# COMBINED SCIENCE

**Paper 0653/11**
**Multiple Choice**

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

## General Comments: Biology

All questions fell well within the scope of candidates offering the paper, with none of them being too difficult or too easy. Perhaps one or two of the questions were answered a little too hastily when a little more time spent thinking carefully before answering might have paid dividends.

## Comments on Individual Questions

### Question 1

This was the easiest question in the biology section of the paper, but there were still those who thought that *all* the enzyme had been denatured even when the rate of reaction was still increasing.

**Question 2**

There is always confusion between the processes of respiration and photosynthesis in a plant. Usually, candidates believe that plants respire only in the dark, but a further problem was exposed by this question with over a quarter of candidates believing that plants respire by photosynthesising.

**Question 5**

Some candidates, seeing the word 'acid' and knowing that an acid is produced during fat digestion, opted for 'amino acid'. Although faulty knowledge was most probably the cause of their downfall, there is also the chance that answers were given without sufficient careful thought.

**Question 6**

Graph interpretation can always be a problem, and in this question almost as many opted for the reverse of what happens than chose the correct answer. It is highly likely that, if *asked* what effect increasing humidity has on transpiration, far fewer would supply the incorrect answer.

**Question 7**

This question proved, by far, to be the most testing question in the biology section of the paper. The more able candidates appeared to experience few problems, but, otherwise, wholesale guesswork was applied. Perhaps the fact that the label line for the correct answer does not, at first sight, appear to indicate any particular structure was, in part, responsible for the confusion.

**Question 10**

Candidates traditionally confuse the functions of the liver and the kidney. Such confusion led over a third of them to believe that adrenaline is destroyed in the kidney.

**Question 13**

This was the only question that did not discriminate well between candidates of different abilities. This may have been because some of the better candidates felt that sewage may well *eventually* decrease the growth of algae and thus reduce the population of those fish relying on the algae. However, the very considerable majority who realised that the fish and algae might both die at approximately the same time, for similar reasons (lack of oxygen) had no problems.

## General Comments: Chemistry

**Questions 17**, **20** and **27** were the easiest for the candidates with **Question 15** and **Question 22** proving most difficult.

## Comments on Individual Questions

**Question 15** was most difficult for candidates. Roughly equal numbers of candidate chose each option. Roughly half did not appreciate that copper does not react with dilute (sulfuric) acid. Even of those who did, there was confusion regarding the amount of solid (copper) remaining in the residue.

**Question 17**

This question involving the simple addition of atoms of three elements within a molecular structure and was extremely well answered.

**Question 19**

It is likely that some more able candidates chose **C**, misreading "hydrogen is reduced" for "hydrogen is produced". Some candidates could benefit from having the differences in the meanings of such similar terms emphasised when these are encountered.

**Question 20**

Candidates have been well-taught the basic principles of redox.

**Question 22**

More candidates chose **B,** copper(II) oxide, than the correct answer **C**, magnesium. The gas test for hydrogen is more well-known by candidates than the reactions that produce the gas.

**Question 27**

Candidates performed well on this question showing they understand the use of fractional distillation as a separation technique.

## General Comments: Physics

In the physics section, **Question 30** was found particularly easy, with none being found particularly difficult.

## Comments on individual questions

**Question 32**

In this question on energy change almost a third of candidates opted for **B**, failing to notice that the block was on a horizontal table, so there was no change in its gravitational energy.

**Question 33**

The subject here was evaporation and temperature change, and slightly more than half of all the candidates believed that the temperature of the remaining water would rise as some of it evaporates.

**Question 34**

Candidates had little difficulty with this contextual question.

**Question 35**

Able candidates had little difficulty with this question on convection, but some candidates chose distractor **A**, believing that cool air rises from the ice cube.

**Question 36**

A large proportion of candidates chose the incorrect option **A**.

**Question 37**

A large proportion of candidates did not take into account that the sound would have to travel 200 m to be detected as an echo at the timer, leading them to choose option **A**.

# COMBINED SCIENCE

**Paper 0653/12**
**Multiple Choice**

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

## General Comments: Biology

The biology section of the paper fell well within the scope of the candidates. **Question 3** and **Question 4** gave candidates little trouble. Candidates found **Question 6** and **Question 7** the most difficult.

## Comments on Individual Questions

### Question 1

Many candidates incorrectly opted for ‘breathing’ as a characteristic of all living organisms.

### Question 5

There was an example here of some candidates just not being sure of their facts, and thus over a quarter felt that vitamin C rather than vitamin D is necessary for strong bones.

**Question 6**

There was a clear understanding that the right side of the heart deals with blood passing to the lungs, but some confusion over which valve must close to allow it to happen.

**Question 7**

This question proved to be one of the more testing questions in the biology section of the paper. The more able candidates appeared to experience few problems, but, otherwise, wholesale guesswork was applied.

**Question 12**

A confusion was exposed by this question. A large proportion of candidates opted for the correct answer **B**, but the question confused some candidates who opted for **C**.

**Question 13**

Faulty interpretation of the diagram led almost a third of the candidates to believe that respiration is the process responsible for carbon passing from plants to animals.

## General Comments: Chemistry

**Question 17** was the easiest for the candidates. **Question 15** and **Question 22** were the most difficult for candidates.

## Comments on Individual Questions

**Question 15**

Strong candidates performed well on this question but it caused considerable difficulty for everyone else. Many candidates opted for the incorrect option **D**, not realising the importance of copper acting as a catalyst. An equally popular distractor was option **A**.

**Question 17**

Candidates had to simply count the number of atoms of two different elements within a molecular structure and had very little difficulty selecting the correct option **D**.

**Question 18**

A majority of candidates realised the lead(II) bromide needed to be molten but a significant number of candidates thought that the heat was required for the lead(II) bromide to react with air.

**Question 21**

Most candidates correctly determined that potassium sulfate was a product, however a significant number of these candidates incorrectly thought carbon dioxide was also produced in addition to water.

**Question 22**

More candidates chose **B,** copper(II) oxide, than the correct answer **C**, magnesium. The gas test for hydrogen is more well-known by candidates than the reactions that produce the gas.

**Question 26**

It is likely that whilst most candidates realised that tanks of sand filter out insoluble matter from the water supply, some of the more able candidates incorrectly thought that the tanks of sand are used to filter out bacteria, which are too small to be separated out this way, and to filter out tree branches and other large objects, which would have been removed by grills before the water reaches these tanks of sand. Candidates

could benefit from a more thorough understanding of contextualised topics, such as this, contained within the syllabus.

## General Comments: Physics

In the physics section, **Question 33** and **Question 39** were the most difficult for candidates. **Question 30** and **Question 40** were less challenging.

## Comments on Individual Questions

### Question 28

This question was on average speed. Stronger candidates had little difficulty, but weaker ones often failed to include the 60 laps of the track, leading them to choose option A.

### Question 33

Many candidates incorrectly thought the gas particles did not move at 0 °C.

### Question 34

The topic here was heat transfer, and many less able candidates appeared to believe that the main process of heat distribution through the water was radiation rather than convection.

### Question 37

A large proportion of candidates did not take into account that the sound would have to travel 200 m to be detected as an echo at the timer, leading them to choose **A**.

### Question 39

Although this question was generally well answered, common errors involved choosing **B** (having the lowest value of individual resistors) or **D** (having only one resistor). Candidates opting for these distractors appeared to be unaware that adding resistors in parallel reduces the total resistance.

# COMBINED SCIENCE

**Paper 0653/13**
**Multiple Choice**

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

## General Comments: Biology

No question proved to be beyond the capabilities of the candidates at this level, though **Question 6** led to some confusion. **Question 13** presented very few difficulties to any of the candidates.

## Comments on Individual Questions

### Question 5

This was a question which was able to attract correct answers only from the best candidates. The rest were clearly confused over exactly where carbon dioxide and water enter and leaves a leaf. The problem revolved around the function of the xylem in these two processes, and 44% of candidates mistakenly felt that if must be involved either in bringing carbon dioxide to the leaf or taking water away from it.

**Question 6**

This proved to be the most difficult question on the paper. It was only the better candidates that realised that glucose is carried by the same structural feature that also carries the blood cells and the platelets.

**Question 11**

A lack of careful learning of the structure and function of floral parts proved the undoing of almost a third of the candidates who felt that pollen is produced by the stigma.

**Question 13**

Questions on food webs and food chains are always likely to test common sense rather than biological knowledge. However, there are always mistakes to be made by the unwary, and there were very few of those in the answering of this question.

## General Comments: Chemistry

**Questions 17**, **19**, **20** and **21** were the easiest for the candidates. **Question 27** was the most difficult.

## Comments on Individual Questions

**Question 17**

Candidates simply had to count the number of atoms of four different elements with a molecular structure. This posed little difficulty for the vast majority.

**Question 19**

This question required candidates to interpret simple temperature-time graphs in order to deduce which represented an exothermic reaction which many did without difficulty.

**Question 21**

Candidates were required to consider the single process not involved in the preparation of crystals of a salt. It is likely that some weaker candidates did not consider the "**not**" in the question. Candidates should be forewarned that some questions are designed with "**not**" emboldened, and they should be encouraged to understand the significance of this emboldening.

**Question 22**

This question was generally well answered. Most candidates knew that the reaction of magnesium with acid produces hydrogen, although a significant number of candidates thought the substance was the carbonate.

**Question 27**

Candidates were required by this question to know the syllabus statement "State the use of … diesel oil/gas oil for fuel in diesel engines." There was evidence of large scale guessing in this question. The recall of one short phrase in the syllabus should have enabled candidates to choose the correct response. It should be noted that where the syllabus states, for example, "diesel oil/gas oil", both terms should be taught and learned as either or both may be encountered in an exam paper.

## General Comments: Physics

In the physics section, candidates had little difficulty with **Question 30** and **Question 33** but **Question 36** caused difficulty.

## Comments on Individual Questions

### Question 28

In this question on average speed, stronger candidates had little difficulty. Some candidates did not notice that the time was given in minutes rather than hours, leading them to choose option **A**.

### Question 29

The most common error here was to link mass to weight, and assume they were measured in the same unit.

### Question 36

The syllabus area covered by this question was refraction of light and total internal reflection. More than half the candidates either failed to notice that the angle of incidence was greater than the critical angle, or did not understand its significance, therefore opting for distractor **B**.

### Question 37

A large proportion of candidates did not take into account that the sound would have to travel 200 m to be detected as an echo at the timer, leading them to choose **A**.

### Question 39

Option C was relatively popular here, probably linked to a belief that the current at all points in a parallel circuit is the same, rather than in a series circuit.

# COMBINED SCIENCE

**Paper 0653/21**

**Core Theory**

## Key Messages

It is very important that candidates read questions carefully and make sure that they answer exactly the question that has been asked.

When asked to explain something, candidates should ensure that they are not simply repeating back information that is provided in the stem of the question.

## General Comments

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

It was encouraging to see that most candidates, when asked to, were able to give formulae used in their calculations in an appropriate format.

A number of candidates had difficulty with questions that asked them to describe a **trend.** They did not seem to understand the term.

