and the consequences of acid rain on plant germination emerged as relatively unfamiliar parts of the syllabus. Similarly in Chemistry many candidates found it very challenging to answer basic questions concerning electrolysis.

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 harmful effects of tobacco smoke were familiar to candidates of all abilities and most gained full credit. The effects on cilia and carbon monoxide concentration in blood were the most frequently selected correct responses.

(b) (i) It was essential that candidates showed unambiguously that carbon dioxide enters the alveolus from the plasma. Only a minority did this and many candidates drew arrows that circulated within the alveolar sac. An arrow that originated from a red blood cell did not gain credit.

(ii) The most important features of the alveoli that candidates are expected to know are large surface area, thin walls and a good blood supply. Other correct answers were accepted. The most commonly seen correct answers referred to the large surface area and thin walls. Many candidates lost credit because they referred to *thin alveoli* or *one cell thick alveoli* rather than specifying that the alveoli **walls** are thin. Weaker scripts contained unqualified statements such as *surface area* or

near veins. Some candidates suggested that gas exchange occurred through semi-permeable membranes.

(c) Candidates could gain marks by describing the involvement of haemoglobin and red blood cells and also by discussing the route back to the heart via the pulmonary vein or left atrium. Many lost credit by referring to the pulmonary artery. Weaker scripts contained very general statements describing the movement of oxygen from the alveoli into the blood which then circulates within blood vessels. Answers like this that lacked scientific detail did not gain credit.

(d) (i) This question required a relatively straightforward answer that showed candidates understood the basic idea that glucose is required for respiration. Several candidates suggested that respiration created glucose or that respiration rate had to increase in order to get rid of all the excess glucose. In general, answers to this question revealed much confusion about the relationships between glucose, oxygen, energy and respiration.

(ii) Large numbers of candidates did not gain credit because they confined their answers to ideas about blood flow. The important idea that candidates needed to describe was the faster delivery of oxygen and glucose to the cells. The type of confusion evident in **(d)(i)** was also seen in answers to this question. Typical of this confusion is the idea that because the pulse rate has increased, the body needs more oxygen and so the rate of respiration has to increase.

Question 2

(a) (i) The majority of candidates wrote the correct formula of octane. Credit was lost for careless presentation including chemical symbols which were clearly not upper case and figures that were not written as subscripts. The answer $H_{18}C_8$ was accepted.

(ii) Many candidates wrote fully correct explanations of the relationships between molecular size, boiling point and intermolecular forces. Good answers were seen across the full mark range. This suggests that the theory of fractional distillation was generally familiar and that candidates had revised it well.

(b) Cracking was recognised by many candidates. Among the variety of incorrect responses, fractional distillation was the most common.

(c) Stronger candidates recognised that a question asking for *types* of hydrocarbon should not be answered with the name of a particular compound or a chemical formula. This question was much more straightforward than many candidates realised, and tested the knowledge that a hydrocarbon can be classified as an alkane or an alkene simply by inspection of its name. Regrettably some candidates wrote fully correct chemical formulae for the three compounds and so lost the credit because they did not answer the question that had been asked.

(d) Dot-and-cross diagrams to represent electron arrangement in a covalent molecule are frequently tested and candidates are advised to learn those specified in the syllabus. Candidates who gained credit for their diagrams tended to be nearer the upper end of the mark range. Many candidates did not appear to be familiar with the technique of drawing these diagrams and many others drew a structural or graphic formula.

Question 3

(a) (i) The majority of candidates gained the mark for recognising frictional force and weight.

(ii) It is usually the case in questions of this type that the mark is awarded for reasoning and not, in this example, for stating that force **B** has the same numerical value as force **A**. However, candidates must make this initial statement before the reasoning is marked. Candidates could either state or imply that the cyclist shows no vertical motion or that the forces **A** and **B** are balanced. The term *equal* was not accepted as an alternative for the term *balanced,* although *equal and opposite* did gain credit.

(b) It is often the case that partial credit may be given for these types of calculation even though candidates do not arrive at the correct final answer. Partial credit might be given for a clear statement of a relationship or mathematical formula that is relevant to the calculation. Partial credit may also be awarded for a correct logical step in the calculation. For this reason candidates should set out their working in a clear and well-organised manner to make it more likely that correct statements worthy of partial credit are recognisable. Responses to this question produced all possible marks with many candidates gaining full credit.

(c) The calculation of kinetic energy using the relationship $\frac{1}{2}mv^2$ is frequently examined and candidates in the upper part of the mark range were well-prepared. The general comments about clear presentation made in the report on **3(b)** also apply here.

