COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

Comments on specific questions (Biology)

Question 2

Responses **A** and **C** had an equal appeal for candidates; the weaker candidates were more likely to choose C.

Question 4

Very few candidates believed that light is not necessary for photosynthesis. A significant minority believed that oxygen is a necessary requirement for photosynthesis.

Question 7

This was a question testing simple knowledge of heart structure. Candidates need to be able to refer to the names of parts of the heart with confidence.

Question 9

Over a third of the candidates did not realise that a geotropic response is a response to gravity, since their answers related to the shoot's response to light.

Question 13

This question was answered very well, demonstrating that candidates are aware of the harmful effects of deforestation.

Comments on specific questions (Chemistry)

Question 17 and **26** were the questions that candidates found most easy across the board, indicating a good mastery of the conditions needed for rusting and the writing of simple chemical formulae

In **Question 17** the most common incorrect response was **C**, indicating that some candidates did not appreciate the difference between steel and iron.

Question 14 was answered well by all ability candidates

In **Question 20** a significant minority chose the distractor **C** rather than the key, **D**. This suggests that candidates may be confusing molecules of a single element (in **C**) with molecules of a single compound (in **D**).

Candidates found **Question 22** the most challenging. The most commonly chosen incorrect response was **C,** indicating candidates were not expecting to see a coloured gas. **D** was the least commonly chosen incorrect response, suggesting candidates knew that copper would be deposited and it would be brown, not silvery coloured.

Almost all the candidates answered **Question 26** correctly.

Comments on specific questions (Physics)

Question 28 was the best answered question. Candidates found **Questions 29, 34** and **35** the most challenging.

Question 29

In this question only a small minority of the candidates appreciated that, as they are made of the same substance, the two cubes will have the same density regardless of their dimensions.

Question 31

Some candidates believed that the skin would warm as a result of evaporation.

Question 33

The most popular distractor in this question was **D**, candidates not appreciating that all the water in this example would be heated, so convection currents could take heat energy up to the ice to melt it.

Question 34

Only a minority of responses were correct here, with evidence of widespread guessing.

Question 35

The candidates found this very challenging. This question concerned the only situation in which the angle of refraction can be equal to the angle of incidence when a ray of light travels from glass into air, that is when both are 0^{o}. The majority of candidates opted for 45^{o} as the answer.

Question 36

Candidates should be aware of the sequence of types of wave in the electromagnetic spectrum.

Question 39

Almost one in three candidates believed incorrectly that a current of 5A would blow a 13A fuse and cause a fire.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

Comments on specific questions (Biology)

Question 2

Responses **A** and **C** had the greatest appeal for candidates, although it was clearly the better candidates who appreciated that only carbon dioxide is diffusing into the leaf from an area of higher concentration.

Question 7

This was a question testing simple knowledge of heart structure. A significant number of the candidates are unsure of the names and positions of the heart valves.

Question 9

A significant minority of the candidates did not realise that a geotropic response is a response to gravity since their answers related to the shoot's response to light.

Question 11

In a question that generally proved relatively easy, a few of the better candidates selected the answer that suggested that an ovary releases an ovum once every 14 days.

Question 13

The effect of deforestation is a topic with which candidates are comfortable, as this proved the easiest question in the Biology section of the paper.

Comments on specific questions (Chemistry)

Those who chose wrong answers for **Question 15** were evenly split between the two distracters which included Carbon Dioxide as a product. Candidates needed to look carefully at the equations included in each option to determine which option included Oxygen as a reactant

A significant minority chose distractor **D** of **Question 19**, suggesting that they believe that a metallic ion can form a compound with another metallic ion.

A significant minority chose distractor **C** for **Question 20**, indicating that these candidates may be confused as to the difference between an element and a compound.

In **Question 22** a significant minority chose the distractor **C** rather than the key, **A**. Candidates clearly knew that a red-brown solid would form at the cathode, but were confused as to the colour and nature of the product formed at the anode.

Question 25: A significant number of candidates believed that magnesium reacts with water to produce a purple flame.

While **Question 26** was the easiest question in the Chemistry section, the most commonly selected incorrect answer was **A**, suggesting that some candidates had confused empirical formula with molecular formula.

Comments on specific questions (Physics)

Question 28 was found to be the easiest, with **Questions 29**, **34** and **35** being answered les well.

Question 29

In this question a large proportion of the candidates needed to appreciate that, being made of the same substance, the two cubes would have the same density regardless of their dimensions.

Question 31

Just over one in four believed that the skin would warm as a result of evaporation.

Question 33

The most popular distractor in this question was **D**. Candidates needed to take into account that all the water would need to be heated so that convection currents could take heat energy up to the ice to melt it.

Question 34

A minority of candidates answered this question correctly, with evidence of widespread guessing.

Question 35

Candidates needed to realise that the only situation in which the angle of refraction can be equal to the angle of incidence when a ray of light travels from glass into air is when both are 0^{o}.

Question 36

A significant proportion answered this incorrectly; candidates need to know the order of waves in the electromagnetic spectrum.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

General comments (Biology)

All questions on the biology section of the paper were correctly answered by more than half of the candidates taking the paper.

Comments on specific questions (Biology)

Question 2

The better candidates appreciated that only carbon dioxide is diffusing into the leaf from an area of higher concentration.

Question 7

Heart structure is clearly a topic that many candidates find challenging. Candidates need to appreciate that atrial walls are not as thick as those of the ventricles.

Question 10

Candidates generally found this question easy. A small minority did not know that an ovum is released by the ovaries at monthly intervals.

Question 13

Although this was the easiest question in the Biology section, it was to the candidates' credit that they appreciated the importance of plants absorbing a potentially harmful greenhouse gas.

General comments (Chemistry)

Candidates found Question 17, 19, 24 and **27** very accessible.

Comments on specific questions (Chemistry)

In **Question 17** the most common incorrect response was **C**, indicating that some candidates did not appreciate the difference in the reactivities of steel and iron.

In **Question 22** there is some evidence that, while candidates recognise the gases that constitute the major part of air, they are unfamiliar with their relative proportions in air.

In **Question 24** the most common incorrect response was **C**, indicating that candidates were able to choose a gaseous response, even if not of molecules of HCl.

In **Question 26** A very significant proportion chose the distractor **A** rather than the key, **B**. Iodine is not a liquid at room temperature.

In **Question 27** the most common incorrect response was **B**, indicating that candidates know the direction of heat energy movement for endo- and exothermic processes, even if the deduction that this reaction is endothermic is incorrect.

Comments on specific questions (Physics)

Candidates found in **Questions 30** and **32** the easiest. The question that candidates found most challenging was **Question 40**.

Question 28

In this question on average speed, significant number of candidates failed to include the resting time when calculating average speed.

Question 29

A significant number of candidates calculated the density using only readings from the right-hand cylinder. Candidates needed to use readings from the right hand and the left hand cylinders.

Question 33

The most popular distractor in this question was D, these candidates failing to take into account that all the water would need to be heated so that convection currents could take heat energy up to the ice to melt it.

Question 34

Option **A** was chosen by a significant minority of candidates, suggesting that these candidates were unsure of the meaning of wavelength.

Question 39

The correct choice of a fuse was the topic of this question, and it was well understood. Of those who were unsure, the most common mistake was to opt for 3.0 A; this would provide protection, but would be unsuitable as the computer drew 3.1 A for a time when first switched on.

Question 40

There was widespread confusion over the effect of a variable resistor on the two lamps in this series circuit, with more candidates choosing distractor **C** than the key **(A)**.

COMBINED SCIENCE

Paper 0653/21

Core Theory

Key Messages

Having completed the paper, candidates should return to questions that have required extended answers and read them through again to make sure that what they have written makes sense and answers the question asked.

General Comments

A triangle of units used to help with the manipulation of an equation or formula is not the equivalent of the formula and does not gain a mark if used on its own.

Should a candidate wish to delete an answer, they need only put **one** line through it.

If, a question asks for a formula, candidates should write a formula down in the space allotted

Candidates should be encouraged to respond to **all** questions.

Comments on Specific Questions

Question 1

(a) (i) Most candidates referred to the reaction between sodium and chlorine, without explaining that the compound is *more stable*. Some used the term stronger, rather than *more stable*.

The best answers described sodium and chlorine as *very reactive.*

(ii) There were three possible answers for this question. The answer least commonly given, but which was most easily explained, was that '*elements are found in the Periodic Table*', with its alternative wording '*compounds are not found in the Periodic Table*'.

Man of the candidates who chose to answer the question by referring to the constituents of elements or compounds presented incomplete explanations. A frequently seen answer was '*compounds are made of two elements*', which excluded the possibility of compounds containing more than one element. Similarly, '*elements only contain one atom*' was not enough to gain credit. These answers needed to refer to '*one* **type** *of atom*'.

(iii) This question was well answered. Many candidates gained credit for *heating or boiling* and were able to present details of the apparatus used.

Fewer answers were accurate in their description of the liquid which evaporated.

Some candidates named the process as crystallisation, without any description. This did not answer the question asked.

(b) This proved challenging for many candidates. Many candidates used the phrases *fluoride atom* or *fluoride element,* rather than the correct *fluorine.* The other common error was that having explained the number 2 in regard to the fluorine, many did not make it clear that they understood there was one calcium particle for every two fluorine particles.

(c) (i) This was quite well answered especially by the higher scoring candidates.

(ii) Many candidates found this question difficult across the ability range, although most understood that the compound lead bromide had been separated. However many either did not explain what the gas was or they used the word brom**ide** for the gas, rather than the correct *bromine.*

Question 2

(a) This was well answered.

(b) Almost all candidates who gave the correct formula, $d = m / v$, gained both marks. Some gave the associated triangle. A triangle is an aid in manipulating a formula, not a formula.

Some candidates gave a formula using units instead of the commonly accepted symbols. These candidates could not gain credit for this.

(c) (i) The arrangement of particles in a solid was well understood. The question stated that it required only twelve molecules; most candidates unnecessarily filled the entire box with particles.

The liquid box proved more problematic. Most candidates managed drawings which indicated a random arrangement of the particles. However most did not show the majority of the particles touching, which was necessary for the mark.

(ii) Almost all candidates gave at least three correct answers.

Question 3

(a) (i) Candidates found this question challenging. Most candidates gave answers referring to the effect of hormones on emotions and in adolescence rather than defining a hormone.

(ii) This question was well answered. Most candidates referred to increases in heart rate.

(b) (i) Most candidates were able to describe the increase then decrease of the blood glucose concentration. Very few noted additionally that the increase was more rapid than the decrease. Many gave the time when maximum concentration was reached correctly. Many referred to the levelling out of the concentration at 100 minutes or 2 units or to normal.