Some questions were left unanswered. When they have completed all the questions that they are sure of, candidates should be encouraged to return to any unanswered questions and make an attempt at answering them.

## Comments on Specific Questions

### Question 1

**(a) (i)** While most candidates identified B as a plant cell, only some also identified D as a plant cell to score the mark.

**(ii)** Few candidates were correctly able to identify that only C was a haploid cell. Many put down multiple answers here.

**(b)** A good number of candidates were able to identify and label parts of a plant cell, usually B. Label lines did need to be drawn with care to show clearly what was being identified. A few candidates identified features common to plant and animal cells.

**(c)(i)** Candidates found this question hard and a number thought the movement of the meniscus showed water being taken in by the leaf, rather than transpiration. Some were still able to gain a mark for recognising that X had less surface area.

**(ii)** As in part **(i)** a number of candidates confused transpiration with water intake here. Very few candidates realised that as humidity decreases the rate of transpiration will increase.

**Question 2**

**(a)** Some candidates did not understand what a 'trend' was here. Those that did generally correctly identified melting point decreasing down Group VII.

**(b)** A lack of precision here lost some candidates marks. Although they correctly identified sodium as losing electrons they said that bromide (rather than bromine) gained electrons and did not get the credit for the second mark. Weaker candidates were confused about which element gained and which lost electrons.

**(c) (i)** This question was very poorly answered with hardly any candidate correctly identifying bromine. Some candidates able to identify bromine in the word equation in part **(ii)** did not identify it here as giving the orange colour to the final mixture.

**(ii)** While some candidates were able to complete the left hand side of the equation, few correctly identified the products in this reaction. Some tried to write equations using formulae, rather than the word equation asked for, and failed to gain credit because their formulae were incorrect.

**(iii)** This proved very difficult with hardly any candidates able to explain why sodium bromide reacts with chlorine but does not react with iodine. Most just repeated information given in the question stem about chlorine being more reactive than bromine without explaining that this meant chlorine could displace bromine from sodium bromide.

**Question 3**

**(a)** Many candidates correctly identified the energy transformation occurring here. A few identified incorrectly that the energy change was from kinetic to potential energy.

**(b) (i)** The vast majority of candidates correctly identified the force here.

**(ii)** Again most candidates were able to draw a correct upwards arrow to identify the direction in which air resistance acts.

**(iii)** Most candidates correctly identified newtons here.

**(c)** Graphs for a number of candidates suggested that they had misread the question and were drawing a graph of how speed changes from the beginning of the fall rather than 'as the rope stretches' as stated in the question. Credit was still gained if they clearly showed a drop in speed that eventually reached zero and touched (or just crossed) the horizontal axis.

**(d)** A good number of candidates realised that the weight of the man hanging from the rope would partially stretch it and so were able to gain credit here. Most wanted to do some calculation to find a value rather than give an estimate of the length as asked in the question.

**(e)** Although a good number of candidates realised that the heat energy came from KE they found it hard to express this in a creditworthy manner. Vague references to the rope being repeatedly stretched were not sufficient to gain credit.

**Question 4**

**(a) (i)** Most candidates correctly identified the urethra but fewer knew where the prostate gland was located, with a number incorrectly labelling the bladder or a testis as the prostate gland.

**(ii)** Some candidates thought the blockage at B would prevent the man having any children. Those that did recognise that the other side was unblocked, often failed to gain full credit here by being too vague in their answer. Examiners needed to see at least 'sperm tube' rather than just 'tube'. The best answers were clear and precise, stating that the other sperm duct was unblocked and so sperm could still travel from the testis through the duct.

**(b) (i)** This question was poorly answered with a number of candidates thinking that menstruation happened between days 5–10 when the lining was lowest.

**(ii)** This was rarely answered correctly.

**(iii)** Very few candidates realised that hormones cause the uterus lining to become thicker. A number thought it was ovulation that triggered the lining to become thicker.

**(iv)** Those that recognised the thickened lining was for implantation often failed to gain credit as they talked of implantation of the egg, rather than developing embryo or zygote.

**Question 5**

**(a)** Answers here needed to be sufficiently precise, so 'plants' was not creditworthy for biofuel and 'cows' was not sufficient but 'cow dung' or 'manure' were accepted.

**(b) (i)** Candidates found this question hard and many did not complete all three boxes. Water (vapour) was rarely recognised as a product of the explosion.

**(ii)** A fair number of candidates recognised this as an exothermic reaction.

**(c) (i)** A good number of candidates gained credit here.

**(ii)** Quite a number of candidates thought this was ionic bonding.

**(d) (i)** Some correctly understood that vapour was condensing at point G but some candidates had not fully understood and simply stated that the change was evaporation or boiling.

**(ii)** A good number of candidates identified different boiling points as explaining why gasoline and diesel separate at different points in the tower.

**Question 6**

**(a)** Candidates found this very hard. Although a number knew that the light ray should bend as it entered the block they did not draw in the normal and so could not mark angle of incidence or refraction and often their ray exiting the block was not parallel to the incident ray.

**(b) (i)** A good number of candidates were able to identify one out of gamma, X-rays or ultra-violet radiation.

**(ii)** A few candidates were able to identify infra-red radiation here.

**(c) (i)** Many candidates were let down here by careless drawing. The best answers showed clearly a wavelength as being the distance between the same point on two consecutive waves. This was often shown as from one peak to the next. Likewise an amplitude shown from mid-line to peak scored but credit was not given where the arrow did not clearly extend the full distance to the peak.

**(ii)** While a good number of candidates correctly identified amplitude as corresponding to loudness or volume, some candidates incorrectly thought that the amplitude was a measure of pitch or frequency.

**Question 7**

**(a)** This was generally well answered by most candidates with most scoring at least one mark.

**(b) (i)** Candidates found this question hard and did not make use of the information provided in the question to explain that oxygen diffuses from an area of higher concentration to an area of lower concentration.

**(ii)** This was another difficult question with many candidates describing how oxygen gets to cells rather than answering the question asked. Hardly any candidate identified that a reaction with glucose happened to release energy. Those that scored a mark here usually did so by mentioning respiration taking place.

**(iii)** The vast majority of candidates gained credit for this question, identifying a wide range of situations where humans would be in a state of “fight or flight” such as being chased by dangerous animals or during competitive events.

**(iv)** Candidates found this question hard to answer and were often too vague. Credit was most often given for identifying a faster heartbeat.

**Question 8**

**(a) (i)** A good number of candidates correctly described the test for hydrogen but some incorrectly suggested a glowing splint be used.

**(ii)** This was poorly answered with a number of candidates suggesting that the hydrogen was coming from the iron.

**(iii)** Candidates found this very difficult. Many suggested using litmus paper. Some who did not gain credit did at least partially remember the test for chloride ions as they mentioned adding nitric acid.

**(b)** Most candidates correctly understood the effect on the reaction of increasing the temperature of the acid. A few incorrectly thought that this was an enzyme reaction and the enzyme would be denatured at the higher temperature.

**(c)** This was another question which demonstrated weak understanding of the reactivity series. Many candidates believed that copper would just react more slowly than the iron and a few even thought copper was more reactive than iron.

**Question 9**

**(a) (i)** Many candidates were able to complete the formula correctly.

**(ii)** A number of candidates simply repeated information from the question about the length being shorter here, rather than explicitly stating that the current is less.

**(iii)** There were a variety of answers here with some candidates thinking that the ammeter reading would go down, others stating it would be unchanged and only some correctly identifying that it would go up. Many candidates did not understand the effect that having resistors in parallel would have on the current.

**(iv)** A fair number of candidates correctly calculated the total resistance.

**(b)** Most candidates correctly identified a bulb. Many drew the symbol for a variable resistor instead of the fixed resistor named in the table. Very few candidates knew the correct symbol for a fuse.

**(c) (i)** Very few candidates correctly identified convection as the correct answer here.

(**ii)** Most candidates were not able to attempt this question. A few, who had identified convection in part **(i)** did attempt to describe experiments which show convection and were able to gain some credit here.

# COMBINED SCIENCE

**Paper 0653/22**

**Core Theory**

## Key Messages

It is very important that candidates read questions carefully and make sure that they answer exactly the question that has been asked.

When asked to explain something, candidates should ensure that they are not simply repeating back information that is provided in the stem of the question.

## General Comments

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

It was encouraging to see that most candidates, when asked to, were able to give formulae used in their calculations in an appropriate format.

A number of candidates had difficulty with questions that asked them to describe a **trend.** They did not seem to understand the term.

Some questions were left unanswered. When they have completed all the questions that they are sure of, candidates should be encouraged to return to any unanswered questions and make an attempt at answering them.

## Comments on Specific Questions

### Question 1

**(a) (i)** Many candidates selected the correct forces for X and Y.

**(ii)** This question proved to be difficult. Some candidates could correctly state that force X would be 750N but few could explain the reason why.

**(b) (i)** This question was answered well by a good many candidates.

**(ii)** Very few candidates were able to convert the speed correctly here. Candidates who showed their working out were sometimes able to gain partial credit.

### Question 2

**(a) (i)** The complete term “fractional distillation” was required here, so candidates who simply put “distillation” did not get credit.

**(ii)** Candidates found this a difficult question to answer although a good number attempted it. Many simply restated information from the question without explaining why it is a physical change and not a chemical change.

**(b) (i)** Some candidates identified the process of boiling (or evaporation) but fewer also identified the process of condensation for full marks here.

**(ii)** Candidates found this question very difficult. Few realised that the information given in the table was about the boiling points of different fractions.

**(c)** Not many candidates were able to gain full marks here but a good number gained some credit, either for recognising that oxygen was a reactant or correctly naming both products of combustion.

**Question 3**

**(a)** This question was generally answered well by most candidates.

**(b) (i)** Some candidates were able to recall the process correctly.

**(ii)** Some candidates just copied information from the table in the question rather than selecting the relevant information to explain why milk is better. Only a few candidates explained fully that athletes would need the extra energy supplied from the high fat content of A.

**(iii)** Candidates found the full calculation difficult. Weaker candidates often wrote down an answer with no working. Candidates who showed their working were able to gain some credit even if the final answer was incorrect.

**(iv)** Many candidates gave an answer that was too general here, such as “older people” without clearly identifying a group that would need more than normal RDA, such as “older people with weak bones/osteoporosis,” for example. However they could still gain credit for correctly explaining that the calcium was needed to strengthen bones.

**Question 4**

**(a)** Many candidates were able to draw a complete circuit and a good number included a switch in an appropriate position to control the electricity supply to the fan heater. Some candidates did not know the correct symbol for a fuse and some also did not place their fuse in the main circuit.

**(b) (i)** While some candidates were able to place an X appropriately on the circuit, this question was left blank by a significant minority of candidates.

**(ii)** This question was answered by almost all candidates. Many were able to gain some credit with many realising the bimetallic strip would bend. Some thought that this would make, rather than break, the contacts.

**(iii)** Candidates found this question difficult and were unable to describe a suitable position for the thermal cut-out.

**Question 5**

**(a) (i)** A good number of candidates correctly identified that bubbles would be given off more slowly.

**(ii)** This question was difficult with most candidates unable to explain their answer with reference to the position of zinc, calcium, copper and/or hydrogen in the reactivity series.