(d) (i) This was a straightforward calculation for those candidates familiar with the relationship between energy, power and time. Only a very small number of candidates obtained the correct answer. A large number of candidates had not identified which relationship they should be using, and a variety of incorrect versions of the calculation emerged.

(ii) The relationship between work, force and distance moved is usually very well-known and many more candidates worked through to the correct answer in this question than in **(d)(i)**.

(iii) The general comments made in the report on **3(b)** are particularly relevant in this question. Since many had difficulties with **(i)** then full credit was not available in this part but a correct statement about the calculation of efficiency did gain partial credit. A common mistake was the inversion of the ratio between energy output and input. A numerical error arising from the correct use of the efficiency expression using incorrect data from parts **(i)** and/or **(ii)** gained partial credit, provided the calculation had been set out clearly enough for this judgement to be made.

Question 4

(a) The terms geotropism or gravitropism were familiar to some candidates although this familiarity did not seem connected to their final overall score on the paper. The most common mistake was to suggest phototropism despite the clear indication in the diagram that the seed had germinated underground. Many candidates were unfamiliar with either term.

(b) (i) A small number of candidates drew a fully correct diagram and many others gained partial credit. Usually, partial credit was given for a correct prediction of the way the root would develop. Common mistakes included showing the shoot and root developing horizontally and showing the shoot developing in the same direction as the root (positive geotropism for both).

(ii) There was some evidence that candidates had learned about the role of auxins in phototropism but they were unfamiliar with their role in geotropism. Many candidates made general comments that lacked scientific detail or tried to answer the question in terms of phototropism.

(c) (i) Full credit here was for a reference to the main compounds released from the burning of fossil fuels that cause acid rain and the fact that these compounds react chemically with water in the atmosphere. The expected compounds are sulfur dioxide or nitrogen oxides and candidates needed to make a clear statement about the way these gases combine with water. Many candidates discussed this environmental issue in terms of carbon dioxide which did not gain a mark. References to clouds were also not credited. Common mistakes included the idea that combustion of fossil fuel creates sulfuric acid which rises into the atmosphere, condenses and then falls again as acid rain.

(ii) Only a minority of candidates referred to the denaturation of enzymes. Some discussed harmful effects on soil but only in a very general way that lacked any scientific information. The majority of candidates made a general comment that acidity is either bad for plants, is harmful for plants or kills plants, the lack of scientific detail leading to loss of credit.

Question 5

(a) The completion of electronic structure in atomic diagrams was very familiar to candidates from across the mark range. Weaker answers showed diagrams that contained twenty four electrons, although partial credit was gained if eight electrons were shown in the second shell.

(b) (i) More able candidates usually gained full credit here. A common misconception was the idea that mass decreased because the magnesium dissolved or was no longer visible and so must have gone somewhere. The idea that the reaction had gone to completion was better understood and many candidates gained partial credit for their answers to the second part of the question.

(ii) Full credit for this balanced equation was more commonly awarded to candidates from the higher end of the mark range. Some candidates adjusted the missing chemical formulae to generate a numerically balanced equation but, in these questions, credit for balancing is always dependent on correct chemical formulae.

(c) (i) The effect of changes in conditions on reaction rate and its explanation in terms of collision theory is very frequently examined, and some candidates were well-prepared. Candidates who gained full credit discussed an increase in the frequency of collisions rather than simply stating that there would be more collisions. Answers in terms of higher energy of collisions were also accepted although the concept of activation energy is not included in this syllabus.

(ii) Many candidates gained full credit. Some responses suggested that candidates associated the term catalyst only with enzyme reactions and suggested that at the end of the reaction the catalyst would be denatured. Others gained partial credit for stating that rate would be increased but then were not familiar with the idea that the catalyst would not suffer permanent change.

Question 6

(a) (i) Many candidates did not recognise that they needed to choose one of the three mechanisms of heat transfer. The numbers of candidates suggesting convection or radiation were similar to those who gained the mark for conduction. Some candidates suggested that the man's clothing would be so insulating that heat transfer would not occur. Others answered a different question and explained the meaning of the term thermal insulator.

(ii) Some candidates realised that this question concerned the retention of heat by the man's body. The mark was awarded to those who explained that air acts as a (thermal) insulator. In answering questions like this one, candidates should avoid discussing the idea that heat is trapped. The other common misconception is the idea that it is the cold that is transferred, in this case, from the outside into the body.

(b) (i) Many candidates realised that at the elevated temperature of the engine, the products from the combustion of the fuel would be formed as gases. This led them to identify diagram **Z**. Credit was gained by those candidates who described the features visible in the diagram that showed **Z** to represent the gaseous state. Thus credit was gained by candidates describing widely separated particles and was not gained by candidates making statements such as **Z** *because it is a gas*.