(ii) Most candidates found this challenging, giving a description of the behaviour described by the graph for glucose concentration with fibre, rather than a comparison of the two graphs. However, many candidates did say that '*the concentration had not risen as high*'.

(c) This question was quite well answered by the higher scoring candidates. A number of the other candidates referred to fibre **causing** constipation and obesity. Some candidates stated simply that fibre helps digestion, which was not enough to gain credit.

Question 4

(a) (i) Very few candidates gave both Y and Z; most usually gave simply Z.

(ii) This was quite well answered. Some explanations which referred to the complete or full outer electron shell often failed to specify that the shell was in an atom and could not be awarded credit.

(b) (i) Many candidates gained the first mark for *Group I.* Some candidates then referred to the drop in melting points down the group as their explanation, rather than referring to the the proton numbers of the elements in the chart.

(ii) This was quite well answered. Some candidates did not limit their answer to the elements shown in Fig. 4.2. and explained that Francium would have the lowest melting point, since it was at the bottom of Group I

(c) (i) This was a very well answered question across the ability range.

(ii) Many candidates found it difficult to name both products. *Water* was the most common given correct answer for one of the products.

Question 5

(a) This was very well answered, across the ability range, with most candidates gaining both marks. A few gave a triangle than the correct formula *speed = distance/time*. A few other answers given used the dimensions for example *speed = kilometres/hours.* Neither of these were acceptable.

(b) (i) This was very well answered by all.

(ii) This again was a very well answered question. A small minority of candidates gave '*a steady speed*' as the answer.

(c) This generally was well answered. Most candidates understood what calculation was required and set it out clearly. Some candidates limited their answer to calculating 70% of the energy.

(d) (i) This was well answered. A few candidates gave *water* as their answer. Unlike *wind,* water is not a source of energy unless it is moving, or held high by a dam. Therefore phrases such as *waves, tidal power* and *hydroelectric power* would have been acceptable alternatives to *water*.

(ii) Many candidates referred to the absence of pollution or stated that solar energy was environmentally friendly. Candidates needed to be specific in their answers without repeating the information given in the question to gain credit.

Question 6

(a) This was a challenging question for all but the highest scoring candidates. Some confused the two names and some, with the correct names, added the term left.

(b) Many candidates referred to the muscles contracting and relaxing, without then going on to explain that it is during the contraction that blood is pushed out. A few very good candidates described the blood pressure as increased.

(c) This was generally answered well.

(d) Most candidates suggested that more oxygen was needed to supply the increased volume of blood flowing because of the increased heartbeat.

A few did say that because the heart was beating faster, it would need more oxygen. The very best candidates went on to explain that energy is obtained by respiration and respiration uses oxygen.

Question 7

(a) (i) The most common incorrect answer given was coal.

(ii) This proved a difficult question for candidates across the ability range. Candidates needed to state that the elements in hydrocarbons are only hydrogen and carbon. It was also necessary for the answer to refer to hydrocarbons as compounds; many candidates referred to substances, or mixtures.

(iii) This was a very well answered question across the ability range. A few candidates gave an incorrect symbol for bromine, for example, BR or B, despite the information given in the diagram. Some others wrote a 2 to the left of the molecule, rather than behind Br.

(b) (i) Many candidates found it difficult to choose the appropriate information from the Fig. 7.2. and where they did focus on the correct information, often gave insufficient explanation.

Many incorrectly chose the insulating material on the kiln walls as proof of the exothermic nature of the reaction.

Some referred to the flame, without explaining that this '*gave out heat*'.

A few gave the answer *temperature*, without specifying that it was high or giving its actual value, *950* degrees. Some candidates used the term heat, rather than temperature.

(ii) Most candidates gained the first marking point with *carbon dioxide*, but few correctly stated that the second compound was *water.* A commonly seen incorrect answer was *hydrogen*.

The explanation proved difficult for most candidates. Most wrote that they were in the waste gases or in propane.

Question 8

(a) This question was well answered across the ability range. Most candidates knew the first three symbols and drew them quite accurately. However, the symbol for the fuse was often left without a response. Some candidates confused the symbol for the resistor and the fuse.

(b) This was very well answered on both marking points. Some candidates missed the second marking point by referring to danger without specifying *electrocution.*

(c) (i) Most candidates gained this mark. However some divided the current between the two ammeters.

(ii) Most candidates gave the correct number of ohms *10.* However, some of these did not give the correct formula, *R = R1 + R2.*

Some candidates used *R = V/I*.

Question 9

(a) (i) This was quite well answered, particularly by higher scoring candidates. Some candidates described the function as protecting the parts inside the cell or keeping the cell in shape.

(ii) This was a very well answered question. Only a few candidates gave answers such as cytoplasm and cell membrane.

(iii) This was not a well answered question. Very few candidates gave the equation

Carbon dioxide + water -> glucose + oxygen

Most answers referred to light energy without stating that the chlorophyll in the chloroplasts in the cell absorb it.

(b) This was a well answered question, with many candidates gaining full marks.

Some candidates lost marks by the use of imprecise terminology e.g. rather than using the correct term *destroys habitats*, they referred to animals losing their homes.

Question 10

(a) (i) This was quite a well answered question. The most commonly seen error was radio waves.

(ii) This was not a well answered question. The most commonly seen error was also radio waves.

(b) The wavelength part of the question was somewhat better answered than the amplitude. Some candidates simply copied the numbers given in Fig. 10.2, that is 300 and 3, rather than the correct wavelength *100 m* and amplitude *1.5 m.*

COMBINED SCIENCE

Paper 0653/22

Core Theory

Key Messages

Having completed the paper, candidates should return to questions that have required extended answers and read them through again to make sure that what they have written makes sense and answers the question asked.

General Comments

A triangle of units used to help with the manipulation of an equation or formula is not the equivalent of the formula and does not gain a mark if used on its own.

Should a candidate wish to delete an answer, they need only put **one** line through it.

If, a question asks for a formula, candidates should write a formula down in the space allotted

Candidates should be encouraged to respond to **all** questions.

Comments on Specific Questions

Question 1

(a) (i) Candidates found this question very challenging. Few were able to state that Q was *a conductor and S was an insulator.* Even fewer were able to link these ideas to the information in the question and explain that *iron was a metal and sulphur was a non-metal.*

(ii) Most candidates were able to name either the gas or the orange layer, but few were able to name both..

(iii) This was quite well answered.

(b) This was quite well answered with most candidates getting at least one answer correct.

(c) (i) This question proved difficult for most of the candidates. Some candidates gave the names of the elements present.

(ii) Many candidates said that this was an example of a hydrocarbon because it contained carbon but made no reference to the lack of hydrogen or to the presence of other elements.

Question 2

(a) (i) This was not well answered.

(ii) Many candidates chose to write *amplitude* or *speed*, rather than the correct answer, *frequency.*

(iii) This was quite well answered.

(iv) any candidates answered *speed* rather than the correct answer *amplitude.*

Almost all candidates attempted every part of this question and that is to be encouraged.

(b) Most candidates gained a mark for stating that sound waves cannot travel through a vacuum. Some candidates lost credit by referring to sound rather than sound waves. The best candidates referred to the sound travelling by vibration of air etc.

Question 3

(a) (i) Many candidates did not attempt this question. However of those who did attempt it, many gained both marks.

(ii) This proved a difficult question for many candidates. Most gained part credit for the answer *transport*. Candidates were more familiar with the function of xylem.

(b) (i) Many candidates found the analysis of the data difficult, although the higher scoring candidates usually gained at least one mark. Some candidates repeated the numbers from low and high phosphate concentration, without describing what the effect of the phosphate was. Other candidates limited their descriptions of the effect of high and low concentrations of phosphate to one of the measurements. Still others referred to the fact that phosphate had affected both measurements without describing the effect.

(ii) Most candidates, across the ability range, found this a difficult question. Candidates needed to be more specific in their answers. Some candidates referred to an increase of number of roots hairs, without specifying that it was the same size of increase; other candidates said the effect of phosphate on root hair length was greater on plant B, without specifying that the effect was to decrease the length.

(iii) Most candidates who some credit referred correctly to the root hairs being *less able to absorb water or minerals.* Only a very few candidates gained additional marking points.

Some candidates wrote that root hairs searched for water, so if they were shorter they would not be able to **find** as much water.

Question 4

(a) (i) This was quite well answered.

(ii) Many needed to give observations rather than deductions from the observations, such as changes in pH or that the acid had reacted with the sodium hydrogen carbonate. While many noted that there would be a colour change, for credit they needed to specify the nature of the colour change e.g. from blue to red.

(b) (i) This proved a difficult question for candidates across the ability range. Many candidates referred to the changes in the cobalt chloride paper and limewater. However they found it difficult to explain which gas produced which change. Some candidates stated that the colour change of the cobalt chloride paper from blue to pink indicated an acidic gas and therefore carbon dioxide.

(ii) Most candidates gained partial credit by stating that the paper is covered in a layer of sodium hydrogencarbonate. The few candidates who gained full credit went on to explain that the layer forms a barrier between the paper and the air.

Question 5

(a) (i) Higher scoring candidates usually gave the correct answer.

(ii) This was well answered across the ability range, with most candidates gaining three marks. A few drew the voltmeter in parallel with part of the circuit, but not in parallel with light A.

(iii) This was well answered by the higher scoring candidates. Most candidates gave the correct answer but some of these did not give the correct formula, $R = R1 + R2$ so only gained one mark.

(b) Almost all candidates who gave the correct formula $d = m / v$, went on to give the correct numerical answer and gained both marks. A few wrote the triangle relationship of m, d and v and some others used the names of the units rather than the variables mass and volume. These candidates were not awarded the formula mark.

(c) This was not a well answered question. Candidates needed to answer by referring to the cooling effect of evaporation from the skin.

Question 6

(a) This question was quite well answered with some candidates giving all three correct answers; *penis, sperm duct, and urethra.* The main error was identifying **C** as the penis.

A few candidates identified some, as parts of the female reproductive system.

(b) Most candidates gained partial credit for explaining that the sperm would not be able to pass through. Some candidates then went on to explain that the egg would not be fertilised and gained the second mark.

(c) (i) Very few candidates gave the whole correct answer *Human Immunodeficiency Virus.*

(ii) This was very well answered across the ability range. A very small number referred only to the use of contraceptives without specifying which type of contraceptive

The correct answers mainly referred to sexual intercourse. Only a few referred to aspects of sharing blood.