**(b) (i)** Strong candidates were generally able to answer this question but there was some evidence that quite a few candidates did not understand what a *trend* is.

**(ii)** Candidates found this question difficult. Some answers did not give observations and so did not gain credit.

**Question 6**

**(a) (i)** A good number of candidates recognised that C and H had identical features to the mother.

**(ii)** Fewer candidates gained credit here as they were still describing similarity in *phenotype* rather stating that *genetic* information was identical.

**(iii)** Again a number of candidates described differences in terms of phenotype rather than in genetic information as asked in the question.

**(b) (i)** A good number of candidates were able to recall that dissolved food substances are transported in the phloem.

**(ii)** Some candidates correctly identified and shaded phloem.

**(c) (i)** Only the strongest candidates correctly recalled the word equation for photosynthesis.

**(ii)** This question was well answered by many candidates.

**(d) (i)** A good number of candidates knew the positive result for the starch test and correctly identified that starch would be found only in the green areas of the leaf.

**(ii)** Candidates found it much harder to explain the link between starch and either chlorophyll or photosynthesis in the green parts of the leaf.

**Question 7**

**(a) (i)** Candidates found this question difficult with many unable to draw a normal to the mirror.

**(ii)** Very few candidates correctly recalled that the image is laterally inverted.

**(b)** A number of candidates wrongly stated that radio waves are used by satellites sending signals to Earth.

**(c) (i)** A number of candidates did not attempt this question. Those that did know the amplitude generally drew a labelled arrow carefully to show the amplitude correctly and gain credit.

**(ii)** Some candidates incorrectly stated that the amplitude showed the pitch or frequency of the sound wave.

**(d)** Many candidates correctly quoted the formula and found out the total distance travelled by the sound. However most then forgot to halve this figure to take account of the fact that the sound had travelled both to the building and back again, therefore twice the distance to the building.

**(e)** Candidates found this question very difficult. Many simply repeated information given in the question rather than explaining why the motorcyclist has become charged and then receives a shock.

**Question 8**

**(a)** Stronger candidates generally scored full marks here. A few candidates put the same answer for both parts. Generally weaker candidates knew that protons and electrons have opposite charges.

**(b) (i)** A fair number of candidates correctly recalled that an atom has the same number of electrons and protons.

**(ii)** Fewer candidates were able to explain that the number of neutrons was the nucleon number less the number of protons.

**(iii)** Many candidates correctly identified that chlorine is on the right hand side of the Periodic Table.

**(c) (i)** Candidates found this question difficult with a number stating that this is the bond between two non-metals rather than explaining that it is the bond where atoms share electrons.

**(ii)** This question also proved to be difficult. Only a few candidates correctly identified that both hydrogen and chlorine were non-metals.

**(d) (i)** This was poorly answered with candidates across the ability range not being able to give the colour of universal indicator in pure water.

**(ii)** Many candidates found this hard with some giving a rise in pH and many not knowing that the pH of pure water is 7.

**(e) (i)** Few candidates realised that X would be a salt. There were a wide variety of incorrect answers including *carbon* and *copper*.

**(ii)** Those who identified the gas produced as carbon dioxide were generally able to go on and describe the correct test for the gas and its positive result. Candidates who identified another gas were able to gain some credit if they could correctly describe the test and positive result for their (incorrect) gas.

**Question 9**

**(a) (i)** Candidates found it difficult to define the term *food chain* correctly. Most did not realise that it shows how *energy* is passed from organism to organism.

**(ii)** A good number of candidates could show how to construct the food web by adding the badger although some misunderstood the direction of energy flow and put arrows in the wrong direction.

**(b)** Some candidates suggested responses which the mice might make, such as moving to a new location or switching to another food supply but some candidates stated that the mice population would drop, which was not a response the mice would make and so not given credit.

# COMBINED SCIENCE

**Paper 0653/23**

**Core Theory**

## Key Messages

It is very important that candidates read questions carefully and make sure that they answer exactly the question that has been asked.

When asked to explain something, candidates should ensure that they are not simply repeating back information that is provided in the stem of the question.

## General Comments

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

It was encouraging to see that most candidates, when asked to, were able to give formulae used in their calculations in an appropriate format.

Some questions were left unanswered. When they have completed all the questions that they are sure of, candidates should be encouraged to return to any unanswered questions and make an attempt at answering them.

## Comments on Specific Questions

### Question 1

**(a)** Most candidates correctly identified the trachea. Some labelled a bronchiole as a bronchus.

**(b)** This question was answered well by most of the candidates.

**(c) (i)** Candidates found this question very difficult. Some gained credit for working out the extra volume inhaled by a person with asthma but very few were able to calculate the average percentage of extra air inhaled.

**(ii)** A good number of candidates gained credit for recognising asthmatic people breathe faster but not many realised that they will take deeper breaths as well.

### Question 2

**(a)** A number of candidates were unable to select information from the correct part of the graph and reported a temperature increase and exothermic reaction.

**(b)** Many candidates incorrectly believed carbon dioxide was produced. This question was generally poorly answered.

**(c)** Some candidates correctly reported an increase in reaction rate. However answers simply stating that there would be “more bubbles” were too vague to be given credit.

**(d)** Candidates from across the ability range did not answer this question. Others thought copper would be more reactive than magnesium. This question proved to be difficult for many candidates.

**Question 3**

**(a) (i)** A good number of candidates correctly identified the force of gravity here.

**(ii)** This question was answered well.

**(b)** This question was also answered well, generally, although some candidates wrongly identified the first transformation as chemical energy to kinetic energy.

**(c)** Some candidates described the motion between B and C as “constant motion” which was insufficient to describe “constant speed”. Weaker candidates described going uphill or along the flat rather than recognising acceleration and constant speed in the different sections.

**(d)** Most candidates wrote down a formula first and many were able to gain credit for a correct formula even if they were unable to rearrange it to calculate distance.

**Question 4**

**(a) (i)** Candidates found it hard to define this term. Only a few realised that the correct *proportion* of nutrients was important.

**(ii)** Here candidates could give a variety of answers but some precision was needed. So while “to strengthen the immune system” was accepted “to stop you getting colds” was too vague to be given credit.

**(iii)** Few candidates referred to molecule size or solubility of vitamin C. Those that gained credit here knew that it could be absorbed into the blood without being digested. A number of candidates did not attempt this question at all.

**(b) (i)** This question was answered well by a good number of candidates. To gain full credit, candidates needed to explain their choice of Kiwi fruit and orange with reference to mass of vitamin C in an average portion, rather than vitamin C in 100 g of fruit.

**(ii)** This question was difficult. Weaker candidates often did not attempt it. Those who showed all their working were able to gain credit for their method even when the final answer was incorrect.

**(c) (i)** There were few correct answers to this question. Candidates needed to be specific in explaining that acid attacks the *enamel* of teeth to gain credit.

**(ii)** The vast majority of candidates correctly described regular brushing of teeth as a way to reduce the effects on teeth of eating acid fruit.

**Question 5**

**(a)** There were a good number of fully correct responses to this question. Those who gained one mark most often knew that metals are good conductors of electricity and that non-metals often have low melting points.

**(b)** This question was well answered by many candidates.

**(c)** Very few candidates recognised that the bubbles of gas were hydrogen. More candidates were able to explain that the resulting solution is alkaline.

**(d) (i)** Stronger candidates generally scored full marks here. The most common mistake was to put sodium chloride as diagram A and chlorine as diagram C.

**(ii)** Many candidates had difficulty answering this question. Some incorrectly described sodium losing *ions* rather than *electrons*. A number of candidates did not attempt the question.

**(iii)** Candidates found this question difficult. There were few correct answers.

**(iv)** A good number of candidates wrote a formula with the correct chemical symbols for the elements zinc and chlorine in zinc chloride. Few were able to write the completely correct formula.

**Question 6**

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

**(ii)** This question was more difficult for candidates. While some correctly calculated the frequency, others remembered the unit of *hertz*. Few managed to record both correctly.

**(b)** A number of candidates did not attempt this question. Only a few correct responses were seen.

**(c)** This was very poorly answered.

**(d)** A good number of candidates gave the advantage that wave energy is renewable. Answers suggesting less pollution needed to be specific about there being less *air* pollution to gain credit.

**Question 7**

**(a) (i)** Most candidates gave vague general answers about why partial deforestation is better than complete deforestation rather than focussing specifically on the advantage *for the soil,* as asked in the question.

**(ii)** Many candidates gave much clearer answers here than in part **(i)** with a good number gaining full credit.

**(b) (i)** This was a difficult question for candidates and very few realised that sewage contained bacteria that would be respiring and using up oxygen in the water.

**(ii)** A good number of candidates correctly understood that less light would reach the aquatic plants. Only a few gave a complete answer by linking less light to less photosynthesis that would affect growth.

**Question 8**

**(a) (i)** A number of candidates made no attempt at this question suggesting that they had not understood the information given in the diagram in the question stem. Very few correct responses were seen.

**(ii)** Again quite a few candidates made no attempt at this question. Those that could recall the test for carbon dioxide generally gained full credit for knowing both the test and the result.

**(b) (i)** A large number of candidates made no attempt at this question.

**(ii)** This question was attempted by almost all candidates. Those gaining only partial credit most often knew that in electrolysis the simpler substances produced are *elements*.

**Question 9**

**(a)** This was a difficult question. A few candidates were able to explain that the liquid expands when heated.

**(b)** Many candidates did not understand what the question was asking. Several answers of *endothermic* and *exothermic* were seen and about half the candidates made no attempt to answer the question.

**(c) (i)** A good number of candidates correctly identified the process here as evaporation.

**(ii)** While a few candidates described molecules moving faster or gaining heat very few explained clearly that evaporation happens when molecules gain enough *energy* to escape.

**Question 10**

**(a)** Only the stronger candidates were able to describe correctly how to charge a plastic object.

**(b)** A good number of candidates recognised that metals conduct or that the plastic was an insulator but did not explain clearly the importance of this with respect to charge leaking or not leaking away.

**(c) (i)** Candidates found it difficult to recall the meaning of the term *electric current*.

**(ii)** Many candidates were able to draw a second heater in parallel with the first and gain credit in this question. Fewer were able to locate the switches so that the heaters worked independently. Weaker candidates made no attempt at this question.

# COMBINED SCIENCE

**Paper 0653/31**
**Extended Theory**

## Key Messages

Those candidates who scored well on this paper ensured that:

- they had read the questions carefully and used the number of marks available for each question as a guide to how much detail to include;
- they used symbols accurately; this means for example, that in Physics equations they correctly used **I** to represent electrical current and not **A**, and in chemical equations they avoided mistakes such as **CL** for chlorine and **h2O** for water;
- they answered questions involving comparison carefully; for example, stating that as the result of heating, molecules move *faster* rather than simply stating that they move *fast*, or that molecules *begin to move*;
- they had learned concise definitions that appear in the syllabus, for example, the meaning of decomposer;
- their handwriting was legible.