(ii) Not many candidates linked all the information given in **(b)** to identify the white trails as containing ice. Many suggested water and carbon dioxide without the additional stage of the water freezing on contact with very low temperature.

(c) (i) Most candidates believed satellite communication was via radio waves. Only a very small number gained the mark here.

(ii) The error for suggesting radio waves in **(i)** was carried into this question and many candidates gained the mark because they had learned the electromagnetic spectrum very well.

(d) (i) The mark was gained by those candidates who made a clear comparison of the relative speeds of electromagnetic waves and sound waves. Several answers suggested that candidates may have understood the reason for the delay but their answers lacked clarity, a typical example is the unqualified statement *sound waves take more time to travel*.

(ii) It was not enough in answering this question simply to make statements such as *by sound waves* which many did. Partial credit was given to candidates who described sound waves in terms of (air) particle vibrations or (air) particle motion. Those candidates who also referred to vibrations originating from the engines which then set off the air particle motion gained full credit.

Question 7

(a) Candidates have usually learned by heart the balanced equation for photosynthesis. Only one mark was available and so candidates needed to get the equation correct in every detail which many did. Essentially, credit depended on whether candidates had revised this topic effectively, and correct answers were seen throughout the mark range.

(b) (i) This question was fairly well-answered and many candidates successfully drew a path from point **Y** through the stoma to the cell labelled **Z**.

(ii) The location of xylem vessels was very unfamiliar to most candidates and very few gained the mark. Incorrect suggestions for xylem vessels included every other type of structure in the diagram, with none particularly more frequently suggested than any other.

(c) (i) Candidates did not recognise that the water molecules referred to in this situation were coming from within the leaf, and consequently attempted to answer this question in terms of ingress of water from outside.

(ii) Significant numbers of candidates wrote answers that stated the inverse of the effect of humidity on transpiration rate. This showed unfamiliarity with the fundamental idea in science that net particle movement seeks to minimise a concentration gradient. An example of a typical incorrect answer that was seen many times is *transpiration rate is greater in **B** because there are more water molecules outside trying to get in.* The description of transpiration as the diffusion of water out of the leaf was given to candidates in the previous question and this could have helped them to answer this one more successfully.

Question 8

(a) Many estimates falling within the accepted temperature range were seen throughout the mark range.

(b) (i) This question was successfully answered by large numbers of candidates throughout the mark range, suggesting familiarity with the consequences of differing metal reactivity.

(ii) Full credit was gained by those candidates who described the transfer of chemical energy to thermal energy. The term heat energy is accepted as an alternative to thermal but candidates should be advised to use the term thermal energy. The term potential energy is not accepted as an alternative to chemical in this context because it is too general. Partial credit was available if only one of the relevant forms of energy was correctly identified.

(c) (i) Large numbers of candidates appeared to be unfamiliar with either the correct answer *cathode* or the likely incorrect answer *anode*. A variety of suggestions were seen including the names of several different substances.

(ii) A very small number of candidates gained the mark for *chlorine.* The most common answer across the mark range was *hydrogen* which suggests that candidates were answering in terms of the electrolysis of aqueous rather than molten sodium chloride.

(iii) Only one mark was available and candidates had to state or imply that the electrolyte had to be molten to allow ions to move (towards electrodes). It was not enough to state that ions could more easily be separated or that melting was needed to weaken intermolecular attraction. Only a minority of candidates gained this mark.

Question 9

(a) (i) Several candidates correctly stated that the reading would be 4.5A but could not explain the reason clearly. Many candidates did gain the mark showing that they had prepared well for questions involving electrical circuits.

(ii) Partial credit was awarded for recognising that the resistances of the two arms of the parallel circuit must be different, and candidates towards the higher end of the mark range tended to gain at least one mark. Some candidates missed a mark because they suggested that the difference in resistance must lie in the ammeters or the switches rather than in the resistors.

(b) (i) Many candidates realised that the circuit described in this question had become a simple series circuit and so gained the mark for knowing that the current at all points in a series circuit is the same. Some unfortunately overlooked the fact that the current had decreased from 6A to 3A.

(ii) Candidates had to use the information given to deduce the potential difference across resistor R_1. Unless candidates could do this it was not possible to arrive at the correct value of the resistance of R_1. Partial credit was awarded to those candidates who attempted to apply Ohm's Law.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

It is important to read all of a question before starting to answer it. For example reading beyond the instructions for the graph might provide information about the extent of the scales.