Question 7

(a) (i) This question was not well answered.

(ii) Most candidates attempted this question. Correct answers had to refer to the actual particles, for example, '*protons and neutrons being greater in number*'.

(iii) All candidates found this a challenging question. Although many candidates recognised that there would be a colour change, very few gave the correct resulting colour, brown.

Some candidates referred to a reaction between the substances without correctly specifying the product iodine or the reason for the reaction i.e. that chlorine is more reactive than iodine / displaces the iodine.

(b) This was a well answered question. Although many candidates referred to killing germs, most also included the correct answer *killing bacteria* and in a few cases, *killing viruses.*

(c) Most candidates gained partial credit for stating the flask would contain a mixture. Fewer gave a correct explanation e.g. helium is a noble gas. Some referred to helium being in Group O. This was not allowed as it is in the stem of the question.

Question 8

(a) (i) Many candidates drew arrows on the diagram without labels. Some drew the labelled arrow for friction force pointing upwards to the contact of tyre and road.

(ii) This was not well answered. Many candidates referred to the wheels or tyres of the car without mentioning the road surface. Other candidates referred to air. However *air resistance* was necessary for the mark. Only a few candidates gave *brakes* as the answer.

(iii) This proved a difficult question for most candidates. Many answers explained that '*the forces were equal*', but needed to add that '*the forces worked in opposite directions*'.

(iv) Generally only the higher scoring candidates gave the answer '*moving at a constant speed*'.

(v) A few candidates gained the mark with the correct reference to gravity or weight of the car. Many candidates referred to push or pull.

(b) (i) This was well answered. Again, a few gave the triangle for s, d and t, rather than the formula and a few others used the units in the formula**.**

(ii) This was quite well answered. Some candidates gave gravitation energy.

(iii) This was quite well answered.

Question 9

(a) (i) Candidates found this question challenging. Many candidates gave the answer *algae* rather than the correct answer *producer.*

(ii) This was not a well answered question. A few candidates gave the correct answer *glucose*. Many gave sea weed or krill.

(iii) Many candidates referred to eating or food rather than the correct answer '*the flow of energy*'.

(b) Many candidates answered by referring to a possible effect on individual organisms. The question asked about the effect on the numbers of the organisms and therefore the answer had to include a reference to numbers e.g. t*he numbers of animals e.g. squid, would decrease.*

(c) Almost all candidates gained the first mark for this question giving *carbon dioxide.* Some simply wrote *carbon* and this was not enough to gain the first mark. A few candidates went on to give the second answer *methane.*

Commonly-seen errors were *hydrogen* and *oxygen*.

COMBINED SCIENCE

Paper 0653/23

Core Theory

Key Messages

Having completed the paper, candidates should return to questions that have required extended answers and read them through again to make sure that what they have written makes sense and answers the question asked.

General Comments

A triangle of units used to help with the manipulation of an equation or formula is not the equivalent of the formula and does not gain a mark if used on its own.

Should a candidate wish to delete an answer, they need only put **one** line through it.

If, a question asks for a formula, candidates should write a formula down in the space allotted

Candidates should be encouraged to respond to **all** questions.

Comments on Specific Questions

Question 1

(a) This was answered well.

(b) Most candidates gave *water* as one of their answers. However many gave *nutrients* for their other answer. Some candidates wrote that the root hairs absorbed sunlight.

(c) (i) Most candidates gained part credit for *transport*. Fewer went on to specify correctly what it is that is being transported.

(ii) Most answers referred to the shortage of water, rather than a shortage of nutrients.

Question 2

(a) (i) This was quite well answered by the higher scoring candidates. However many candidates gave the answer as *oxygen.*

(ii) Most candidates gained part credit, but only a few went on to explain that there was a metal and a non-metal.

(b) (i) This was well answered. A few gave the name of the whole atom as *phosphorus*.

(ii) Most candidates were able to answer this question fully, but some candidates missed marking point 2 by not stating that the number of the protons is the same as the number of electrons.

Question 3

(a) While some candidates knew the name of component Z, fewer were able to describe its function.

(b) This question required both the correct letter X and the explanation that ammeters are connected in series. Many candidates who gave the correct letter struggled to find the correct terminology to describe how ammeters are connected.

(c) The candidates who showed their working more often gave the correct answer. The correct unit, *ohms,* was given by most candidates; the symbol is allowed here as well as the name of the unit.

Question 4

(a) The most commonly seen errors related to the reagents for the test for protein (biuret) and fat (ethanol).

(b) This question was quite well answered across the ability range. Most candidates' answers involved the building and repair of muscles. A few candidates referred to protein as a source of energy and could not receive credit since this is not an important role of protein in a balanced diet.

(c) This was not a well answered question. Most candidates referred to chewing making the food into smaller pieces but needed to go to explain that this would increase the surface area and make it easier for the enzymes to make contact with food particles.

(d) This was a well answered question. Many candidates showed a deal of interest and knowledge of the topic. The best answers referred to an increase in carbon dioxide and stated that some animals may become extinct. Some answers stated that there would be less oxygen or that animals would die; these statements could not be awarded credit.

Question 5

(a) (i) Most candidates gained the first two marks; correctly choosing metal *Q* and identifying the orange layer as rust. However, very few explained that there was oxygen in the water which enabled rust to form.

A few candidates chose metal S, stating that iron does not react with water.

(ii) This was quite well answered. A few candidates gave Group 1 metals such as lithium. The reaction of hydrochloric acid with these metals would have been far more violent than indicated in the diagram; and it is unlikely that a student would have been carrying out the experiment.

(iii) This proved difficult for all but the most able candidates. Many answers stated that P is a different metal, without specifying that the relevant difference is in reactivity.

(b) (i) This question was not generally well answered. Many did not give a response. Some candidates gave density as an answer rather than different boiling points.

(ii) Candidates were asked to state a use of gasoline and then explain why it is suitable for this use. Many candidates did not clearly state a use of gasoline, although they often then went on to correctly explain why gasoline was used as e.g. a fuel.

(c) (i) Most candidates showed understanding of what was required and drew a hydrocarbon, with four bonds to carbon atoms and one bond to each hydrogen atom. A few candidates drew ethane or larger molecules.

(ii) Most candidates identified the missing reactant for partial credit, but fewer went on to identify both products for full credit.

Question 6

(a) This was a well answered question.

(b) Almost all candidates drew very good sine waves. A few needed to be more precise when indicating wavelength. A commonly seen mistake was the amplitude shown as the complete vertical distance between maximum and minimum.

(c) (i) Almost all candidates, across the ability range, drew the image at the same horizontal level as the nose. Many drew the cross on the mirror, rather than an equal distance from the mirror behind the mirror.

(ii) This was a well answered question with many candidates gaining at least two marks for the answers *same size as object* and *upright.* Fewer said that the image was virtual.

Question 7

(a) (i) Almost all candidates gained the mark for correctly labelling the lung. Many incorrectly named the trachea as oesophagus or throat.

(b) (i) There were some very good answers to this question such as '*diffusion is the movement of molecules from an area of high concentration to low concentration down a concentration gradient*'. Many candidates used the terms *liquids* or *gases* rather than *molecules.*

The answers that referred to density rather than concentration could not gain credit.

(ii) Candidates should know that it is the plasma that carries the carbon dioxide, not the red blood cells.

(iii) This proved a difficult question for candidates. Some gained some credit for stating that more energy is used but needed to go on and link this to increased respiration and production of carbon dioxide.

(iv) Most candidates were able to describe correctly the effect on the rate of diffusion; some candidates wrote *fast* rather than *faster* and could not gain credit as the question asks for a comparison or an effect, rather than an absolute. Very few were able to explain why the rate of diffusion increased.

Question 8

(a) (i) This question was well answered by the higher scoring candidates. Many candidates showed they knew that limewater was the test reagent and that it turned cloudy when carbon dioxide was present. However, for credit, candidates needed to specify that the gas must be bubbled into the limewater, either in the diagram drawn or in the written explanation.

Suggestions that a lighted spill that would go out in the presence of carbon dioxide be put at the end of the delivery tube did not gain credit.

(ii) This question was correctly only by the very highest scoring candidates.

(iii) **O**nly the higher scoring candidates gained marks for both answers. Some candidates treated NO as one atom or element.

(b) (i) This proved a challenging question for all candidates. Rather than explain the conclusion given, many simply rewrote it. Candidates needed to relate the rate of the reaction to the concentration of the acid, and the concentration of the acid to the value of pH.

(ii) This was quite a well answered question. Most candidates gave a correct answer *temperature.* Answers referring to *heat* were not allowed.

Question 9

(a) (i) Almost all candidates gave the correct answer.

(ii) Most candidates gave a correct description. A very few described the cart as moving at a constant speed.

(iii) This question proved rather challenging for many candidates. Some candidates failed to state whether the forces were balanced or unbalanced before going on to explain the reasoning that led them to their answer.

(b) This was very well answered, although some candidates gave the answer *water.* Unlike wind, water is not a source of energy unless it is moving or held high in a dam. Therefore answers that were not specific about the type of energy source e.g. hydroelectric or wave could not be given credit

(c) (i) This was generally well answered.

(ii) This was also generally well answered.

(d) This was quite well answered. Some candidates gave the triangle relationship, or they used the units, or they used weight rather than mass and lost the mark for the formula.

(e) This was a well answered question.

A few candidates drew too many particles in the box, meaning that the particles were too close together and sometimes touching.

COMBINED SCIENCE

Paper 0653/31
Extended Theory

Key messages

Candidates should read the command words in questions to ensure that their responses answer the questions correctly. In particular candidates should distinguish between 'describe' and 'explain' in their responses, and understand when a comparison has to be drawn between different sets of information.

General comments

There was a wide range of achievement by candidates, including some very good scripts. These reflected a good understanding of both the syllabus and examination technique.

Candidates seemed to have enough time available to complete the examination and made sensible use of the space for responses on the paper. Candidates are reminded when answering a question that it is not necessary to repeat parts of the question in their response. This wastes available space for answers. They are also reminded to write legibly and clearly so that all of their responses are clear for the Examiner to read.

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

Comments on specific questions

Question 1

(a) (i) Many candidates correctly focused on the relative reactivity of the elements and the compound.

(ii) There were several acceptable responses to this question and many candidates responded successfully. Candidates must remember that to gain full credit they must explain their point for both items in the question. For example 'A compound is formed by a chemical reaction' is not enough to gain full credit. By adding 'No chemical reaction is needed to form a mixture' provides the full comparison.

(b) (i) Some higher-scoring candidates made correct responses to this question which needed only two ions, K^+ and Ca^{2+}.