## General Comments

Many scripts were seen from candidates of high ability who had mastered most parts of the syllabus and who were very well-prepared for examinations of this type. Some of the candidates who were less successful might have been better suited for entry to the core paper.

Some questions tested the ability of candidates to apply their knowledge and understanding of Science to describe and explain contexts that may be unfamiliar. Some candidates, who had learned syllabus topics well, found these questions challenging. It is to be hoped that colleagues provide as much practice in this type of question as time allows.

Success in answering questions covering the three Science disciplines was well balanced and the majority of candidates completed the paper. Some copied lengthy sections of the question into their answers and in many cases they did not add any new information. Candidates need to be careful to avoid falling into this trap since no credit can be awarded for what is often a lot of effort.

Candidates should write their answers legibly to ensure that Examiners award as many marks as possible.

## Comments on specific questions

### Question 1

**(a)** This was answered very well and the majority of candidates gained full credit.

**(b) (i)** The most common mistake was to suggest that cigarette smoke would damage cells producing mucus and so reduce mucus production. Candidates who stated that cilia would be killed did not gain credit. It was also not enough simply to state that cilia would stop working. Many candidates gave the most accurate answer that cilia in smokers become paralysed.

**(ii)** Candidates needed to make clear that bacteria or pathogens would remain trapped in the excess mucus and so cause lung infections. Having suggested in part **(i)** that mucus would be reduced or absent it was natural for some candidates to be led to the idea that bacteria would get into the lungs more easily. This was a very common reason for loss of credit.

**(c) (i)** Candidates from across the ability range had learned the correct form of the equation for respiration. It is not necessary for additions such as + *energy* to the right hand side but candidates were not penalised for doing so. No credit was gained for the word equation even if it was correct.

**(ii)** Some very good candidates did not realise what this question was asking and wrote sound descriptions of the circulatory system for which no credit was available.

**(d) (i)** Many candidates were able to interpret the data in the table. They correctly stated that person C had most recently smoked before the test because they had the highest carbon monoxide level in their blood at the start of testing. Candidates who simply stated that person C had a high carbon monoxide level or who did not find a way of referring to the start of testing did not gain credit.

**(ii)** Candidates generally had no problems gaining full credit for this question, and correctly referred to the increase in carbon monoxide level during the testing period.

**Question 2**

**(a)** The diagram provided a very strong hint for the correct answer and the majority of candidates gained credit. Weaker candidates did not make the connection between the physical states shown in the diagram and the melting point trend.

**(b) (i)** Although this was intended to be a low demand question, only a minority of candidates gained credit. The suggestions *sodium chloride* or *sodium chloride + bromine* were very frequently seen, which indicates that candidates had some knowledge of halogen displacement. Others were clearly guessing and suggested impossible combinations of elements.

**(ii)** This was a higher demand question and only candidates towards the upper end of the mark range gained credit. Of those who attempted a symbol equation, many suggested

$Cl$ + NaBr $\longrightarrow$ NaC$l$ + Br. The credit for balancing the equation depends on writing correct chemical formulae and so none could be gained for this answer.

**(iii)** The majority of candidates listed the halogens in the correct reactivity order. Names of halide ions were not accepted.

**(iv)** Candidates usually gained credit for stating that fluorine is the most reactive halogen. Not very many gained full credit that was available for the general statement linking relative reactivity to displacement.

**(c)** Most candidates gained some credit and showed familiarity with the theory of electrolysis. Candidates could gain full credit in a number of ways depending on the starting point of the fluoride ions in their descriptions. Many gained partial credit either for describing and/or explaining the movement of fluoride ions towards the anode, or for their descriptions of the electrode reaction. Although symbolic electrode equations are not included in this syllabus, correct versions were accepted as alternatives to the published marking points.

**Question 3**

**(a) (i)** Most candidates answered this correctly, stating either *gravity, weight* or *gravitational.* Credit was lost if candidates suggested *gravitational potential*.

**(ii)** Credit was gained by the majority of candidates**.** Carelessly drawn arrows that deviated from the vertical were penalised, but fortunately most candidates did not make this mistake.

**(b) (i)** Most of the more able candidates ticked the first two boxes which regrettably meant that they did not gain credit. This tests candidates' understanding of the difference between acceleration and velocity/speed. The fact that at the lowest point, when speed becomes zero, the acceleration becomes a maximum is not at all obvious. The unfamiliarity of the context in terms of an examination question made this question an extremely challenging one.

**(ii)** Large numbers of candidates did not realise that their graphs should describe only the speed change from the moment the elastic rope started to stretch, and attempted to show how speed changed from the moment the jumper left the platform. Candidates who gained credit for their

graphs made sure that their lines started from the vertical axis and reached the horizontal. A degree of leniency towards the exact form of the graph allowed many candidates to gain some credit.

**(c) (i)** Candidates usually correctly identified *kinetic* as the first answer and some gained the credit for going on to state either *potential, elastic* or *strain.* Many lost credit by suggesting *gravitational potential,* and *movement* was not accepted as an alternative for *kinetic*.

**(ii)** Physics calculations of this form are usually well answered. Many candidates gained full credit, showing familiarity with the use of the formula *energy transferred* = *mass* x *g* x *height*. Candidates using a symbolic form of the equation usually quoted *m* x *g* x *h*. An accepted alternative was *weight* x *distance dropped,* but misuse of symbols, for example, *w* x *g* x *h* was not accepted.

**Question 4**

**(a) (i)** Rather a large number of well-prepared candidates lost credit by not reading the question carefully enough. Only correctly-labelled cell parts found in both plant cells and not in animal cells could gain credit. Many candidates had learned the importance of taking great care when labelling the cell wall and avoided the mistake of allowing their labelling line to touch the cell membrane.

**(ii)** In general, the functions of the cell parts identified in part **(i)** were correctly described. A common mistake was to describe the function of the cell wall as if it was the cell membrane. Candidates needed to describe the contents of the vacuole in more detail than simply stating that it held *fluid*.

**(b) (i)** Common reasons for loss of credit here included descriptions of trivial differences, particularly the curved or straight leaf stem, and lengthy, often valid, descriptions of leaf function. The word *thinner* was not allowed as an alternative for *narrower* or *lower surface area* when describing leaf X.

**(ii)** Answers discussing photosynthesis occurring within leaf **X** were commonly seen but gained no credit. Some candidates were clearly familiar with the context and gave model answers, but these were in the minority. Some candidates cited the advantage of the larger surface area of leaves like **X** at the top of the tree, having identified in part **(i)** that they had a smaller area.

**(iii)** A wide variety of possible advantages for leaves like **Y** was suggested, but only those related to capture of light and photosynthesis gained credit. The term *the sun* is not accepted as an alternative for light. Several candidates thought that water needed for photosynthesis arrived via absorption through the leaves and suggested that this was the advantage of broader leaves in the shaded part of the tree.

**Question 5**

**(a)** Many candidates lost credit by giving vague answers or by suggesting uses rather than sources of methane. Acceptable answers included all large-scale sources of methane whether or not they were useful. Answers judged to be too vague were usually single word suggestions such as *oil, cows, petroleum* and *waste.* However, when such answers contained more detail credit was often gained, for example, references to digestion processes in cows.

**(b) (i)** This proved to be a challenging question. It was clear that most candidates had not realised that the main gases in the can before the explosion were methane and air and so missed that the answer required in the left hand column of the answer table was *nitrogen*. Inevitably this meant that they would also miss the fact that one of the gases required in the right hand column was also nitrogen. Only candidates near the very top of the mark range gained full credit. A few more gained partial credit for recognising that methane would produce carbon dioxide and water on combustion. The question asked for the main gases and so carbon monoxide was not accepted.

**(ii)** Candidates needed to state that *chemical* energy is transformed and so the single word *potential* did not gain credit. Many answered this question correctly but lower-scoring candidates did not seem to realise that an energy transformation was required and described combustion or suggested *exothermic* even though this was the answer to the next question.

**(iii)** The term *exothermic* was very familiar and the majority of candidates gained credit.

**(c) (i)** Many candidates chose to give detailed explanations of the group and period based on electron configuration and the majority did this successfully.

**(ii)** Candidates were familiar with covalent bonding diagrams and this question was answered very well across the ability range.

**(d) (i)** This aspect of atomic structure was very familiar across the ability range.

**(ii)** Most candidates gained full credit in both **(d)(i)** and **(ii)** although in their answers to this question they had to ensure they emphasised that the outer (valence) shell was *complete* or *full* rather than simply stating that it *contained eight electrons*.

**Question 6**

**(a) (i)** The most common reasons for loss of credit were mis-labelling of the angles of incidence and refraction and an emergent ray that was not parallel with the incident ray.

**(ii)** This proved to be a challenging question for candidates across the ability range and full credit was gained only by the most able candidates. Most appeared to be quite unfamiliar with the idea that light rays would be refracted by the atmosphere. Many candidates treated the atmosphere shown on the diagram as an optic fibre and suggested an explanation based on reflections. It was not uncommon for weaker candidates to state that a person at **X** would see the sun because of the Earth's rotation.

**(b) (i)** The majority of candidates had not learned that infrared radiation from the sun is responsible for warming the Earth. A variety of incorrect suggestions were seen including alpha and beta although ultra-violet was the most common.

**(ii)** Credit was rarely gained for answers to this question. Frequent suggestions were based on the experience of candidates that water always feels cooler anyway or that water is shiny and so it must be reflecting all the heat away. Some other candidates thought that it must be something to do with the fact that at the beach there is a greater area of water than sand and so it is somehow more concentrated on the sand. Some of the stronger candidates suggested reasonable alternative answers to that shown in the mark scheme and if these were valid they gained the credit.

**(c)** This proved to be the most challenging question on the paper, and very few candidates gained credit. Unfortunately some stronger candidates showed that they understood the reasons for refraction without addressing the question. The majority of candidates did not realise that this needed to be answered in terms of mathematics. Although partial credit was made available to candidates who simply stated that the wavelength would decrease, many only went as far as stating that the wavelength would change which was re-stating the question.

**Question 7**

**(a)** Candidates who had learned a text-book definition of *decomposer* easily gained full credit. Many candidates had a clear idea of the role of decomposers but used unscientific language in their attempt to construct a definition. The phrase *decomposers eat dead bodies* was not accepted as an alternative for more scientifically accurate expressions such as *decomposers obtain energy by breaking down / feeding on dead organisms.*

**(b) (i)** Partial credit was frequently awarded for the idea that the enzymes from the fungi had a role in breaking down the material in the tree trunk. Stronger candidates went on to describe chemical digestion to produce molecules that the fungi could absorb.

**(ii)** Stronger candidates realised that this question was concerned with denaturing of digestive enzymes under acidic conditions. Large numbers of candidates, however, suggested that the rate of digestion would increase because the acid rain would speed up the breakdown of the wood and so assist the enzyme activity.

**Question 8**

**(a) (i)** Full credit could be gained here simply by making the connection between rate and acid concentration. The majority of candidates did this although their answers were sometimes part of a very lengthy paragraph.

**(ii)** Most candidates gained the credit here.

**(iii)** Success here relied on candidates having read the question carefully and understanding that the iron wire was in excess. The main mistake made by candidates was to suggest that the iron wire rather than the acid was used up. Some weaker candidates suggested that the reaction stopped because no more gas was produced.