General comments

Very few candidates were unable to complete this practical paper. The Chemistry question proved to be the most challenging question, probably because it approached analysis in a slightly different way.

Comments on specific questions

Question 1

Most candidates knew that Benedict's test needs heating.

In **(b)** it was clear that nutrients in chickpea varied according to the source. Allowance was made for this if the supervisor's report included a set of results as requested. Generally the expected results were seen for banana and egg white. Some candidates placed ticks and crosses in the table instead of a record of what they saw.

The conclusions in **(c)** had to be consistent with the observations recorded in **(b)** rather than the expected nutrients. There are still a significant number of candidates who believe that this test is for any sugar or carbohydrate. Glucose was accepted as an alternative response to reducing sugars.

Knowledge of the test for fats in **(d)** was better than when last tested. Some candidates proposed the use of ethanol without water but were still credited for ethanol. The idea of an emulsion being formed in the presence of a fat was required for the last mark and mention of a precipitate only was not accepted.

Question 2

This question required candidates to identify pairs of compounds and later identify two compounds. Candidates needed to be able to use the Notes for Qualitative Analysis on the back page of the question paper and to know about alkalis. This caused problems in many cases so in **(a)** a lower number than expected were able to identify H as being a neutral solution, hence the two salts silver nitrate and barium nitrate, and J as being an alkali, ammonia or sodium hydroxide. Some candidates gave one compound for H and one compound for J at this point.

Part **(b)(i)** can be quite tricky to carry out and in many cases candidates were not able to isolate the white precipitate by filtration. Some did not appreciate that they were adding copper sulfate to ammonia rather than the more usual ammonia to copper sulfate and wrongly quoted the observations from the Notes for Qualitative Analysis.

A good number of candidates were able to identify J as ammonia in **(b)(ii)**. Significantly less were able to identify H as barium nitrate, perhaps because they did not isolate the white precipitate of barium sulfate in the previous part.

The last part required a lot of thought and pleasingly many candidates realised that iron(III) sulfate would not distinguish between the two alkalis because the observation would be the same brown precipitate in both cases.

Question 3

This experiment worked well and most candidates generated a good set of results. Common errors were recording the meter readings in milliamps and millivolts and recording the current to only one decimal place. Resistance values were generally well calculated. Some candidates incorrectly recorded their resistance values to an inconsistent number of significant figures. Correct rounding should be carried out rather than leaving an unrounded number with the recurring symbol. Similarly if three significant figures is chosen as the appropriate accuracy then a value of 8.00 would be more appropriate than 8.

Graph plotting skills were good. Common errors were not starting the scales at the origin, non-linear scales, difficult scales, which usually resulted in candidates making mistakes in the plotting of points, and poor best-fit straight lines. Often the non-linear scale was between zero and 20 cm so the candidate was able to gain the plotting, line and gradient marks. Non-linear scales throughout the *y*-axis resulted in no marks for the graph, extrapolation and gradient. Consequently construction of linear scales is an essential skill.

Many candidates did not construct a scale to include l = 110 cm, probably because they had not read ahead of **(b)**. These candidates were still able to access the mark in **(c)(i)** if they extended their line beyond the grid and accurately measured the value of R for l = 110 cm.

The relationship in **(c)(ii)** was well understood and clearly stated in most cases.

COMBINED SCIENCE

Paper 0653/52
Practical Test

Key messages

It is important to be aware of possible sources of inaccuracy in an experiment. This is a skill which can be practised.

General comments

There was a good balance of marks between Biology, Chemistry and Physics. It was rare to see a script with parts unanswered.

Comments on specific questions

Question 1

The drawings of a flower were generally well done and were rarely too small or too large for the box. Some drawings did not depict the ovary.

In **(b)**, candidates were asked to draw a straight line across their drawing from one edge to the other. It was anticipated that this would be from left to right across the widest part. Some candidates did not draw the line but carried out the measurements. Other candidates drew vertical lines or lines across narrow parts of the drawing. These variations were all allowed. Lengths of the line were well measured. A small number of candidates recorded the lengths in centimetres rather than millimetres. Many candidates processed the measurements incorrectly to obtain reciprocals of the magnification. Some candidates gave the magnification as a ratio or as a percentage. This was accepted if some mathematical processing had been carried out.

Benedict's solution was well known as the reagent required in **(c)**. Most knew that heat was required. Some candidates wrongly proposed heating the flower before testing with Benedict's solution. Linking the colour to the amount of reducing sugar was less well done. Some candidates just discussed the identification of reducing sugars. Others discussed darkness of the mixture with no reference to specified colours.