(ii) There were some good responses to this question from candidates who scored full credit. Candidates are reminded that 'swap and drop' does not provide an adequate explanation for the formula. Explanations using the ideas of charge balance or electron transfer are needed.

(c) (i) Most candidates correctly identified the need for the attraction between opposite charges to cause the calcium ions to go to the cathode. Some candidates needed to state that the cathode is negative in their answers, rather than assuming that the mention of the cathode is enough to indicate that it is negative. Others needed to remember the polarity of the cathode and anode and that the charge on the calcium ion is positive, not negative.

(ii) Many candidates scored well in this question correctly describing the gain of two electrons by the calcium ions.

Question 2

(a) (i) The majority of candidates correctly drew an arrow pointing vertically downwards. The subsequent influence of warmer air further down the refrigerator to cause the movement of air upwards was not relevant to the question and therefore was not credited.

(ii) There were some good responses by better-scoring candidates. It was important to explain that the density of the air increases due to the particles becoming closer together. Candidates need to be aware that phrases such as '*the particles become more dense*' are imprecise – the particles remain the same density; the substance becomes more dense as a result of the particles moving closer together.

(b) The calculation of the mass of air was well done by many candidates who rearranged the equation density = mass/volume successfully. Candidates are reminded that formula triangles may be a useful memory aid but they are not acceptable as a response when an equation or formula is asked for. The formula must be written out correctly to gain credit. Most candidates used the correct unit. Others are reminded that the answer following a correct calculation must have the correct unit, in this case kg.

(c) (i) The diagrams of the particles in solid ice and liquid water were challenging for candidates. In order to provide correct responses the particles should all be the same size. The particles should be touching and in a regular arrangement in the diagram of ice. In the case of the liquid water the particles should be in a random arrangement with most of them touching. Candidates need to take care with these diagrams.

(ii) Most candidates made a good attempt at this question and obtained some credit. The description '*It fills a closed container*' was incorrectly described as a liquid by many candidates. The remainder of the descriptions were correctly identified by most candidates.

(d) Some candidates produced correct responses to this question. The focus of the question was on the different surfaces; a correct comparison of the different surfaces was expected in the answer.

Candidates need to use the correct terms in their responses. For example, some answers mentioned surfaces *attracting* or *conducting* heat.

Question 3

(a) Some candidates correctly described trends shown by the graph. Candidates are reminded to read the question instruction carefully. More candidates would have gained full credit if they had not compared the glucose trends of cornflakes with fibre with cornflakes without fibre. Explanations of the trends were not relevant to this question which asked the candidates to describe <u>how</u> the blood glucose concentration changed after eating cornflakes with no added fibre.

(b) Some candidates correctly made the connection between the digestion of the starch in the cornflakes and the absorption of the glucose into the blood leading to the subsequent changes in blood glucose concentration. In general, candidates would have obtained more credit if they had described the role of enzymes in the digestion of the starch.

(c) (i) Many candidates correctly concluded that the effect of adding fibre to the cornflakes was to make the increase in blood glucose smaller than with no added fibre. Candidates who wrote '*The effect was to decrease the glucose concentration*' needed to explain that the maximum glucose concentration reached was decreased compared with the case of eating cornflakes with fibre.

(ii) This question was answered well by some candidates. Candidates need to remember that fibre prevents constipation. It does not cause it.

Question 4

(a) This question was answered correctly by many candidates who correctly identified silicon as the element. Candidates are reminded not to miss out the first period containing hydrogen and helium when looking for the third period of the periodic table. Many incorrectly wrote 'germanium' from period 4 as the required element.

(b) (i) The majority of candidates correctly identified Group 1 as the group containing the elements in the graph, pointing out that the proton numbers matched those of the Group 1 elements. Candidates should be aware that descending melting points down a group is not unique to Group 1.

(ii) There were many correct estimates of the melting point at proton number 55 obtained by extrapolation of the graph.

(c) (i) Some candidates correctly identified the gas as carbon monoxide.

(ii) There were several good responses to this question. Candidates were credited for the correct identification and description of the reduction process. Responses in terms of a displacement reaction were not accepted.

(iii) Some candidates correctly gave the word equation. Candidates are reminded to read the question carefully and not provide a symbolic equation when asked for a word equation.

Question 5

(a) (i) This question was generally well answered. The area under the graph was determined either by adding the areas of the triangle and the square or by finding the area of the trapezium. Candidates who simply multiplied 30 x 4000 needed to remember to take the area of the triangle (1/2 x 1000 x 30) away from their calculation. The vast majority of candidates correctly wrote metres for the unit.

(ii) The calculation of acceleration was correctly done by most candidates.

(b) (i) Many candidates calculated the efficiency correctly. Some candidates who did not answer this question correctly managed to apply the fact that only 10% of the solar energy is transferred to the motor when answering part **(b)(ii)**.

(ii) This was well answered by many. Candidates needed to take into account the energy loss by the solar cell before reaching the electric motor in the vehicle. Therefore many candidates incorrectly gave 700 000 J as their answer.

Question 6

(a) (i) Some candidates correctly responded that the main effect of the contraction of the ventricles is to increase the pressure of the blood contained in them. The flow of the blood into the aorta results from this. Candidates need to remember that the blood does not flow from the left ventricle into the pulmonary arteries or the left atrium.

(ii) There were many correct responses to this question. Candidates, who successfully identified the blood as leaving the heart, correctly described the valve as closing during contraction of the left ventricle.

(b) (i) Some candidates correctly responded in terms of oxygen being needed for respiration. In their responses most candidates explained the need for the heart to keep beating constantly with no further explanation. If they had linked this idea to the need for a constant release of energy for the contraction of the heart muscle, implying constant respiration they would have gained more credit.

(ii) Many candidates shaded the correct area of the wall of the right ventricle. There was a wide range of answers to this question. The most frequent error was just filling in the section of the coronary artery below the blockage, ignoring the fact that the area of wall supplied by this section of coronary artery would be affected by the loss of its blood supply.

(iii) This question was generally answered well by the full range of candidates.

Question 7

(a) (i) Several candidates correctly identified the colour change from orange to colourless in this question. Candidates need to remember that the words transparent and clear are not specific enough to be acceptable alternatives to the word colourless.

(ii) Only a few candidates correctly identified the type of reaction as an addition reaction. Centres are reminded that the syllabus indicates that recognition of the term addition reaction is required.

(iii) Many candidates successfully used the information in the introduction to part **(a)** to answer this question. Most responses contained added hydrogen and chlorine atoms. The most common errors were responses with 2 added chlorine atoms, or which retained the double bond between the carbon atoms.

(b) There were some fully correct responses produced by some candidates who interpreted the question well to produce a balanced equation. Candidates needed to know the formula for steam is the same as for water. Also the formula for hydrogen is H_2, representing hydrogen molecules, rather than just H.

Question 8

(a) Some candidates correctly interpreted the circuit and added up the currents in the branches of the parallel circuits when the switches were closed. Several candidates gave 0 A as both answers which was not the case since switch **A** was closed in both cases providing at least one complete circuit.

(b) There were many correct answers here, with candidates writing the correct formula and applying it successfully.

Many candidates provided very complicated calculations using incorrectly scaled-up versions of the formula R = R1 x R2 / (R1 + R2), which could not gain credit.

Question 9

(a) (i) Many candidates correctly identified the palisade mesophyll as the correct tissue.

(ii) Several candidates provided good explanations and gained full credit. Other candidates could have obtained more credit if they had mentioned that the chloroplast is the site of photosynthesis. Many responses simply stated that the chloroplast absorbs sunlight when chlorophyll was required as the chemical that absorbs sunlight. Candidates need to read the question carefully; the question asks about the cell, not the leaf in which the cell is found.

(b) This question was reasonably well attempted by the full range of candidates. Most responses correctly included a reference to the increase in carbon dioxide levels of the atmosphere due to deforestation. Candidates are reminded to read the question carefully since some responses included irrelevant material about all aspects of deforestation.

Question 10

(a) (i) This question was answered quite well by candidates across the ability range.

(ii) Many candidates successfully wrote *microwaves* as their answer. The most frequently seen error was *radio waves*.

(b) Many candidates correctly provided the correct speed of X-rays. Candidates are reminded that all the waves of the electromagnetic spectrum travel at the same speed, 3×10^8 m/s. Many answers varied from this figure.

(c) This question was well answered by many candidates who successfully calculated the wavelength and frequency of the wave. It is important for candidates to remember to halve the height of the wave to calculate the amplitude of the wave, resulting in an amplitude of 1.5 m, not 3 m, the answer given by many candidates.

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Extended Theory

Key Messages

The question instructions often contain useful guidance about the detail that candidates should be including in their answers. If a question asks for explanation or a description in terms of particles then candidates should review their answer to make sure that they have included references to particles. If a question asks candidates to describe how oxygen reaches a fetus they should answer by describing how waste products are removed from the fetus.

General Comments

Many excellent scripts were seen from candidates who showed sound examination technique and who demonstrated mastery of the syllabus sections that were tested. Candidates with very low marks may have found Paper 2 a more suitable option. There was no evidence that candidates generally were unable to complete the paper in the time available. The general standard of examination technique continues to improve and there are now far fewer examples of candidates spending time writing lengthy answers which do not address the questions asked. In general, candidates use proper symbols in the formulae used in Physics calculations and most remember to include correct units. Candidates should be reminded that poor handwriting might sometimes result in loss of credit because it could mean that correct information cannot be read.

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

Comments on specific questions

Question 1

(a) A minority of candidates achieved full credit for their answer. Many candidates lost credit because they did not state that decane could not conduct because ions are not present. Candidates had learned that conduction in non-metals usually requires mobile ions but they often stated that the ions in decane could not move.

(b) (i) Candidates needed to state that the gas would be chlorine. *Chloride* did not gain credit. The most commonly seen incorrect response was *hydrogen*.

(ii) Many candidates showed excellent understanding of the electrode reaction producing copper and gained full credit. The question asked candidates to explain the electrode process in terms of ions, electrons and atoms. Many candidates wrote sensible statements such as *copper is negative and goes to the positive* without mentioning the relevant types of particles involved. Others showed that they had revised electrolysis but chose to describe details of chlorine formation.

(c) Many candidates made this into a far more complicated question than it was and wrote lengthy discussions of electronic bonding theory, often suggesting covalency. Candidates had to recall that sodium chloride is an ionic compound and so would contain oppositely charged ions that would attract. Although some excellent answers were seen, the majority of candidates were challenged by this question.