**(b) (i)** Stronger candidates gained full credit for their graphs which started higher than the given line and ended before eight minutes. Many seemed reluctant to allow their graph to cross the given line and scored only partial credit. Some did not appreciate that they were required to draw their graphs onto the supplied figure and re-drew their own axes in blank space on the paper. This made it impossible to award full credit unless it was entirely clear that both marking points had been met which usually was not the case.

**(ii)** The quality of answers to questions concerning collision theory is now usually very good and candidates from across the mark range gained credit. Candidates wrote about *increased frequency of collisions* rather than simply stating *more collisions* and referred to *increased kinetic energy* rather than simply *more energy*. Some candidates also attempted answers based on activation energy and correct suggestions gained credit.

**Question 9**

**(a) (i)** Candidates are very familiar with calculations based on Ohm's Law and the majority gained full credit. Candidates should avoid using the symbol A for current.

**(ii)** This was understood by the majority of candidates who answered it correctly. The most common mistake was to suggest double the value obtained in part **(i)**.

**(b) (i)** The equation for electrical power was not as familiar as Ohm's Law.

**(ii)** Candidates had learned the unit and symbol for power although they needed to be careful to convince the Examiner that they had given an upper case **W** for the symbol.

**(iii)** This was a challenging question for all but the most able candidates. Very few gained any credit and many made no attempt. Of those candidates who were familiar with the correct equation many forgot to convert 2 minutes to 120 seconds. Many weaker candidates were distracted by the term *energy output* in the question and attempted to apply an efficiency equation.

**(c) (i)** This was intended to be a low demand question but large numbers of candidates did not recognise convection. The variety of incorrect responses was not limited to radiation and conduction and included several energy-related terms including *exothermic* and *combustion*.

**(ii)** Many gained partial credit for stating that thermal energy would be transmitted by conduction. A much smaller number could discuss conduction in terms of vibrational collisions between atoms. As this question about thermal energy transfer was set in the context of an electrical circuit some weaker candidates confused electrical and thermal conduction. A few able candidates discussed conduction of thermal energy through delocalised electrons which gained full credit.

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# COMBINED SCIENCE

**Paper 0653/32**
**Extended Theory**

## Key Messages

Those candidates who scored well on this paper ensured that:

- they had read the questions carefully and used the number of marks available for each question as a guide to how much detail to include in their answers;
- they used symbols accurately; this means for example, that in Physics equations they correctly used $I$ to represent electrical current and not *A* and in chemical equations they avoided mistakes such as CL for chlorine;
- they had learned concise definitions that appear in the syllabus, for example, the meaning *of trophic level* or *physical changes*;
- in Biology questions they correctly referred to *killing bacteria* and *denaturing enzymes* rather than *denaturing bacteria* and *killing enzymes*;
- they were able to carry out mathematical calculations involving exponents;
- their handwriting was legible.

## General Comments

Many scripts were seen from candidates of high ability who had mastered most parts of the syllabus and who were very well-prepared for examinations of this type.

Some questions tested the ability of candidates to apply their knowledge and understanding of Science to describe and explain contexts that may be unfamiliar. Some candidates, who had learned syllabus topics well, found these questions challenging. It is to be hoped that colleagues provide as much practice in this type of question as time allows.

Success in answering questions covering the three Science disciplines was well balanced and the majority of candidates completed the paper. Some copied lengthy sections of the question into their answers and in many cases they did not add any new information. Candidates need to be careful to avoid falling into this trap since no credit can be awarded for what is often a lot of effort.

Candidates should write their answers legibly to ensure that examiners award as many marks as possible.

## Comments on Specific Questions

### Question 1

**(a) (i)** Candidates across the ability range answered this question successfully and the majority gained full credit.

**(ii)** Most candidates gained partial credit for stating that the value of weight was 30 000 N. Although many candidates correctly quoted Newton's Third Law they needed to go further and justify the weight by stating that the vehicle was not accelerating in the vertical plane.

**(iii)** Large numbers of candidates simply gave the one-word answer *gravity*. In order to gain the credit they needed to develop this idea by describing gravity as a pull from the Earth.

**(b) (i)** Interpretation of the speed/time graph presented few problems and most candidates gained full credit. The main reason for loss of credit was failing to link the periods of constant speed and deceleration to specific times.

**(ii)** The success in part **(b)(i)** was repeated here and it was clear that most candidates were very familiar with calculations involving areas on a speed/time graph. Several candidates omitted to convert their final answer to km. Some candidates correctly used the expression for the area of a trapezium.

**Question 2**

**(a) (i)** Most candidates correctly stated that the initial heating was required to kill unwanted bacteria existing in the milk. Some were penalised for referring to denaturing bacteria. Unscientific terms such as *germs* are not accepted alternatives for *bacteria* or *pathogens.* No credit was gained for vague references to *purification* although *pasteurisation* was allowed.

**(ii)** Many candidates correctly referred to the avoidance of denaturing enzymes in the bacteria that were added. Answers such as *so enzymes are not killed* did not gain credit nor did vague references to temperatures needed for bacteria to *work*.

**(b) (i)** The majority of candidates identified *proteins*. The most common mistake was *fats*.

**(ii)** The majority of candidates correctly discussed the action of enzymes and correctly named examples were accepted. Regrettably some candidates lost the credit by suggesting an incorrect enzyme. Some candidates suggested the answer *by using a catalyst* but this was not specific enough to gain credit.

**(iii)** It proved difficult for candidates across the mark range to find a form of words that was detailed enough to gain full credit. Usually partial credit was awarded for stating that the use of two types of bacteria would speed up the process of yoghurt making. Otherwise answers needed to focus on the beneficial effect provided by one bacterium on the growth of the other. Large numbers of candidates made simple statements such as *each bacterium helps the other* or suggested that the use of two bacteria would improve the nutritional value or flavour of the final product.

**(c) (i) (ii)** In these questions candidates needed to show that they could select relevant data. They needed to select yoghurt **D** and then make a comparison with **C**. Those who gained credit stated that compared with **C**, yoghurt **D** contained less fat in **(i)** and more calcium in **(ii)**. Some candidates who clearly understood the Biology lost credit because they did not answer the questions as they were asked. Candidates who stated that **D** was high in fat and calcium similarly lost credit because they failed to compare the two yoghurts.

**Question 3**

**(a) (i)** Most candidates correctly stated *fractional distillation*. *Distillation* on its own was not accepted.

**(ii)** Those candidates who had learned text book definitions of chemical and physical changes had no difficulty answering this question. However, such candidates were in the minority. Many wrote answers suggesting that they did know that fractional distillation involves physical changes, but often they did not say enough to gain credit. The incorrect idea that chemical changes cannot be reversed still persists and caused some candidates to suggest that fractional distillation involves physical changes simply because they can be reversed.

**(b) (i)** Only candidates towards the upper end of the mark range tended to gain the credit here. Many others did not suggest the physical property indicated by the data, but opted instead to repeat what was in the table heading. Others suggested a physical property such as odour that could not be derived from the data and some others described the different volumes of the fractions shown in the diagram.

**(ii)** Many of the more able candidates understood the connection between boiling point and molecular size and many gained at least partial credit. It was less common for candidates to explain the increased boiling point in terms of intermolecular forces although fewer candidates than in previous years discussed the breaking of bonds without qualifying this idea.

**(c)** The majority of candidates had learned how to draw ethane and gained full credit.

**(d)** Most candidates towards the upper end of the mark range had learned that unsaturated hydrocarbons/alkenes react with bromine. The answer *ethene* did not gain credit since the question asked for a more general answer.

**Question 4**

**(a)** The great majority of candidates at least gained partial credit for their circuit diagrams. Weaker candidates tended to draw simple series circuits, but many others correctly showed the motor and heater in parallel. A common reason why these candidates did not gain full credit was that they forgot to include a switch in their circuit.

**(b) (i)** Provided candidates had shown the motor and heater in parallel in **(a)** they had the chance to gain credit here, which most of them did.

**(ii)** This was a very high demand question and few candidates gained any credit. Not only did answers have to show that candidates could describe metal expansion in terms of atomic separation, but they also had to study the diagram to decide whether it was brass or steel that would show greater expansion. Many candidates wrote statements that included the idea of metallic expansion but made no reference to atomic separation or the fact that brass would undergo greater expansion.

**(iii)** Many candidates had difficulty separating the formalised circuit diagram from the real circuit in the fan heater. Only a minority realised that they needed to be thinking about locating the cut-out where it would monitor the air temperature in the room. Many just attempted to explain their answer to **(b)(i)**.

**Question 5**

**(a) (i)** Candidates from across the ability range did not take note of the sentence which told them that the male and female gametes were not drawn to scale. Very many assumed they were drawn to the same scale, measured the male gamete and wrote an answer which was some seventeen times too large. This suggests that some of these candidates may have unquestioningly abandoned Biological facts that they had learned.

**(ii)** Most made sensible suggestions. However, the answer *infinity* was not accepted for the male gamete. Several candidates did not suggest numbers but went for general statements such as *many every day* for males and *one per month* for females. This was allowed partial credit.

**(iii)** Many candidates, especially near the upper end of the mark range, wrote with confidence about haploid and diploid cells. Correct relative numbers of chromosomes were also frequently seen as were more general statements about the differences in DNA. All of these answers were accepted. The simple idea that the zygote would have a larger nucleus than a male gamete was not enough. Weaker candidates made suggestions that showed confusion between the terms, gamete, zygote, embryo and fertilisation.

**(b)** Amniotic fluid was identified by most candidates and a variety of correct functions was also seen allowing full credit for large numbers of candidates. The more common mistakes included *amniotic sac* and *uterus*.

**(c) (i)** This was a relatively low demand question that simply required candidates to make the connection between the narrowed umbilical blood vessels and the consequent reduction in blood flow rate. Answers that suggested that blood would be *cut off* did not gain credit, nor did answers that ignored blood flow rate and strayed into the following question.

**(ii)** Many candidates lost credit here by assuming that the reduced blood flow was so severe that oxygen and nutrients would be cut off from the fetus that would then die. This was not accepted. Many candidates did discuss the reduced passage of oxygen and nutrients but only a minority gained full credit for stating that this would reduce growth rate.

**Question 6**

**(a) (i)** Most candidates correctly stated that bubbling would be seen and also that this would be less vigorous than seen for calcium. The most common mistake was to suggest that there would be no visible reaction.

**(ii)** Either candidates explained bubbling in terms of the relative positions of zinc and hydrogen, although this was relatively uncommon, or they explained the difference in vigour between zinc and calcium. Full credit was only available for both ideas.

**(b) (i)** The question attempted to emphasise that candidates should be thinking in terms of ions and atoms but most did not give the answer *atoms*. A very wide variety of answers was suggested and only some of these were *copper* which might have been expected.

**(ii)** The emphasis on blue copper ions in the question did not usually prompt an answer to this question based on the removal specifically of copper ions from solution. Large numbers wrote that *zinc displaces copper* which while logically correct was not judged to answer this particular question. Any implication that candidates were referring specifically to the removal of copper ions was allowed but few gained credit.