Question 2

The results of some centres were unexpectedly low. This was caused by the reduced activity of certain batches of marble chips. It is important to check that the chemicals listed in the Confidential Instructions react in the usual way.

Most candidates carried out **(a)(i)** and **(a)(ii)** correctly. A small number confused the columns in the recording of V_1 and V_2. In **(a)(iii)** the recording of temperature to the nearest 0.5°C was tested. Technically readings should have ended in .0 or .5. Whole numbers were accepted in this case. Some candidates recorded volumes lower than in **(i)** and **(ii)**, suggesting that too much air was allowed into the measuring cylinder in these earlier parts.

Most candidates calculated the volume of gas collected correctly. A small but significant number added V_1 and V_2.

In **(b)(ii)** candidates were instructed to use their graph to describe the relationship between temperature and rate. This was generally done well. Some candidates gave the expected relationship when their data suggested an alternative relationship.

A large number of candidates proposed the same method for **(c)** and consequently their answers were not credited. All three methods in the mark scheme were seen and a small number of candidates proposed the equally acceptable timing of limewater to go milky. All too often in this type of question the apparatus is described but details of the measurements are omitted.

Question 3

Generally the first three measurements in **(a)** were recorded correctly to an appropriate accuracy and the calculation of the volume well done. The units for density were fairly well known and many candidates were able to record the density to two or three significant figures and with correct rounding.

Most candidates were able to describe one possible source of inaccuracy. Few described two. The reading of the volume on the measuring cylinder was the most common correct response.

Part **(b)(ii)** was not well answered. Many answers were too vague and did not relate the change in the calculated value of density to the chosen source of inaccuracy. Error carried forward was often applied here.

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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 syllabus.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard and food tests were well known. 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 and to draw smooth curves with a single line. 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. Knowledge of identification tests for ions was limited and many found drawing diagrams of apparatus very difficult.

Comments on specific questions

Question 1 – Food Tests

(a) About half of the candidates gained credit and although all reagents were seen biuret was the most common incorrect response.

(b) Many candidates gained partial credit with some gaining full credit. Many candidates gave remains the same or doesn't change for the negative tests, or omitted the tests for the negative results, none of which gained credit as the question asked for colours. Common incorrect responses included: colour of the biuret solution itself to be purple and colour of iodine in starch to be blue.

(c) Many candidates gave the method from the stem of the question and so did not gain credit. Control of the amount of the two solutions was seen from more able candidates. Many thought that either the degree of redness or the speed that the solution changed to red indicated the amount of sugar content.

(d) The addition of alcohol was well known but the subsequent addition of water was seen rarely. A significant number of candidates gave the result as suspension or precipitate rather than emulsion.

Question 2 – Identification of Solutions

(a) Some candidates gained credit for **H** but fewer appreciated that **J** was alkaline. Often candidates gave one of the correct substances and gave an acid for the other in each pair.

(b) (i) Candidates found this very difficult and a significant number omitted the question. Many added copper oxide to sulfuric acid and crystallised. Many used electrolysis and some fractional distillation.

(ii) More able candidates identified **J** but far fewer identified **H**.

(c) Candidates found this very difficult with few gaining any credit. Some discussed the relative reactivity of copper and iron, some thought that because iron(III) would not give a blue colour then it would not be useful and others discussed displacement reactions.

Question 3 – Resistance of a Wire

(a) The vast majority of candidates read the voltage correctly. A few candidates gave 0.37.

(b) (i) While most candidates performed both calculations correctly many didn't follow the pattern of data in the table and only gave the answer 2 to one sig.fig., hence gaining credit for the second calculation only.

(ii) Whilst generally the graph was done well, there were still a large number of candidates who had non-linear axes mainly the x-axis.

(c) (i) Many candidates gained credit. The most common error was attempting to read a value from a non-linear scale.

(ii) The relationship was well described by many. The most common error was to describe the relationship as proportional when their line of best-fit didn't pass through the origin.

(d) Candidates found this very difficult. Common non-creditworthy responses included: varying thickness of the wire, voltmeter broken, not increasing the length in regular amounts. Those that gave an inaccuracy often didn't give a correct associated precaution.

Question 4 – Blood

(a) The majority of candidates gained credit.

(b) (i) The majority of candidates correctly labelled the red blood cell but a significant number did not gain credit for the platelets.

(ii) The quality of the drawings varied enormously. Many candidates drew an enlarged cell but some had difficulty with the three lobed nucleus. A significant number ignored the white cell in the diagram and drew from memory either an animal cell or a plant cell with all of their associated features. Many didn't label the cell. Common incorrect labels included: the nucleus labelled as an antibody and the outer membrane labelled as the cell wall.