Question 2

(a) (i) Candidates across the ability range were familiar with the propagation of electromagnetic rays through optical fibres by total internal reflection. Partial credit was often awarded to candidates that had chosen to draw careful diagrams showing the path of the reflected infra-red ray through the fibre. More-able candidates went on to gain full credit for a correct reference to the critical angle. Candidates should be encouraged to use scientific terms such as *rays reflect* rather than *rays bounce*.

(ii) Candidates of all abilities produced fully correct answers to this question, and full credit was very frequently gained.

(iii) This was another question that was far simpler than candidates assumed. A very wide range of incorrect answers were seen, many from the more able candidates who overlooked the simplest reason for the time difference. Only a minority of candidates gained credit here.

(b) This was well-answered and most candidates from across the ability range gained credit. Candidates had learned that sound propagation requires a medium and that in this case this is provided by air.

Question 3

(a) (i) The majority of candidates gained credit. Candidates generally knew that the stated colour change of the indicator showed that an alkaline solution was formed. They needed to state how the pH value would change. No credit was gained for statements such as '*an alkaline solution forms*'.

(ii) Full credit was not very often gained for answers to this question. Some candidates realised that there would be effervescence, and that because acid would be in excess, the solution would change colour to red. Many realised that the alkaline solution would initially be neutralised and suggested that the solution would turn back to green. The question asked for observations and so on this occasion statements such as *carbon dioxide is given off* were not accepted.

(b) (i) The tests for water and carbon dioxide were very familiar to candidates across the ability range and the majority of candidates gained credit.

(ii) Many correct answers were seen for the balanced equation. This shows that candidates were able to select the relevant information from other parts of the question and also had the skills necessary to balance the equation.

(iii) This question proved very challenging for the great majority of candidates. Those who gained credit realised that the information contained in earlier parts of the question was relevant in this unfamiliar context. Credit was available for reference to a barrier effect between the paper and oxygen from the air but very few candidates referred to this. Candidates frequently suggested that sodium hydrogen carbonate could not burn and so the paper would not burn.

(iv) This question concerning energy transformation set in a Chemistry context proved very difficult for those in the middle to lower-end of the mark range. Credit was often gained for stating that thermal (heat) energy would be absorbed by the sodium hydrogencarbonate. Some candidates attempted to discuss bond breaking although there was evidence of much confusion with some candidates suggesting that the reaction would be exothermic because energy would be released when bonds were broken.

Question 4

(a) (i) The majority of candidates extracted the required information from the data in the table very successfully and full credit was very often gained.

(ii) Part **(ii)** proved to be far more difficult than part **(i)** although many candidates gained full credit for well-expressed answers. Partial credit was often gained by candidates who commented on the significantly greater effect of increased phosphate concentration on the reduction in root hair length in type **B** plants.

(iii) The function of root hairs was familiar to many candidates and most gained some credit for their answers. One reason for loss of credit was confusion of the functions of the root as a whole with the function of the root hairs. It was important for candidates to use the term *ions* when referring to minerals. The general term *nutrients* was not accepted as an alternative. Another incorrect answer referred to reduced ability of shorter root hairs to anchor the plant. Credit was also available for a discussion of photosynthesis but this was rarely seen.

(b) The processes leading to eutrophication had been very well learned by candidates at the higher end of the mark range. These candidates very often gained full credit for some outstanding answers. Only a minority of candidates appeared to be unfamiliar with eutrophication and attempted to answer in terms of the toxicity of excess fertiliser. Common mistakes made by those gaining partial credit included suggesting that a layer of fertiliser is responsible for reducing light penetration, and that since water plants would die the consequent lack of photosynthesis was the reason for reduced oxygen levels.

Question 5

(a) Nearly every candidate gained the credit for recognising this parallel circuit.

(b) (i) Candidates across the full range of abilities showed that they were very familiar with calculation of the combined resistance of resistors in parallel, and full credit was frequently gained. Some candidates lost credit because they quoted the formula as $R = 1/R_1 + 1/R_2$ although many of these candidates did work through to the correct final answer.

(ii) Most candidates gained credit for stating Ohm's Law and many went on to substitute and calculate correctly. Many candidates needed to read the question a little more carefully and used their answer from part **(ii)** in this calculation rather than the resistance of lamp **A** alone.

(c) Full credit for this calculation was gained by the great majority of candidates from across the ability range.

Question 6

(a) Most candidates drew their labelling lines carefully and gained some credit. A very frequent mistake was the labelling of the vagina or the amnion under the fetus's head rather than the cervix itself.

(b) A few candidates wrote excellent, carefully-worded answers and gained full credit. Expressing all of the required Biological information proved a great challenge to most candidates. It was important that candidates' answers focused on the roles of mother's and fetus's blood while making it clear that oxygen and not blood diffuses through the placenta. Candidates very often did not mention that oxygen attaches to fetus's blood which then passes through the umbilical cord. Many candidates wrote unnecessarily about the mechanisms of nutrient supply to and waste removal from the fetus. These candidates then often did not refer to the mother's blood as the source of oxygen nor make it clear that oxygen diffused through the placenta. Candidates must be careful to read the question asked and make sure that it is that question that they are answering.

Question 7

(a) The majority of candidates were able to use their knowledge of the trends in physical properties of the halogens to predict the physical state of fluorine. The question makes clear the detail required in the explanation and so answers such as '*fluorine is a gas because it's at the top of the group*' or '*fluorine is a gas because boiling points increase down the halogen group and chlorine is a gas*' did not gain credit.

(b) (i) The great majority of candidates correctly identified the type of bonding. The question asks for a brief explanation which it was hoped would deter candidates from writing details of the electronic theory of covalency. This is tested in part **(iii)** and was not accepted here.

(ii) The great majority of candidates gained the credit here. One mistake that was seen a few times was 14. This may have been made by candidates who recalled that fluorine and chlorine molecules are diatomic or who interpreted the question as requiring the sum of the outer electrons of a fluorine atom and a chlorine atom.

(iii) Candidates from the middle and high end of the mark range usually deal with questions testing electronic bonding theory very well. This question tested this in a slightly different way from previous papers but these candidates still produced some very good answers and many gained full credit. Despite giving the correct answer to part **(ii)** some candidates also gave the answer 7 in this part, not realising that they should be considering the atoms bonded in the CFC molecule.

Question 8

(a) (i) Credit was awarded for correct indication of both of the forces acting on the car. Candidates should be advised to draw these forces carefully, preferably with a ruler, and to try to draw them parallel to the ground. Some candidates over-answered this question showing gravity, reaction from the ground and air resistance in addition to the requested pair of forces. Showing the frictional force caused problems for quite a few candidates. The exact location of the arrow showing friction was not critically important provided the arrow was horizontal and pointing from left to right.

(ii) The required answer needed to contain the ideas that balanced forces are of equal size but act in opposite directions. Most candidates restricted their answers to statements such as '*the driving and frictional forces are the same size*'. Answers like this did not gain credit, particularly since some of these candidates had not gained credit for part **(i)**. One alternative answer that was accepted was that '*the resultant force is zero*', although very few candidates gave this.

(iii) The wording of the question should have deterred candidates from suggesting that the car would be stationary, but many gave this answer. Another suggestion which could not be accepted was *constant motion*. Approximately half of the candidates gained credit in this question.

(iv) This was the most successfully answered question in part **(a)**. The majority of candidates gained credit for answers which either stated directly or implied that the driving force exceeds the frictional force when the car accelerates.

(b) (i) The use of the formula to calculate work done was very familiar to the majority of candidates and full credit was frequently gained. The most common mistake was to forget to convert the distance travelled to metres although some candidates who did not make this conversion gained full credit by stating the answer as 10 000 kilojoules.

(ii) The use of the formula to calculate power was very familiar to the majority of candidates and full credit was frequently gained. An error carried forward from part **(i)** was allowed in this case.

(c) (i) Candidates at the middle and high end of the mark range tended to know that infra-red radiation is involved in the transfer of thermal (heat) energy. Although most of the main regions of the electromagnetic spectrum appeared in response to this question, *microwave* was probably the most common incorrect answer.

(ii) Full credit for this question was gained by a minority of candidates. Many gained partial credit by recognising that the construction of the radiator resulted in a high surface area of metal.

Question 9

(a) (i) Correctly identifying gases **1** and **2** presented few problems and many candidates gained full credit. The most common cause of lost credit was reversal of the gases.

(ii) The majority of candidates had learned a good definition of diffusion and gained credit. It was important that candidates discussed the movement of molecules (particles) rather than a bulk material. Full credit was not awarded if candidates' answers suggested that diffusion could only occur through a semi-permeable membrane.

(iii) Candidates in general were familiar with the process of gas exchange through alveoli. The question clearly asks candidates to describe the wall of the alveolus and so credit was not gained for referring, as many candidates did, to the large surface area. The idea that the thin wall reduces the diffusion distance or increases rate of diffusion was given by some candidates from the higher end of the mark range.

(b) (i) Many more harmful substances are contained in cigarette smoke than are listed in the syllabus or the mark scheme. Any correct alternative was accepted. Many candidates gained partial credit for naming two or three harmful substances. The most common way of gaining partial credit was to name nicotine and carbon monoxide. Full credit for naming four substances was much less common. Many candidates suggested *smoke* rather than *particulates* or *smoke particles.*

(ii) This proved to be a challenging question and full credit was gained by very few candidates. Most candidates seemed unfamiliar with the role of mucus and many did not refer to it at all. Many simply suggested that damaged cilia would be unable to filter out bacteria from inhaled air.

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Extended Theory

Key Messages

- In questions where it is suggested that candidates may wish to draw a diagram, it is usually a good idea that candidates follow this suggestion.
- It is a good idea to read through all parts of a question before starting to answer it. If candidates find that they are using the same words or ideas to answer two or more parts of the same question then it should prompt them to review their understanding of what a particular question is asking.
- In questions asking candidates to make comparisons it is essential that comparative terms are used in the answer. For example, when explaining the higher boiling point of diesel compared to gasoline, candidates should refer to molecules in diesel being larger than those in gasoline and not simply that diesel molecules are large.

General Comments

Many excellent scripts were seen from candidates who showed sound examination technique and who demonstrated mastery of the syllabus sections that were tested. Candidates with very low marks may have found Paper 2 a more suitable option. There was no evidence that candidates generally were unable to complete the paper in the time available. The general standard of examination technique continues to improve and there are now far fewer examples of candidates spending time writing lengthy answers containing irrelevant information. In general, candidates use proper symbols in the formulae used in Physics calculations and most remember to include correct units. Candidates should be reminded that poor handwriting can in loss of marks because correct answers cannot be read.