**(iii)** In contrast to the difficulties candidates experienced in identifying how parts **(i)** and **(ii)** should be answered most gained credit here with large numbers gaining full credit.

**(c) (i)** This presented no difficulties to the great majority of candidates.

**(ii)** This question was very successfully answered by many candidates who made the connections between the observations in the diagram and the relative reactivities of all of the metals involved.

**Question 7**

**(a)** The law of reflection in a plane mirror was very familiar to most candidates. Candidates are advised to construct the normal when requested to draw accurate ray diagrams. Reasons for loss of credit in this question included omitting or reversing the arrows showing the direction of travel of the ray from the car to the observer, misplacing the rays so that the angles of incidence and reflection were clearly not equal, drawing the rays carelessly without the aid of a ruler and failing to have the incident and reflected rays meeting at a single point on the surface of the mirror.

**(b)** Quite a number of candidates were unfamiliar with the use of microwaves in GPS positioning. The most common incorrect answer was radio waves.

**(c) (i)** The relationship between wave speed, frequency and wavelength was very familiar to all but those candidates towards the lowest end of the mark range. In general, candidates used correct symbols or words.

**(ii)** Having stated the correct form of the equation in part **(c)(i)** many candidates were able to work through this calculation successfully. Despite gaining the credit in part **(i)** some candidates made mistakes in rearranging the formula for use in this part. Many candidates correctly stated Hz or hertz for the unit of the answer but others lost credit for an incorrect suggestion, very often m / s. Many candidates made mathematical errors when attempting to deal with numbers involving exponents and this may be something that needs more practice.

**(d) (i)** Candidates were fairly familiar with calculations involving the relationship between electrical power, current and potential difference and many gained full credit.

**(ii)** Many candidates knew how to calculate the total current in this parallel circuit and an error was allowed to be carried forward from part **(d)(i)**

**Question 8**

**(a) (i)** Candidates who had learned a text-book definition of *trophic level* easily gained full credit. However, these candidates were in a minority and most had difficulty explaining the term accurately enough to gain credit. Many wrote statements such as *trophic level is the movement of energy between organisms* or *organisms that live in a different level* or *the number of organisms in a food chain.* There was a wide variety of answers like this and they all showed familiarity with diagrams of food chains and webs but suggested that candidates had not considered how to define trophic level efficiently and accurately.

**(ii)** Candidates were far more confident in their answers to this question compared with part **(i)**, and the majority showed familiarity with the loss of energy along a food chain and the fact that there would be insufficient to sustain more than five trophic levels. Most candidates gained at least partial credit. One type of incorrect suggestion that occurred quite often was the idea that because *there are only tertiary consumers there can only be three levels.*

**(iii)** Most candidates gained credit for their food webs with only the weakest failing to understand that the only additional organism should be the badger. The most common mistake made by those who drew a food web rather than a food chain was the omission or reversal of the arrows showing energy flow.

**(b)** Candidates who had learned a definition of *decomposer* easily constructed an answer that gained full credit. Many candidates had a clear idea of the role of decomposers but used unscientific language in their answers which often lost them credit. Candidates must avoid phrases such as *decomposers eat dead living things* or that *decomposers clean up dead bodies*. Candidates should also avoid vague references to *waste* and be sure about the meanings of the words *organic* and *inorganic*. Candidates must avoid phrases such as *decomposers decompose things,* and instead bring out the meaning of decomposition in this context. Other vague statements candidates should avoid include *decomposers make fertiliser/manure/fossil fuel* and *make carbon for the air.* In Science examinations candidates should be advised that *carbon* is not an alternative for *carbon dioxide.*

**(c)** The question was worded in a way that was intended to prompt positive responses of the population of mice when threatened with food shortage. Large numbers of candidates discussed decreases in population, starvation and death and so did not gain credit. Other candidates answered a different question and discussed the impact on the populations of other organisms if the mouse population decreased.

**Question 9**

**(a) (i)** The great majority of candidates were familiar with the structure of the Periodic Table and gained the credit here. Responses that were not accepted included *chlorine is a halogen* and *chlorine only has to gain one electron*.

**(ii)** All but those candidates at the lowest end of the mark range were familiar with the relationship between group number and valence electrons.

**(iii)** Candidates near the middle and lower end of the mark range found it difficult to gain credit here. Many had the right idea but lost credit with incorrect detail, for example suggesting that *if there are 1 or 2 outer electrons it will be a metal but 3 or more means non-metal.*

**(b) (i)** The correct equation tended to be seen only from candidates in the upper half of the mark range. The most common mistake seen from candidates attempting a symbol equation was $H + Cl \rightarrow HCl$. The mark for balancing depends on correct formulae and so this answer gained no credit.

**(ii)** Candidates are usually very familiar with representing covalent molecules using dot and cross diagrams. This was answered very well and large numbers of candidates gained full credit. One of the more common mistakes was to draw the compound in an ionic form which could not be accepted because the question clearly asked for a hydrogen chloride molecule.

**(c) (i)** Either candidates knew that full range indicator is green in neutral water or they did not. Most did.

**(ii)** The accepted lower end of the pH range was restricted to 3 or below since at pH 4, full range indicator is orange. A majority of candidates gained the available credit.

# COMBINED SCIENCE

**Paper 0653/33**
**Extended Theory**

## Key Messages

Candidates should read the examination paper carefully and

- make sure that all parts are answered including questions requiring labelling a diagram,
- carefully study information provided and use it to answer questions where appropriate, as in **7(a)**,
- copy information from the stem accurately, including chemical formulae and electrical symbols.

## General Comments

There were some excellent scripts from candidates of high ability who had mastered the syllabus and prepared well for this type of paper. The candidates had prepared well for all three Science disciplines and were generally able to apply their knowledge successfully to unfamiliar situations.

The available space on the examination paper was used wisely by most candidates. However, some candidates repeated the stem of the question as part of their answer. This practice is rarely beneficial and uses up valuable response space.

The handwriting of most candidates was legible, but there were some scripts which were completed using bad handwriting, and in some cases key response words could not be read, leading to marks being lost unnecessarily.

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

## Comments on specific questions

### Question 1

**(a)** This question was successfully answered by most candidates who realised that the combined area of the alveoli is large, though understanding that the area of each alveolus is small. Candidates who showed a good understanding of gaseous exchange knew that the short diffusion pathway for diffusion of gases is provided by capillaries.

**(b)** This question was generally well answered. Candidates whose response was just 'the size of the bronchiole wall' were only credited if the size of the airway was also discussed as part of their response.

**(c) (i)** Some candidates found this question challenging. Most candidates calculated the volume of extra air breathed in correctly and calculated this as a percentage of the original volume. The main reason why candidates did not gain full credit was by calculating the increase as a percentage of the higher volume breathed in by the asthmatic person.

**(ii)** Many candidates gave good responses to this question linking the increased breathing rate to the need to provide extra oxygen for respiration. Breathing in extra air, or just saying the oxygen was required for the release of energy were not considered detailed enough to gain credit.

**(d)** The responses to this question required an effect of the change and a harmful consequence of the change. Many candidates successfully wrote that the increase in mucus would make the bronchioles even more blocked with mucus. A consequence such as an increased risk of bacterial infection would have enabled full credit to be obtained. Those candidates who chose the 'cilia

become paralysed' change usually responded that the mucus could not be cleared from the airway successfully. Those candidates who omitted to mention the role of the cilia in clearing mucus in addition to bacteria did not gain full credit.

**Question 2**

**(a)** Candidates generally found this question challenging. The word 'endothermic' was the most frequently written response. This described the type of reaction but not the actual energy change that was occurring.

**(b) (i)** This question required a connection to be made between the gradient of the graph and the rate of reaction. Many candidates did not do this successfully, the vast majority making their gradient parallel to the one provided, not steeper.

**(ii)** There were many excellent responses to this question about collision theory. Candidates successfully explained, in a variety of ways, that the increased concentration led to more frequent collisions. Credit was not awarded for just stating 'more collisions' without reference to a time frame. Although most candidates gave a response describing collisions, some did not relate their explanation to the rate of reaction.

**(c) (i)** Most candidates successfully completed the sentences therefore gaining full credit.

**(ii)** This was answered successfully by many candidates. The most frequent error was placing silver just above copper on the reactivity series. Candidates are reminded that the more reactive metal in this case was copper because it could displace silver metal.

**(iii)** Many candidates successfully answered this question. Candidates are reminded that when metals ionise they lose electrons. Therefore credit was not given to responses that referred to metals both gaining and losing electrons easily.

**Question 3**

**(a)** This was generally well answered. A few candidates were not credited when their responses referred to energy terms, for example gravitational potential.

**(b)** The vast majority of candidates successfully described the energy change and gained full credit.

**(c) (i)** Most candidates correctly identified the motion occurring at the two required parts of the graph. Candidates who wrote 'acceleration at a constant speed' were not credited.

**(ii)** The calculation of the area beneath the graph to find the distance travelled was successfully done by most candidates. Careful reading of the question would have prevented some candidates from losing credit due to calculating the whole area beneath the graph.

**(d)** This challenging question was tackled well reasonably well by candidates who responded in terms of the differences of the particle arrangements in a gas and a solid and their respective abilities to separate to allow the skateboard through. Some candidates would have scored higher if they had mentioned that the kinetic energy of the skateboarder had to be absorbed by the water in order for the skateboard to stop.

**Question 4**

**(a) (i)** Most candidates had the correct idea of an individual having a range of nutrients in a balanced diet. Credit was only given if the responses included that the nutrients have to be eaten in the correct proportions for an individual.

**(ii)** The function of vitamin C to prevent scurvy was widely known.

**(b) (i)** The trend showing that as the temperature increased the mass of vitamin C decreased was correctly identified by most candidates.

**(ii)** The question was requiring candidates to suggest reasons for the mass reducing. There were many correct suggestions including the idea that the vitamin had been destroyed by heat. Several

candidates thought that vitamin C was an enzyme, or was produced by an enzyme in the fruit juice. This was not accepted because the activity would have shown an increase above 4°C before a decrease due to denaturation.

**(iii)** This more open-ended question was challenging for many candidates. Most responses contained a cause for the initial masses of vitamin C to vary. The response also had to include an explanation for their suggestion and many candidates would have gained full credit with a feasible explanation for their cause. Responses that referred to different climates without further explanation needed more detail to gain credit.

**(c)** The candidates had to apply the information supplied in the table to answer this question. Some responses said that all the vitamins and other nutrients would be destroyed by boiling water. Statements like these did not gain credit because the evidence supplied by the table was only about vitamin C.

**(d)** The advantages and disadvantages of bottle feeding were familiar with most candidates. Credit was awarded for the advantage that other people beside the mother could feed the baby, for example the father. The disadvantage of cost, or the failure to pass on antibodies to the child (as in breast milk), were the most frequent acceptable answers. Credit was not awarded for vague statements, for example 'Bottled milk is more convenient' or 'Bottled milk contains more nutrients'.