(c) (i) Whilst many candidates measured the cell correctly, a large number then recorded the measurement in cm or gave 80 or 90 mm.

(ii) Most candidates did not give the measurement to the nearest 0.5 mm and gave an integer value.

(iii) Most candidates calculated the magnification correctly but a large number then did not give the answer to the nearest whole number. A small number inverted the division.

Question 5 – Rate of Reaction

(a) Candidates found this difficult and quite a large number omitted this question. More able candidates gained credit usually for a syringe and its label. Many candidates attached a sealed test-tube to the delivery tube or collected over water into a test-tube with no graduations or into a beaker. A few collected into a balloon.

(b) The majority of candidates calculated the values correctly.

(c) Whilst many candidates chose 2.5 many gave the reason that higher concentration leads to a faster reaction with no reference to the data. Some cited 65 cm^3 of gas given off without an interpretation of this being the largest. A small number chose 0.2.

(d) (i) More able candidates gained credit. A wide variety of equipment was named but pipette, burette, syringe and measuring cylinder were the most common.

(ii) More able candidates gained credit. Measuring cylinder was a common incorrect response.

(e) (i) More able candidates gained credit. Mass or amount of calcium carbonate was the most common incorrect response and volume of acid was seen often.

(ii) Many candidates gained credit. Fair testing and correct result were non-creditworthy responses seen quite often.

(f) Many candidates gained full credit here. However almost as many candidates thought the gas given off was hydrogen and of these many gave the test using glowing splint. Chlorine, oxygen and ammonia were also seen quite often.

Question 6 – Heat transfer

(a) Quite a few candidates gained credit. Common incorrect responses included: clasp, holder, tongs, stand and claw.

(b) Candidates found this difficult. Common non-creditworthy responses included not using mercury thermometers, goggles, lab coat, tying hair back.

(c) (i) Most candidates plotted the two points correctly.

(ii) Many candidates gained partial credit for the smooth 'reverse s' shaped curve but many either drew the curve through the anomalous point or shifted the curve a long way towards it. A small number drew a straight line.

(iii) Many candidates estimated the temperature correctly but of these many did not show on the graph how they had reached this estimate.

(iv) Many candidates correctly described the relationship although some did not use the variables identified in the question. Few candidates appreciated that the decrease was non-linear or that the temperature was becoming constant.

(v) Generally well answered but lamp too far away was seen quite often with no reference to the temperature.

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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.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard, calculations were done well and food tests were well quite known. The standard of graph drawing was generally high although candidates need to remember to include quantities and units on the axes and to draw smooth curves with a single line. 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.

Comments on specific questions

Question 1 – Flowers

(a) (i) This was well answered with almost all candidates gaining some credit and some full credit. Some candidates drew feathery outlines rather than clear solid lines or drew very small flowers. A significant number drew a flower from memory rather than the one in the photograph and so drew many petals rather than just the two. Most candidates included the internal flower parts.

(ii) Both structures were well known but there was sometimes ambiguity in where the label lines ended. Common errors included labelling the filament as the anther, and reversing the labels.

(b) (i) A significant number omitted to draw the line or measured in cm.

(ii) Calculation of magnification was well answered although a significant number inverted the division.

(c) Many candidates drew the circle on their drawing rather than on the photograph but if correct these were credited. Common errors: circling the whole structure or the anther.

Question 2 – Reaction Rate

(a) (i) Almost all candidates calculated the values correctly.

(ii) Generally the graphs were quite drawn well. However, axes were sometimes unlabelled and of those that were labelled the units were often omitted. A significant number chose a scale which did not extend over at least half of the grid. Candidates often plotted the points correctly but then opted to draw a straight line rather than a curve. There were a small number of feathery or multiple lines drawn. A significant number of candidates plotted the values for V_2.

(iii) The relationship was described well although a number of candidates discussed the volume of gas rather than the rate.

(b) (i) Few candidates gained credit. Many thought that the reaction would be faster in the second minute or that the gas needed time to travel into the measuring cylinder.

(ii) Few candidates gained credit. The most common responses were that the marble chips had already been used up or that the experiment would not have been fair.

(iii) More able candidates gained credit, usually for the syringe, with the most able gaining full credit for appreciating that the measurements needed to include timing. Many candidates redrew the diagram from the question stem which was not creditworthy.

Question 3 – Density of Water

(a) (i) The majority of candidates gained credit but a significant number gave 51.27.

(ii) Most candidates read the volume correctly.