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

Comments on specific questions

Question 1

(a) (i) This question was answered very well. Most candidates gained credit for careful labelling of the cell membrane. A minority of candidates lost credit because they used the correct biological terms to label the diagram but did not link the terms to the functions of those parts by using the letters **A** or **B**. The most common mistake was to label the cell nucleus as **A**.

(ii) The function of root hairs cells had been very well learned and most candidates gained credit for their answers. The most common reason for loss of credit was confusion of the functions of the root as a whole with the function of the root hair cells. Some candidates stated that the root hair cell would be able to penetrate further from the plant in search of water and mineral ions. Unless it was also made clear that these would be absorbed they lost credit. It was important for candidates to use the term *ions* when referring to minerals. The general term *nutrients* was not accepted as an alternative.

(b) (i) Many candidates showed that they were familiar with this experiment and gained credit. They were able to describe transpiration and to state that the dye solution rises through the xylem. No credit was given for phrases such as '*the dye was sucked up the plant*'. This contains no scientific terms or explanation of why the dye solution rises toward the leaf. No credit was given for the suggestion that the dye solution was replacing water used for photosynthesis.

(ii) This part of **Question 1** was the least well answered. Some candidates attempted to explain the slower rise of the dye solution in terms of rate of reaction, including enzyme activity, or increased viscosity of liquids at lower temperature.

Question 2

(a) This question was answered very well by most candidates. Rather than simply identifying both elements as non-metals, some candidates gave lengthy descriptions of the electronic theory of covalent bonding.

(b) Electronic theories of chemical bonding are usually very familiar to candidates and this question was very successfully answered by the majority of candidates. Most candidates wisely chose to draw a bonding diagram which could gain partial credit even if not completely correct. An accepted alternative for the chemical formula of phosphine was H_3P, but PH^3 was not accepted.

(c) Most candidates gained credit for their answers to this question. *Chlorine* is not accepted as an alternative for *chloride*.

(d) The majority of candidates were able to state the reactivity order of **Q**, hydrogen and **P**. Some excellent explanations in terms of displacement were given by higher-scoring candidates. Many candidates tended to re-write the information in the table of observations without relating this to the relative reactivity of the three elements.

Question 3

(a) Both parts of the answer had to be correct to gain credit. Candidates often gave the correct response to the second part but an incorrect answer to the first part.

(b) Factors affecting the resistance of a wire had been very well learned by the majority of candidates. Some candidates lost credit because they suggested the material from which the wire is made, which variable had already been mentioned in the question.

(c) (i) The relationship *power = current x voltage* was familiar to most candidates who gained credit. As usual in Physics calculations, the correct unit is an essential part of the answer, and most candidates were able to provide this. A minority of candidates lost credit by using the symbol A or the word *amperes* in the formula. Only correct symbols or words, and not units, must appear in formulae.

(ii) Candidates could either state the formula *power = (force x distance) / time* or use two formulae, *power = work / time* and *work = force x distance* in order to gain credit. This question was equally as well answered as part **(i)**.

(iii) Many candidates did not gain credit for their answers to this question, making non-specific answers such as '*they are measuring different things*' or '*one is output and the other is input*'.

(iv) Many candidates who did not gain credit in the previous question went on to gain full credit in this question. Numerical errors from parts **(i)** and **(ii)** were carried forward into this question although full credit could not be gained for answers greater than 100% (or 1). A statement such as *efficiency = (output power / input power) x 100* was an allowed alternative to showing numerical working.

Question 4

(a) (i) Most candidates knew that bacteria are used in converting milk to yoghurt. The two most common incorrect answers were *yeast* and *enzymes*.

(ii) Only a minority gained full credit for their answers to this question. Candidates needed to be careful in how they expressed their answers. Some credit was awarded for the main idea that the warmer temperature speeds up the production of yoghurt. Candidates could then explain this in terms of the faster (or better) working of the microorganism as a whole or they could discuss the need for an optimum temperature for enzymes within the bacteria. The term *optimum temperature* was only accepted if it referred to enzyme activity. A significant minority of candidates thought that the higher temperature was required to kill bacteria.

(b) (i) Candidates did very well with this question and the majority successfully described what was shown by the graph. A minority gave responses that answered part **(ii)** and lost some credit as a result.

(ii) Candidates answered this question very well. A minority scored partial credit for describing the greater concentration of lactic acid with added sugar but then went on to suggest that this was because the sugar was acting as a catalyst.

(c) Candidates across the ability range are generally familiar with the negative effects on the environment of deforestation. This question was answered very well. A minority suggested that deforestation would reduce atmospheric oxygen levels to the point where animal life would be endangered.

Question 5

(a) Most candidates had learned the limewater test and gained full credit.

(b) (i) The majority of candidates scored partial credit for stating that rate increased as acid concentration increased. A far smaller number of candidates went on to state that the relationship was linear or (directly) proportional.

(ii) The better answers to this question described how increased concentration would lead to increased collision **frequency** and hence higher rate. Most candidates gained at least partial credit for answers implying that reaction occurs as the result of particle collisions.

(iii) This question was well answered, and candidates found a variety of acceptable ways of explaining that experimental results would be unreliable if temperature was allowed to vary.

Question 6

(a) (i) The great majority of candidates gained full credit in this question.

(ii) Most candidates in the middle and high ability ranges gained credit in this question. Alternative answers to the speed of travel in a vacuum were that all electromagnetic waves were transverse or require no medium. An incorrect response, seen several times, was that all types of electromagnetic radiation damage human tissue.

(b) Candidates across the ability range were very familiar with the propagation of light rays through optical fibres by total internal reflection. Candidates should be encouraged to use scientific terms such as '*light rays reflect*' rather than '*light rays bounce*'.

(c) (i) and **(ii)** The great majority of candidates gained the credit for part **(i)**, but found part **(ii)** more challenging. The best answers were seen from candidates who had located the position of the image accurately, possibly by measurement, and then connected the image with the eye through the reflection points on the mirror.

Question 7

(a) Candidates were very familiar with the trachea and the lung. *Windpipe* is not accepted for *trachea*.

(b) (i) Many candidates had learned a good definition of diffusion and gained credit. It was important that candidates discussed the movement of molecules (particles) rather than a bulk material. Full credit was not awarded if candidates' answers suggested that diffusion could only occur through a semi-permeable membrane.

(ii) This proved to be a challenging question, particularly for lower ability candidates. It was important that answers included statements which explained how vigorous exercise would require a **higher** rate of respiration than normal. Many candidates attempted to answer this question in terms of breathing rate or heart rate and others described processes associated with anaerobic respiration.

Question 8

(a) (i) Most candidates successfully converted the structural diagram into a molecular formula. An accepted alternative was $H_{18}C_8$ but C^8H^{18} was not accepted.

(ii) To gain credit in this question, candidates needed to explain that an alkane is a hydrocarbon and that it contains only single bonds. Only a minority of candidates made both points.

(b) Some candidates wrote excellent answers to this question, showing they understood the importance of molecular size in determining the properties of hydrocarbons. Candidates needed to be careful, when discussing intermolecular forces, that their wording does not imply that chemical bonds have to be broken for boiling to occur.

(c) (i) Details of the use of bromine solution for testing unsaturation had been learned very well by the more able candidates. It was evident that colleagues have successfully encouraged candidates to avoid suggesting that bromine becomes *clear.*

(ii) Only a very small minority of candidates gained credit for this question.

(iii) Large numbers of candidates gained full credit for this question, demonstrating that candidates generally are skilled in constructing balanced equations.

Question 9

(a) (i) This kinetic energy calculation presented few problems for most candidates.

(ii) The majority of candidates from across the ability range gained the credit for this question. The most common incorrect response was *constant speed*.

(iii) Some good answers were seen from more able candidates but in general only partial credit was gained mainly for the idea that thermal (heat) energy passes from the golfer's body into the sweat.

COMIBINED SCIENCE

Paper 0653/04

Coursework

(a) Nature of tasks set by Centres.

All the assessments set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates work was comparable with previous years with candidates covering the whole mark range.

(b) Teacher's application of assessment criteria.

The assessment criteria were understood and applied well.

(c) Recording of marks and teacher's annotation.

Tick lists are generally used for skill C1.

Many scripts had teacher's comments aimed to help the candidate improve in future occasions. There were some comments justifying marks awarded.

(d) Good practice.

Tick lists used were appropriate.

Centres are reminded when annotating scripts, to annotate the script at the place where the marks are awarded.

COMBINED SCIENCE

Paper 0653/51

Practical Test

Key message

When instructed to indicate on the graph the values used to calculate the gradient, it is important to show these values on the graph rather than in the space provided for the calculation.

General comments

Candidates were able to attempt all questions on this paper and only a very small number of candidates left parts unanswered.

Comments on specific questions

Question 1

Some Centres appeared to use very large volumes of water to contain the visking tubing. Other Centres found that the time for the Benedict's test was crucial.

The correct observations were usually seen in **(a)(i)** but these were not always linked to correct conclusions. There was evidence that some candidates confused the test for starch with the test for reducing sugars. Other candidates reported the absence of sugar because they had observed a green or yellow colour rather than a red precipitate. Benedict's test can give a range of colours and candidates should be made aware of this.

Generally part **(a)(ii)** was only well answered if part **(a)(i)** had been completed correctly.

Good candidates scored four marks for **(b)(i)**; common errors were stating that starch was present due to a brown colour and confusing the starch and sugar tests.

Many candidates correctly stated that amylase broke down or, less correctly, that amylase reacts with starch. Fewer candidates completed the conclusion by saying that sugar had been formed in the process.

In part **(c)** many candidates needed to conclude that starch is a large molecule or that sugar molecules are small enough. Some candidates answered this part in terms of absorption.

Question 2

Following instructions, making measurements and recording observations are skills required for this paper. This lens experiment was a good test of these skills and differentiated well. The only problem for some Centres was that the focal length of their lenses was not 15 cm. However this was allowed for in the mark scheme and candidates were not penalised.

The table in **(a)** was always completed. Common errors were not recording distances to the nearest mm and using too few significant figures for the values of v/u. Occasionally candidates produced very odd sets of v/u values, the origin of which was impossible to tell.

For the graph, scales chosen did not always make the best use of the grid. Where the scales were sensible, the plotting was usually carried out accurately. Odd scales should be avoided wherever possible as this makes plotting difficult and time-consuming for the candidates. A small number of candidates plotted points as unacceptably large blobs. Some candidates wrongly plotted *u* despite the axes being labelled. Many candidates drew curves despite the instruction to draw a best-fit straight line in the stem.