**Question 5**

**(a)** The arrows showing the trends requested were correctly drawn by the majority of candidates.

**(b) (i)** Many candidates successfully gave hydrogen as the identity of the gas produced. Incorrect statements either referred to the wrong gas being produced, or stated that the bubbles indicated that a reaction was taking place. Many candidates correctly identified the change in colour of the indicator to show that an alkali was produced. Candidates should be aware that sodium metal is not an alkali or base. It is only after the reaction with water that an alkaline solution is made. Responses which described sodium as an alkali or base or were not credited.

**(ii)** The response required by this question was a description of a difference in the reaction that could be observed so credit was given for describing a more vigorous reaction, or a faster production of hydrogen. Most candidates explained the difference in reactivity by describing the trend of reactivity of the elements down Group I. Candidates who wrote that the reactivity decreases down the group are reminded reactivity decreases down the group in Group VII, on the other side of the Periodic Table. Some candidates tackled the explanation in terms of the ease of ionisation of the two atoms. Credit was awarded for satisfactory explanations about this.

**(iii)** The fact that all Group I metals have one outer electron was the key to answering this question correctly. Many candidates gave the same incorrect answer of 3 electrons in the outer shell, having calculated the numbers of electrons in each shell incorrectly.

**Question 6**

**(a) (i)** The majority of candidates could do the calculation of frequency. Candidates are reminded that the unit for frequency is Hz. Credit was not given for waves/second which many candidates gave for the unit.

**(ii)** Most candidates correctly calculated the speed of the waves.

**(iii)** The application of the answers of the preceding two questions to the wave equation was successfully done by the higher–scoring candidates. There was scope for errors to be carried forward so that full credit could be obtained. The most frequent cause for losing credit in this question was inaccurate recall of the wave equation $v = f \times \lambda$.

**(b)** The displacement being twice the amplitude in a new context was successfully answered by the higher-scoring candidates.

**(c)** The position of radio waves in the table was successfully recalled by many candidates. The most common error was the positioning of the letter R one square to the left of the correct place, in the area belonging to microwaves.

**(d) (i)** This question required speculation about an advantage of a tidal generator over a wave generator. Acceptable ideas included the predictability of a tidal generator compared to a wave generator, and the lack of visual pollution provided by the tidal generator. Responses which referred to the tidal generator as using renewable energy were not accepted since this was not an advantage over the tidal generators. There was not enough evidence in the stem of the question to indicate which generator produced more electricity, so responses which said that the wind generator provided more energy were not acceptable.

**(ii)** The vast majority of candidates successfully calculated the efficiency of the tidal generator.

**Question 7**

**(a)** Fig. 7.1 was provided to give candidates an explanation of the greenhouse effect. Responses to **(a)** should have made use of this information. Many candidates did this, and included the role of the greenhouse gases in absorbing the infra-red radiation emitted by the surface of the Earth. Other candidates completely ignored the supplied information, and made vague statements about the atmosphere being like a blanket which could not be given credit in this question.

**(b)** The two greenhouse gases mentioned in the syllabus, carbon dioxide and methane, were the required answers here. Many candidates gave carbon monoxide as one of their responses and this was not accepted because this gas, like many others, contributes in a small way to the greenhouse effect. Though missing from the syllabus, water vapour was given credit since it plays a large role as a greenhouse gas.

**(c)** The questions required candidates to indicate how the human activities increased at least one of the greenhouse gases mentioned in **(b)**. Many candidates correctly described the burning of fossil fuels and deforestation as activities that would increase the greenhouse effect.

**(d)** Many candidates gave correct suggestions about a measure to reduce the levels of greenhouse gases, many following on naturally from the previous question. Catalytic converters were not credited because of their production of carbon dioxide, a greenhouse gas.

**Question 8**

**(a) (i)** Many candidates successfully wrote a balanced equation. The formulae of the copper carbonate and copper chloride were supplied in the stem and the word equation was given. Some lower-scoring candidates changed the given formulae and so could not be credited. Candidates are reminded to read the stem carefully and to use the formulae provided unchanged.

**(ii)** The majority of candidates knew the limewater test for carbon dioxide and therefore gained full credit.

**(b) (i)** The labelling of the electrodes with the products was successfully done by most of the higher-scoring candidates. Candidates should remember that once the chloride ions have been oxidised at the anode they form chlorine gas and responses which said that chloride was formed were not credited. If a formula was provided $Cl_2$ was needed to show that molecules are formed. Candidates are reminded to read all of the information and questions provided in the examination paper because many candidates across the ability range did not respond to this question.

**(ii)** This was successfully answered across the range of candidates who gained full credit.

**(c) (i)** The higher-scoring candidates scored well here, being able to relate the need for charge balance in the formula. Other candidates who gave explanations about sharing electrons or described covalent bonding in any way did not gain credit for the explanation.

**(ii)** Most candidates successfully provided one of the properties of transition metals.

**(d)** Many candidates scored well in this question and were able to write the correct structural formulae. Candidates are reminded that carbon atoms only form four bonds in these formulae and that a double bond counts as two bonds. One frequent error was to write the formula for ethane with a double bond in the middle as the response for ethene. This resulted in too many hydrogen atoms and an inaccurate number of carbon bonds in the formula.

**Question 9**

**(a)** This question was successfully answered by many candidates. To gain full credit candidates had to refer to movement of the plates and some candidates omitted to do this.

**(b) (i)** Many candidates successfully recalled the definition of an electric field as defined in the syllabus.

**(ii)** This question was successfully answered by the majority of candidates who drew a possible route for the electron travel towards the positively-charged plate.

**(c) (i)** Candidates were expected to draw a circuit with the heaters in parallel and the lamp in the main circuit. The main error was to place the lamp in parallel with the heaters which could provide a short circuit. Candidates were given the symbol for a heater in the stem of the question yet many drew a line through the centre of the symbol, resulting in a loss of credit.

**(ii)** This description of convection required the candidates to explain that the heated water becomes less dense and rises. Candidates who described particles as being hot or less dense were not awarded, though descriptions of particles gaining kinetic energy and moving further apart were credited.

# COMBINED SCIENCE

**Paper 0653/04**

**Coursework**

## Key Messages

Choice of tasks must be made very carefully, to ensure that the task allows candidates to demonstrate their full abilities within the chosen skill area or areas.

Work should be fully marked by the teacher.

Details of each task must be provided for external moderation.

## General Comments

Relatively few Centres entered candidates for Paper 4.

Centres are reminded that the external Moderators need to have complete information about how the assessment of candidates was carried out. This includes full details of the tasks that were set. This could be copies of the worksheets provided to the candidates, or a summary of oral instructions that were given to them.

It is also important that the samples of candidates' work have been fully and clearly marked by the teacher carrying out the assessment. This involves writing on the work itself by hand, or adding comments in Word if the work has been submitted to the teacher electronically. It is not appropriate for fair copies of the work to be used for assessment or submitted for external moderation. Original work, marked by the teacher, is expected.

For C1, no written work by the candidate will be produced, but the Centre should provide some evidence for the way in which the mark has been obtained. This is generally done in the form of a checklist, completed 'live' as the candidates work through the task.

In general, Centres have become adept at providing tasks that allow candidates access to the full range of marks. Occasionally this is not the case. For example, non-quantitative tasks make it almost impossible to achieve a mark of 6 for C3, and problems that do not involve the effect of one variable on another do not allow the award of high marks for C4. Guidance on the selection and design of appropriate tasks is provided in the *Coursework Training Handbook*.

# PRACTICAL TEST

**Paper 0653/51**

**Practical Test**

## Key Message

When a question asks for a reference to the results obtained during the experiment, then this must form part of the answer.

## General Comments

The majority of candidates were able to carry out all three practical exercises. Clearly the lack of graph plotting removed some time pressure. Where there were problems with chemicals or apparatus, such as the starch in **Question 2**, allowances were able to be made during the marking process.

## Comments on Specific Questions

### Question 1

Most candidates were able to record the colour of the cobalt chloride paper and the appearance of the limewater in **(a)**. Some stated that the limewater remained the same. This was not accepted as there was no description of the limewater in the question. On re-testing the contents of the test-tube after the food had been burned, most candidates observed that the cobalt chloride paper turned a pink colour and correctly deduced that this indicated the presence of water. Fewer candidates observed the correct change in the appearance of the limewater. In **(d)**, only the more able candidates could give two correct observations to show that energy is released when food is burned. The most common response was heat. Many candidates tried incorrectly to relate their answers back to their observations in **(b)** and **(c)**.
Correct answers to the more demanding **(e)** were rare. Very few candidates realised that the tests were to deduce that water and carbon dioxide were not already present. The term 'control' was rarely seen. In **(f)**, respiration was well known.

Most candidates were able to state a sensible safety precaution.

### Question 2

Most candidates recorded a time in excess of 10 s for the solution to turn blue-black. Times recorded varied greatly from 20 s to 1500 s, which suggested that the starch had not been freshly prepared in some cases. Candidates were not penalised for this. The addition of the $Fe^{2+}$ and $Fe^{3+}$ ions generally resulted in candidates correctly recording much shorter reaction times. Inappropriate precision was often used.

The majority of candidates correctly concluded that the metal ions were acting as catalysts for the reaction. Many were able to use their results to explain why they had arrived at their conclusion.

Only the most able candidates were able to make a sensible comment about the reliability of the experiment by comparing the results they had obtained when no metal ion was present. The term reliability was often confused with the term fair test. Very few candidates understood that if the results on repetition were close (within 10%), then they could consider their results to be reliable.

In **(e)**, most candidates understood the need to maintain a constant volume but very few were able to propose a sound modification.

**Question 3**

This straightforward measuring exercise was performed competently by the majority of candidates. When measuring the diameters of the top and bottom of the cup and the height of the cup, candidates were expected to quote their measurements with an accuracy which reflected the resolution of the ruler they had used. A significant minority of candidates wrote down distances which were to the nearest centimetre which was not accepted. A relatively small number of candidates wrongly took their measurements from the diagram of the cup that appeared in the question paper.

The average diameter and the volume of the cup were usually calculated correctly in **(a)**. The volume was very often quoted to an unacceptably large number of decimal places or significant figures. Most candidates missed the clue in the stem of the question, namely to calculate the approximate volume, to quote their answer to the nearest $cm^3$.

Part **(b)** appeared to be carried out well despite some candidates encountering difficulties with the total volume of the measuring cylinder and with the lack of scale at low values of volume. The most common correct sources of inaccuracy suggested by candidates were that either water was spilled on transfer or that it was difficult to judge when the cup was full. A significant number of candidates misread the question and made a comment about the procedure carried out in **(a)**.

$V$ and $V_w$ were stated as answers to **(b)(iii)** fairly equally. This was despite being told in **(a)** that the method was an approximate one. Of those candidates who correctly chose the second method, many could not produce an acceptable explanation.

# COMBINED SCIENCE

**Paper 0653/52**

**Practical Test**

## Key Message

In Chemistry, a lack of effervescence with the addition of an acid should be reported as this indicates the absence of the carbonate ion.

## General Comments

Candidates were able to carry out all three practical exercises in the allocated time. The standard of graph plotting was high and there were fewer difficult scales.