(iii) More able candidates gained credit. Common non-creditworthy responses included allowing the water to settle, using a more precise measuring cylinder or getting someone else to check the results.

(iv) The majority of candidates calculated the value correctly but fewer gave the correct unit. Common incorrect units included g, kg, cm^3.

(b) (i) The majority of candidates calculated the volume correctly.

(ii) The majority of candidates calculated the value correctly but fewer considered the number of significant figures appropriate and so gave the answer 1.

(c) (i) Few candidates gained credit. Common non-creditworthy responses included: reliability, to get an average, test-tube not vertical.

(ii) Few candidates gained credit. Many thought that the experiment was being repeated for reliability or accuracy or for checking the answer rather than considering the order of the processes.

Question 4 – Sugar and Starch content of Plants

(a) Many candidates gained partial credit but many of these did not include a time factor. A significant number thought the plant should be boiled in alcohol to destarch it.

(b) (i) Most candidates gained partial credit usually for iodine and sometimes for the correct colour. Few candidates appreciated the need to remove the chlorophyll by warming in alcohol. Many colours were seen for iodine including orange, brown, blue and dark blue.

(ii) Many candidates gained credit for the reagent and correct colour change but few remembered that heating is required.

(iii) Whilst most candidates gave a safety precaution, few explained why that precaution should be taken and so did not gain credit.

(c) More able candidates gained credit. Many cited either' light' or 'carbon dioxide' rather than both. A significant number only repeated the results from the Table.

Question 5 – Salt Preparation

(a) (i) Only the more able candidates appreciated that an observation was needed in order to gain credit. The most common non-creditworthy responses were that the copper sulfate was no longer dissolving and a blue solution was forming.

(ii) Most able candidates gained credit. Incorrect responses included: to form crystals, to complete the reaction and to concentrate the solution.

(iii) Filtration was well known. Common incorrect responses included heating and distilling.

(b) (i) Very few candidates gained credit, many thought the copper sulfate was burnt since it was black. Many thought that the copper had reacted with oxygen.

(ii) More able candidates appreciated that the solution needed to be heated but few gained further credit. Many candidates repeated the initial stem describing the formation of the copper sulfate solution.

(c) Many candidates knew the sulfate test but many used silver nitrate and a significant number omitted the question.

(d) Many candidates gained at least partial credit with many gaining full credit. The most common incorrect response was zinc and chlorine.

Question 6 – Evaporation and Temperature

(a) (i) Many candidates gained credit but several used a measuring cylinder. A teat pipette or dropping pipette should not simply be called a dropper. Many described how the cotton wool should be held, for example with tongs.

(ii) More able candidates gained credit. Many thought incorrectly that this was needed for the cotton wool to absorb the same amount of alcohol.

(b) (i) Most candidates read the thermometers correctly.

(ii) Whilst most candidates calculated the value correctly many did not follow the pattern of data in the question with regards to decimal places and so gave a value of 9.

(c) (i) Many candidates gained credit. Common incorrect responses included 120 s and 150 s.

(ii) Candidates found this quite difficult. Many discussed changes in the room temperature, or the student touching the thermometer or errors in timing.

(d) More able candidates gained credit. Common incorrect responses included: the end of the reaction, it has reached its lowest temperature and the alcohol is evaporating.

(e) Candidates found this very difficult. More able candidates appreciated that the temperature was decreasing but didn't appreciate that the rate of decrease was decreasing and so gave a straight line.

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Key messages

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General comments

Candidates from some Centres demonstrated good understanding of practical knowledge. The reading of the instruments was of an excellent standard. The standard of graph drawing was generally high although candidates need to remember to draw straight lines with a ruler. Undertaking practical work helps the candidates to state observation and to interpret and evaluate experimental methods, techniques and results. Knowledge of identification tests for ions was limited and many found drawing diagrams of apparatus difficult.

Comments on specific questions

Question 1 – Respiration in Yeast

(a) The majority of candidates read the volumes correctly. 16.2 was seen a number of times.

(b) Generally the graphs were well drawn, linear axes and plotting of the points scoring most highly. Common errors included: not labelling the axes or labelling the axes and either omitting the units or giving the unit of time as m, drawing a straight line which ignored many of the points, drawing a dot-to-dot line or a feathery line.

(c) (i) Many candidates gained credit. Common incorrect responses included: oxygen, hydrogen, ammonia, and sulfate.

(ii) Candidates found this more difficult with quite a large number omitting the question. Common incorrect responses included: evaporation and oxidation.

(d) (i) The majority of candidates gained credit but a significant number either drew a line totally or partially above the original line.