Candidates were asked to indicate on their graphs the values chosen for calculating the gradient. Only the candidates that followed this instruction were able to gain credit for this part. For the second mark, gradients calculated from table values were only accepted if the best straight line passed through these points.

The last part was well answered.

Question 3

Despite being based on simple well known Chemistry, this question resulted in a wide range of marks.

In part **(a)**, most candidates reported a black colour but some thought it was a liquid because of the way the powder was moved by the gas evolved.

The colour change on adding the hydrochloric acid to **X** in **(b)(i)** was often not recorded but most candidates reported a change in the limewater. For the limewater test candidates should be reminded that 'cloudy' is not an acceptable alternative to 'milky' or 'white precipitate'. Most candidates realised that the gas was carbon dioxide but this mark was only awarded when evidence of a gas or a change in the limewater had been recorded. Identification of the anion as a carbonate was not dependant on any other responses.

Part **(b)(ii)** was well answered. Part **(c)** did cause some problems in that many candidates recorded 'blue ppt' or 'dark blue solution' rather than both. Many candidates needed to use the word '*precipitate*' or its abbreviation '*ppt*' where appropriate. Alternative descriptions were generally not accepted. The misuse of '*soluble in excess*' or '*insoluble in excess*' was commonly seen, for example, '*blue ppt insoluble in excess to give a dark blue solution*'.

X was often identified correctly as copper carbonate. Those candidates just giving '*copper*' as their answer did not gain credit.

COMBINED SCIENCE

Paper 0653/52

Practical Test

Key message

When instructed to indicate on the graph the values used to calculate the gradient, it is important to show these values on the graph rather than in the space provided for the calculation.

General comments

Candidates were able to attempt all questions on this paper and only a very small number of candidates left parts unanswered.

Comments on specific questions

Question 1

There may have been an issue with some Centres finding that 'dead' grains still produced starch digesting enzymes. Some allowance was made for this so that candidates could still access the majority of the marks.

All candidates scored in **(a)(i)** and generally this was well drawn. Again the drawing mark in **(a)(ii)** was deservedly awarded but not all drawins were labelled to show the colours. Although most candidates drew yellow or brown areas where the grains had been, few made this connection in **(a)(iii)**. Consequently **(a)(iv)** was often answered in a rather muddled way. Only the best candidates discussed the breakdown of starch, sometimes mentioning starch digesting enzymes. Some candidates erroneously believed that the grains had produced the starch. In **(a)(v)** only a few candidates identified the use of dead grains as a control however credit was given for clear answers discussing the comparison of dead and living grains for breaking down starch.

For part **(b)**, there were many responses which referred to accuracy or fair testing and so did not access this mark. A significant number correctly discussed the need for repetition to improve reliability or the chance of a grain failing.

Candidates who thought that the seeds produced starch tended not to score the mark for **(c)**. However some correct answers were seen, even by candidates who had not included 'starch digestion' in answers to previous parts.

Part **(d)** was not well answered. Candidates need to be more precise about which conditions are kept the same, what is varied, what is measured and how results will be used.

Question 2

Tables were always completed and nearly all showed the expected trend. For **(a)(ii)** most candidates described the method for finding the balance point. Correct descriptions were marked generously providing the intent was clear.

For the graph, scales chosen did not always make the best use of the grid, despite candidates being prompted that there was no need to start the axes at the origin. Plotting was carried out accurately if the scales were sensible. Odd scales should be avoided wherever possible, particularly for the independent variable. A small number of candidates plotted points as unacceptably large blobs.

Candidates were asked to indicate on their graphs the values chosen for calculating the gradient. This was rarely seen and was marked strictly according to the mark scheme. For the second mark, gradients calculated from table values were only accepted if the best straight line passed through these points.

Part **(c)** was well answered. Some candidates lost the mark due to a poor choice of significant figures and incorrect rounding, despite being able to carry out the calculation.

Question 3

In **(a)(i)** reasonable alternatives to '*no reaction*' were allowed.

There was still a problem with candidates not using the word '*precipitate*' or its abbreviation '*ppt*' where appropriate. Alternative descriptions were not always accepted. It should be noted that '*chlorine ions*' were not an acceptable alternative for chloride.

In part **(b)** the candidate had to filter the mixture. In such cases it is important to describe the mixture, the residue and the filtrate. Many candidates did not describe the filtrate and consequently copper ions were not identified.

For part **(c)** many candidates just listed the ions they had identified previously, rather than pairing up cations and anions to give compounds as required.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters, etc.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on Specific Questions

Question 1

(a) A knowledge of the iodine test for starch and the Benedict's test for reducing sugar was required to answer this question. The colours of the tests were given and candidates were expected to state whether starch or sugar was present or absent. A number of candidates could not match the colours with the results and others failed to state if the substance was present or absent.

(b) Most candidates realised that the sugar molecules were now small enough to pass through the visking tubing but a number failed to say that the amylase was responsible for the breakdown of starch into sugar.

(c) Most candidates realised that the visking tubing represented part of the intestine, however, to gain credit the answer had to specify "small intestine". Some of the better candidates named a part of the small intestine, e.g. ilium, which also gained credit. The water, representing blood or capillaries was much less known.

(d) Most candidates realised that starch molecules are too big to pass through into the alimentary canal and therefore need to be digested before they can be absorbed.

Question 2

(a) Most candidates could read a metre rule correctly, but a few did not realise that results must be tabulated to the same degree of accuracy as results already given in the table.

(b) Results were generally plotted correctly, although a few candidates confused the scales or did not notice the very different scales on each axis. Most drew a line of best fit correctly, and a number showed how they found the gradient, ideally by drawing a triangle on the graph as instructed; a few used values from their table. Again some candidates failed to take the different scales into account, and no credit was given for lines that were non-linear at the point of the gradient determination.

Question 3

(a) Almost all of the candidates knew that carbon dioxide turns limewater milky, and most interpreted this test to imply that a carbonate was present, although many suggested carbon instead.

(b) Most candidates scored full credit for a labelled diagram illustrating filtration, but quite a few omitted either the funnel or the filter paper.

(c) Very few candidates identified copper hydroxide as the precipitate on adding dilute ammonia to an aqueous copper salt, and even fewer referred to the blue solution formed in excess ammonia.

(d) Few candidates correctly described the changes in appearance of the solution or iron filings when displacing copper from copper nitrate solution, suggesting unfamiliarity with this experiment.

(e) Several sulfates and iron compounds were deduced through incorrect observations; only the best candidates gave the correct name and formula of copper carbonate.

Question 4

(a) A number of candidates were unable to measure the lengths correctly, with some giving a magnification of less than 1, even though their drawing was larger than the photograph.

(b) Candidates had to add to their drawing in **(a)** a line to represent a transverse cut through the root and to label the xylem tissue on Fig. 4.2. Some candidates appeared to have missed this part and moved on to the next. It is very important to read the question fully and carefully.

(c) Candidates were asked to outline an experiment to find where the xylem tissue is distributed in the stem, a common experiment that few candidates described well. Many failed throughout their explanation to mention the stem, and only considered the root. Other candidates failed to take notice of the credit allocation and gave simple one line answers.

Question 5

(a) Almost all candidates identified magnesium and many identified silicon rather than silica.

(b) A number of candidates thought that P was potassium.

(c) The colour of chlorine was well known. It is important that candidates avoid making ambiguous statements such as “one is coloured” or “by colour”. Descriptions of how to test for chlorine were unacceptable as the question asked about appearance.

(d) Some candidates realised that electrical conductivity was a suitable test for all metals, but several chose to react aluminium with an acid, and others gave non-general metal tests.

(e) Most candidates knew that sulfur burns with a blue flame, but there were some interesting ideas with regard to the addition of water including “cooling it” and “to put out the flame”. Many scored well on the colours of Universal Indicator.

Question 6

(a) Many candidates made errors when reading the meters, but overall most scored some credit. Some credit was lost by candidates who did not give their readings to the same degree of accuracy as the figures already in the table.

(b) The most commonly suggested reason made reference to the variation in the variable resistance or the current and voltage. Many candidates realised that the results should be averaged.

(c) Electrons were often identified as the particles involved in conductivity, but not many gave the correct direction of travel in the circuit.

CO-ORDINATED SCIENCES

Paper 0653/62

Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters, etc.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on Specific Questions

Question 1

This question tested candidates' knowledge of the tests for starch and reducing sugars and that starch can be converted to reducing sugar. Many candidates thought that it was the grains that were being tested, rather than the gel.

(a) (i) Candidates were asked to describe the results in dish **A**. Many candidates offered an explanation, which was not required at this stage.

(ii) A number of candidates failed to realise that the gel in the Petri dish was a starch-agar mixture and that the colour change of the iodine solution was brought about by an enzyme in the living barley grains. Some incorrectly stated that the grains produced the starch.

(iii) The use of a control, in this case using dead grains, was well known.

(b) The use of Benedict's solution to test for the presence of reducing sugars was not well known and therefore few candidates realised that the enzyme in the barley grains had converted the starch in the gel to sugar.

(c) The use of more than one grain was well known, although a number thought that it was to increase accuracy.

(d) The results would be a greater or smaller area of brown. Some candidates tried to explain why the areas would be different in size which did not answer the question.

(e) When asked to outline an experiment candidates will usually be expected to explain how they would adapt the experiment in the question. The question stated they should use starch-agar gel, and therefore candidates were expected to place different varieties of seeds on the gel, keeping all other conditions constant, and then compare the sizes of the brown areas.

Question 2

(a) Some candidates did not follow the instruction to read the position on the rule of the centre of **M**, and so were not awarded credit. The results already given in the table gave an indication of the level of accuracy required and candidates should, therefore, have recorded their results to one decimal place, i.e. 68.0 rather than 68.

(b) (i) Plotting of points was mostly very accurate and few candidates had problems. The calculated points should lie on or very close to the best straight line. Candidates whose plotted points did not lie on or near to the line of best fit should have realised that either their calculations or plotting were incorrect and should have carefully checked their working.

(ii) Calculation of gradients caused problems for some candidates, and the instruction to show on the graph the values used was often ignored.

(c) The gradient was used to calculate the mass of the rule using the equation given. Whatever value the candidate calculated for the gradient could be used with no further loss of credit provided the answer was correctly calculated. Some candidates, however, incorrectly rounded their answers, giving, for example, 123 when the calculated value was 123.67 and therefore should have been rounded to 123.7 or 124.

(d) Candidates whose formulae did not use the symbols given could not gain credit for this part of the question.

Question 3

This question consisted of a series of tests, observations and conclusions a candidate made to identify the ions present in an unknown solution. Candidates from many Centres were aware of the tests and results involved in analytical chemistry, although it appeared that candidates from some Centres had little practical experience of these tests.

(a) (i) When dilute nitric acid is added to solid **X**, a gas is given off and a green solution formed; the student would have observed bubbles rising in the solution. The green colour suggests the presence of a transition metal.

(ii) Candidates were told that the unknown solid contained carbonate ions, and so the limewater would turn cloudy.

(iii) The formation of a white precipitate when aqueous silver nitrate was added would show that the unknown also contained chloride ions.

(b) The cations were identified, by the addition of ammonia solution and sulfuric acid, as copper(II) and iron(III).

(c) Finally candidates had to name the salts that could have been used to make the solution **X**. Either iron(III) chloride and copper(II) carbonate or copper(II) chloride and iron(III) carbonate were acceptable.

Question 4

(a) After reading the scales and completing a table candidates had to plot a graph and draw a smooth curve. Candidates should always use as much of the graph paper as possible, and many realised that with all the points lying in the range 10.0 to 14.1 it was sensible not to start the axis at 0. The vertical axis had already been labelled, but many failed to label the horizontal axis with a name and unit. When asked to calculate the average extension between two points, many candidates struggled and their answers suggested that they did not understand what they were doing, as the extensions given were longer than any of the figures in the table.

(b) It is important that candidates read the questions properly and answer the questions rather than what they think has been asked. Often the answer to part **(ii)** was given in part **(i)**, or was simply a repeat of the question.

(c) Again, some candidates did not read the question carefully. When asked for one other factor that should be kept the same when investigating a piece of vein of the same length, some gave the answer "same length".

Question 5

(a) The scales were read correctly by many candidates. Some, however, confused 28.2 with 27.8. Most candidates were able to identify the most and least concentrated sample.

(b) It was rare to see a correct equation even though the salt, sodium ethanoate, was given in the question. Few gave the correct colour for a weak acid, many giving red or a shade of red.

(c) A number of candidates did not attempt to answer this question part. As indicated by the credit allocation, a detailed answer was required. Some thought that it was enough to give 'crystallise' with no further experimental detail. Many believed that the solution could just be evaporated to dryness to leave crystals in the dish.

Question 6

(a) **(i)** A large number of candidates appeared not to be familiar with the term *amplitude*.

(ii) A number of candidates ignored the instruction "to the nearest 0.1 cm".

(iii) Many were able to rearrange the equation to calculate a frequency.

(b) Although some candidates tried to put figures in the space for units, many scored well here.

(c) Candidates were required to calculate the speed of the trolley at a different point.

(d) The question stated that the trolley accelerates, so a simple answer such as "it gets faster" was not credited unless reference was made to the calculations in **(b)** and **(c)** as instructed in the question.

COMBINED SCIENCES

Paper 0653/63
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques 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 measuring cylinders, thermometers, stopwatches, etc.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Comments on specific questions

Question 1

(a) Most candidates correctly assigned a scale to the vertical axis and then correctly plotted the points. A significant number did not label the axes or indicate the units used. Despite the instruction to draw a best-fit curve many candidates simply joined the points, and in some cases used a ruler.

(b) Many candidates identified a possible anomalous result but did not suggest a reason for the result and so were unable to gain credit for their choice. Many candidates incorrectly chose **A**, because it was so much larger than the others. They should instead have looked at the trend in the results and realised that two results were almost identical and therefore one was likely to be anomalous. A significant number misinterpreted what was being asked and described the trend in the results.

(c) The majority of candidates used their graphs to predict a value beyond the scope of the line they had drawn.

(d) (i) The majority of candidates suggested modifying the experiment by changing the temperature. The more able candidates identified the control of concentration and the most able included the necessary experimental details.

(ii) Many candidates labelled the axes correctly, but a significant number inverted the axes, plotting temperature against concentration or temperature against activity of enzyme. Only the most able candidates were able to correctly sketch the shape of the expected graph; most sketched either an ascending curve or a descending curve.

Question 2

This followed an investigation into the resistances of lamps in series and in parallel.

(a) (i) The majority of candidates read dial $\mathbf{A_1}$ correctly; a significant number read dial $\mathbf{A_2}$ as 2.25 A and/or dial $\mathbf{A_3}$ as 5.3 A.

(ii) and **(iii)**
The majority of candidates correctly calculated the resistances, although incorrect rounding was frequently seen.

(b) Many candidates calculated the combined resistance correctly, but a number went on to double their answer. A significant number of candidates attempted to use $1/R = 1/R_1 + 1/R_2 + 1/R_3$.

(c) The vast majority of candidates did not refer to the numerical quantities involved and most did not refer to a reason for either the closeness of the values or the difference in the values.

(d) (i) The more able candidates could correctly identify **Y** as the brighter lamp. Many candidates discussed the amperes in the circuit rather than the observation asked for in the question.

(ii) Only the more able could correctly identify the parallel circuit in Fig. 2.1 as having the brighter bulbs. Many candidates discussed the relevant brightness of the two bulbs within each circuit separately, rather than comparing the two circuits. A significant number of candidates discussed the resistances or the meter readings rather than the observation requested in the question.

Question 3

(a) The majority of candidates were able to correctly read the values on the thermometers, although a significant number gave 26.45 °C for **A** and 27.45 °C for **B**.

(b) In part **(i)** most candidates were able to calculate the temperature change correctly and in part **(ii)** both the term *exothermic* and the reason were well known by many of the candidates.

(c) The most able candidates appreciated that identical temperature changes would be caused by identical volumes or concentrations of sodium hydroxide. Many candidates focused on the fact that the amounts of acid were the same, although the question did not specify whether the acids were mono-, di- or tri-basic or on the fact that it was the same reaction of hydrogen ions and hydroxide ions, without considering that the amounts of these present is also important.

(d) Only the most able candidates gained credit here, usually for suggesting either higher temperature change or faster reaction, but often with no explanation as to why this would lead to smaller percentage errors. The vast majority of candidates thought that doubling the concentration would either ensure that all of the acid would react or that it would take a longer time to react or discussed collisions and their need for a longer reaction time. A significant number of candidates omitted this question.

(e) Few candidates knew the test for chloride ions but those who did also knew the observation. A significant number of candidates omitted this question. Universal Indicator and litmus were frequent responses.

Question 4

(a) (i) Many candidates were able to interpret the graph and so correctly describe an increase and then a decrease in pH over the 24 hour period. Many candidates discussed the peak or trough at sunrise and sunset without considering the changes over the time, or only described the increase in the first part of the graph or the decrease in the second part of the graph.

(ii) More able candidates understood the connection between pH and concentration of carbon dioxide and so realised that the answer here was the inverse of the trend in part **(i)**. As in part **(i)** many candidates either discussed the peak or trough at sunset and sunrise without considering the changes over the time, or only described the increase from sunrise to sunset or the decrease from sunset to sunrise.

(iii) Many candidates correctly explained why photosynthesis affects carbon dioxide levels; fewer discussed the role of respiration on levels of carbon dioxide and fewer still discussed both. A significant number reversed photosynthesis, thus producing carbon dioxide and, some also reversed respiration. Weaker candidates did not refer to photosynthesis and respiration at all. A significant number of candidates answered in terms of oxygen rather than carbon dioxide.

(b) (i) Many candidates correctly placed the **X** in the middle of the ascending left-hand part of the graph. A number placed the **X** at the peak at sunset and others placed the **X** at either or both of the sunrises.

(ii) The more able candidates recognised the role of respiration. The majority of candidates answered in terms of a lack of photosynthesis.

(iii) Many candidates realised that there would be less oxygen produced during a cloudy day and so drew the whole of the line beneath the existing line. However, there were many carelessly drawn lines, mostly drawn below the existing line but crossing above it in places. A significant number drew the line above the existing line, suggesting that more photosynthesis would occur on a cloudy day.

(c) Only the most able candidates gained any credit in this question. Many candidates rewrote part of the question stem or answered in general terms without outlining a method for the investigation. A significant number of candidates did not attempt this question. The more able candidates either described how to vary the light intensity, or stated that the amount of oxygen and the time needed to be measured, but few made both points. A small number of the most able candidates gave three creditworthy points.

Question 5

In this experiment candidates were following a reaction to make a salt and its subsequent crystallisation.

(a) (i) Many candidates appreciated that the pieces of apparatus needed included those for measuring the volume of acid, such as a measuring cylinder, for adding the powder to the acid, such as a spatula, and for stirring the solution, such as a stirring rod. A significant number of candidates included goggles, beakers, filter funnels and evaporating basins.

(ii) Many candidates did not read the question carefully and so gave the observations showing that the reaction was occurring, rather than the observations which would be made to show that the reaction was complete, such as the bubbles stopping or the magnesium carbonate no longer dissolving.

(b) It was appreciated by many that the mixture needed to be filtered, but a significant number of candidates either did not include both filter paper and a filter funnel in their diagram, or did not include any labels. A significant number of candidates thought the mixture should be decanted, evaporated or distilled.

(c) (i) Few candidates could describe how to obtain crystals from a solution. Many suggested heating the solution until all of the water had been evaporated, rather than just saturating the solution by reducing the volume and then leaving to cool for the crystals to form.

(ii) Very few candidates knew a method for growing one large crystal, e.g. by tying a seed crystal onto a piece of string and suspending it in a saturated solution of the salt. Many candidates suggested heating the crystals, perhaps believing that they would melt into one large crystal. A significant number of candidates did not attempt to answer this question.

Question 6

This experiment involved the reflection and refraction of light rays.

(a) (i) Many candidates drew the reflected beams parallel to each other, at an angle of 30° to the mirror. A significant number of candidates transposed the rays to the right so that they were not actually reflected at the point of incidence.

(ii) More able candidates quoted the law of reflection. A significant number discussed the angle of refraction or just stated the term *law of reflection*. Boyle's Law and Hooke's Law were also named by some candidates.

(b) More able candidates constructed the lines passing through **F** in order to obtain a correct value of around 2.0 cm. Many candidates constructed the correct lines but then measured the distance from the lens to the screen and so gave the value as around 7.0 cm.

(c) (i) Many candidates constructed the diagram carefully, keeping the rays in each medium parallel, with the beams bending towards the normal on entry to the block and away from the normal on leaving the block. A significant number of candidates drew the beams refracted beyond the normal. Many did not draw the emergent beam parallel to the incident beam.

(ii) Some candidates drew a normal as the beam entered the block, and only the more able candidates correctly labelled the angle of incidence and the angle of refraction. A significant number of candidates omitted this question.