(ii) Quite well answered but the most common incorrect response was time.

Question 2 – Identification of Ions

(a) (i) Candidates found this difficult. Most connected a delivery tube between the two test-tubes but many had a bung in the tube containing the limewater or did not have the delivery tube dipping into the limewater. Many did not label the delivery tube.

(ii) Few candidates gained credit. Answers included: to stop explosions, to stop the reaction, so that only the gas goes into the limewater, to absorb all the gas and to stop the gas escaping.

(iii) Few candidates gained credit. The most common incorrect responses were it contains or is carbon dioxide. A significant number described the colour change.

(b) A small number gained partial credit, usually for copper sulfate and even fewer gained full credit. Many substances were given including iron(II), sodium sulfate, carbon sulfate. Many omitted either one or both substances.

(c) Candidates found this difficult and many omitted the question. Answers seen were varied and showed no pattern.

(d) Few candidates could recall this test and those that did often did not include the confirmatory result. Many omitted the question. A wide variety of responses were given including Universal Indicator, silver nitrate and colour changes.

(e) (i) A small number of candidates gained credit. Many omitted this question. Answers seen were varied and showed no pattern.

(ii) Few candidates gained credit and many omitted this question. Some thought the residue had already been filtered out but other answers seen were varied and showed no pattern.

Question 3 – Focal Length of a Convex Lens

(a) (i) Many candidates measured this correctly. Common incorrect responses included 15, 25, 35 and most commonly 37.5.

(ii) Those candidates that answered **(a)(i)** correctly usually answered this part correctly. Few candidates gained credit as error carried forward from **(a)(i)**.

(iii) Whilst many candidates calculated the two values correctly many did not gain credit as they did not follow the pattern of data in the table and gave the answer as 40 rather than 40.0.

(b) Few candidates gained credit. Common non-creditworthy responses included: make accurate measurements and repeat.

(c) (i) Generally the graph was drawn well but often the line was drawn without a ruler or was a dot-to-dot line.

(ii) Many candidates gave a correct intercept for their line but some candidates did not extend their line to the y-axis and often guessed at an intercept value or omitted this question.

(iii) Those candidates who gave an intercept value in **(c)(ii)** usually calculated the value correctly and often it was within the limits of accuracy.

Question 4 – Effect of Temperature on Germinated Seed Growth

(a) Most candidates gained partial credit, usually for water and some gained full credit. Many candidates thought light was required and a significant number thought nutrients were needed.

(b) Many candidates gained credit. Tying the shoots to a stick was the most common non-creditworthy response.

(c) Most candidates gained full credit and the rest gained partial credit.

(d) A significant number of candidates omitted this question. Many of the remainder recalled Benedict's although iodine and biuret were seen quite frequently. The confirmatory colours were quite well known but heating was not seen often.

(e) A significant number of candidates gained credit but many thought it to be for either better or more accurate results or to compare between dishes.

Question 5 – Rate Of Reaction

(a) Some candidates appreciated that the volume of gas needed to be measured although many discussed amount of gas or movement of the syringe. Few candidates appreciated the need for a time measurement.

(b) (i) Candidates found this very difficult and few gave an observation; most said the reaction would be faster or more gas would be made. Whilst some candidates appreciated that the measurement of gas would be larger, few included a time reference and so did not gain credit.

(ii) Many candidates gained partial credit for trials with more surface area or repeats and a few gained full credit. Using a different metal was seen quite often.

(iii) Many candidates gained partial credit, often for temperature, and some gained full credit. Common incorrect responses included time, amount of magnesium and same apparatus.

(c) Some candidates knew the gas given off and gave the correct test. Several tested with a glowing splint or just referred to the squeaky pop test, neither of which gained credit. Common incorrect responses included oxygen, carbon dioxide and magnesium oxide.

Question 6 – Energy Transfer

(a) Most candidates read the distance correctly. 44 was seen a few times.

(b) (i) The plotting of the point was quite accurate but some misread the scale and placed the point too high. The drawing of the line proved difficult with many drawing a curve including the anomalous point or a straight line.

(ii) Many candidates described the basic relationship but almost no-one appreciated that the increase in distance was deceasing.

(c) More able candidates increased the angle but few specified a range or a high enough number of values. Many thought the mass of the ball bearing should be constant despite the size changing.

(d) (i) The energy change was quite well known but thermal and chemical energy were seen quite often and the energy change was sometimes reversed. A significant number omitted the question.

(ii) More able candidates gained credit. Many candidates just wrote the word friction with no explanation and a few thought it would avoid damage to the bench or would keep the ball in place. A significant number omitted the question.