## Comments on Specific Questions

### Question 1

For food test questions, it is important to know which food group is identified by which test. In **(c)**, allowance was made for incorrect responses in **(a)**. When recording observations of food tests, candidates should record final colours and avoid responses such as 'no change'. This experiment generally gave useful results and many candidates were able to process their observations correctly.

The test for fats in **(d)** was not well known. Many candidates knew that ethanol was involved but did not know how the whole test should be carried out. The positive result of a fat test was sometimes recorded accurately although several unacceptable alternatives for 'emulsion' were seen.

### Question 2

Although **P**, calcium ethanoate (acetate), is not a chemical that is routinely analysed at this level, the tests in this question are frequently encountered by candidates. Relatively few candidates observed the blue flame of propanone (acetone) burning and the darkening of the solid. Condensation was often recorded.

In **(b)** the correct change in the colour of the litmus was often seen. The lack of effervescence on adding the acid and its significance were rarely recorded. This test, indicating the absence of the carbonate ion, has now appeared several times in practical tests.

The reaction between **P** and nitric acid produces calcium nitrate and **Q** which is ethanoic acid (acetic acid). Many candidates performed well in **(c)** and often identified ethanoic acid by its smell, although the identification was not required at this level.

The solid **R**, formed in **(a)** by heating **P**, is calcium carbonate. In **(d)**, most candidates observed the white precipitate in the limewater. The effervescence produced by adding acid to **R** was rarely recorded. Nearly all candidates correctly deduced the presence of carbonate but not all prefixed this with 'calcium' which was needed to identify compound **R** fully.

**Question 3**

This electrical exercise produced good sets of results. Most errors in **(a)** were either the omission of units, transposing voltage and current readings or recording readings to inappropriate numbers of decimal places.

Plotting of points for the graph was generally done well and choosing sensible scales always helps with this. Scales should result in at least half of the grid being used for plotting the points. Most candidates drew a suitable straight line although curves and poorly sketched lines were seen.

Candidates continue to use less than half of their line to calculate the gradient and so not obtain the first mark. Also too many do not indicate on the graph, either with a triangle or with coordinates, which values were used. A small number of candidates used data from the table which is only valid if the line passes through these points. The calculation of the gradient was usually correct and many candidates chose the appropriate number of significant figures, two or three, for the answer in **(d)**.

# 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 measuring cylinders, thermometers, stopwatches etc. Candidates should have performed identification tests on the range of substances detailed in the specification. Candidates need to enter data into tables to the same number of significant figures as the data already there.

## General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. The drawing of chemical apparatus proved very challenging for many candidates. The standard of graph drawing was generally high but drawing of curves proved challenging for some candidates. Designing an experiment proved to be very difficult for many candidates. Knowledge of identification tests for ions was limited.

## Comments on Specific Questions

### Question 1

**(a)** Many candidates gained credit. Common incorrect responses included: acid, carbon dioxide and oxygen.

**(b)** A majority of candidates gained credit.

**(c)** Some candidates gained credit. Common responses which were not creditworthy included to test for water, to test for carbon dioxide, to see if limewater goes milky.

**(d)** Many candidates gained credit. Digestion was a common incorrect response.

**(e)** More able candidates gained credit. Many candidates discussed the criteria for chemical change.

**(f)** Many candidates gained credit but some answers were of a vague "stay away from..." type without an explanation of how.

**(g) (i)** Some candidates gained partial credit with some gaining full credit. Some answers lacked the detail to be creditworthy such as "do it carefully" or "repeat".

**(ii)** More able candidates gained credit.

### Question 2

**(a)** Many candidates gained credit. Incorrect responses included iodine and water.

**(b) (i)** More able candidates gained credit. Incorrect responses included beaker and flask.

**(ii)** Many candidates gained credit although test tube was seen quite often.

**(c)** Most candidates gained partial credit and many gained full credit. The value for experiment 3 was often given as 3.9.

**(d)** The majority of candidates gained credit. A few chose $Fe^{3+}$ and some didn't give a reason.

**(e) (i)** More able candidates gained credit. Common incorrect responses included zinc, iron and potassium and many omitted this question.

**(e) (ii)** Many omitted this question and few gained credit. A wide variety of answers were seen but more common responses included copper oxide, copper sulfate, sodium hydroxide and ammonia.

**(f)** Very few correct responses seen. Many omitted the question. Many added a metal ion or a catalyst solution.

**Question 3**

**(a) (i)** A large majority of candidates measured the height correctly.

**(ii)** A large majority of candidates measured the diameter correctly.

**(iii)** A large majority of candidates measured the diameter correctly.

**(iv)** Many candidates calculated correctly. Some candidates averaged **(i) (ii)** and **(iii)**.

**(v)** Many candidates calculated correctly.

**(b) (i)** A large majority of candidates read the volume correctly.

**(ii)** Most of the candidates who gained credit in **(b)(i)** also gained credit here.

**(c)** More able candidates gained partial credit usually for spillage of water but few gained full credit.

**(d)** More able candidates gained credit with many candidates subtracting the masses but not relating the answer to the volume.

**Question 4**

**(a)** Most candidates gained partial credit with many gaining full credit. Light was a very common incorrect response.

**(b)** Few candidates appreciated that all of the seedlings would grow and so most added the leaves to the stems already drawn rather than extending them and so did not gain credit. Almost no candidates gained credit for Dish **C**.

**(c)** More able candidates gained credit with the most common incorrect responses being photosynthesis and geotropism.

**(d)** Many candidates gained at least partial credit but many candidates described the test for starch.

**(e)** More able candidates gained partial credit usually for the idea of one or some of the seeds being damaged. Few gained full credit. Averaging was a common non creditworthy response.

**Question 5**

**(a)** The diagram proved challenging for many candidates and few gained credit. Incorrect responses included people blowing into the delivery tube, a sealed collection vessel and the delivery tube not going into the water. Those that drew the correct apparatus often missed gaining credit as they bubbled the gas into limewater instead of water.

**(b) (i)** Few candidates gained credit. Watching carefully was a common non-creditworthy response. Putting a cross and watching through the solution until the cross disappears does not give an indication of when the precipitate begins to form.

**(ii)** Many candidates read the volumes correctly but some didn't record all of the values to 0.1 $cm^3$.

**(iii)** The majority of candidates averaged the volumes correctly.

**(c)** More able candidates gained credit. Dividing by the sum of the volumes was a common error.

**(d)** More able candidates gained credit for their choice of indicator but many candidates then gave the incorrect colour change as they didn't appreciate that carbon dioxide is slightly acidic and so gave the colour for a strong acid.

**Question 6**

**(a)** More able candidates gained credit. Most candidates gave vague and generalised answers usually about sharing the tasks so that every member has a job.

**(b)** The vast majority gained credit.

**(c) (i)** Most able candidates gained partial credit with few gaining full credit. Dividing 4.9 by 3.5 was a popular incorrect response.

**(ii)** Most able candidates gained some credit. Many candidates quoted the times and then restated the question stem and many omitted this question**.**

**(d)** Very few candidates gained credit. Most candidates thought that the trolley would travel more quickly because it was heavier.

**(e)** Many candidates appreciated that the trolley would travel more quickly but few could explain why this would make the results inaccurate.

**(f)** Many candidates gained credit. Common incorrect responses included starting with chemical energy or the correct energy change returning to gravitational potential energy at the end.

# COMBINED SCIENCE

**Paper 0653/62**
**Alternative to Practical**

## Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, thermometers, stopwatches, etc. Candidates should have performed identification tests on the range of substances detailed in the specification. Candidates need to enter data into tables to the same number of significant figures as the data already there.

## General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. The drawing of chemical apparatus proved very challenging for many candidates. The standard of graph drawing was generally high but drawing of curves proved challenging for some candidates. Designing an experiment proved to be very difficult for many candidates. Knowledge of identification tests for ions was limited.

## Comments on Specific Questions

### Question 1

**(a)** Many incorrect responses had colours for the reagents rather than the reagent name.

**(b)** Some candidates gained partial credit often for the starch iodine colour.

**(c) (i)** Some candidates scored partial credit for ethanol but few also included water.

**(ii)** More candidates gained credit for the observation. Precipitate was a common incorrect response.

**(iii)** Some candidates gained credit. Incorrect responses included liquid and contains fat.

### Question 2

**(a)** A very small minority of candidates gained credit. Most gave the test for either hydrogen or oxygen.

**(b) (i)** Most candidates gained credit for the result of the test but few gained credit for the diagram. Incorrect diagrams included sealed receiver vessels and delivery tubes not going into the limewater.

**(ii)** Many candidates gained credit although hydrogen was seen quite often.

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**(c)** Some candidates gained credit. Calcium chloride was a popular incorrect response.

**(d) (i)** Many candidates chose a correct indicator and gave the correct colour change but some reversed the colour change.

**(ii)** Few candidates gained credit. Popular incorrect responses included the reaction being too fast or the tube breaking.

**(e)** More able candidates gained credit for monitoring the gas often by use of a syringe but very few appreciated the use of a specific time or a time for a specific amount of gas. Common incorrect responses included timing until the reaction was complete or choosing the one in which the bubbles stop first.

**Question 3**

**(a)** Some candidates read the ammeter dials correctly but many candidates values had a difference of 0.1 from the actual value. Most candidates read the voltmeter dials correctly.

**(b) (i)** Many candidates gained full credit for the plotting and the line.

**(ii)** Some candidates indicated the values on the graph but many did not. When calculating the gradient of a line over half of the line should be used and the triangle used should be drawn. Many candidates inverted the division.

**(iii)** More able candidates gained credit.

**(c) (i)** Few candidates gained credit.

**(ii)** Most able candidates gained credit. To make sure the current or voltage didn't run out was a popular incorrect response.

**Question 4**

**(a)** More able candidates measured the total length of the pollen tube in the image correctly. Many candidates divided the value by 100.

Few candidates calculated correctly the actual length of the pollen tube.

**(b)** Most candidates gained credit. A very small minority summed the values but did not divide by three.

**(c) (i)** While many candidates labelled the axes with the variable being plotted many did not include the units. Many candidates gained credit for the scale and the plotting of the points. The best fit line proved more challenging, feathered lines or use of a ruler did not gain credit.

**(ii)** Many candidates gained credit.

**Question 5**

**(a) (i)** Most gained credit.

**(ii)** Many candidates gained credit. A significant number thought the nail would rust albeit more slowly.

**(iii)** More able candidates gained credit. The most popular answer gave paint as the reason without saying what the paint does to prevent the rusting.

**(b) (i)** Many candidates gained credit. Some candidates omitted the lighted splint or used a glowing splint. A small number used limewater.

**(ii)** More able candidates added a correct reagent but although they had the correct colour of the product they frequently omitted precipitate**.** A number of candidates omitted this part.

**(iii)** Many candidates gained credit.

**(iv)** Few candidates gained credit.

**(c)** More able candidates gained some credit with a few candidates gaining full credit. Many candidates discussed a Hooke's Law experiment with the wire extending rather than bending or repeated the stem of the question or discussed their knowledge of the relative strengths of iron and steel.

**Question 6**

**(a)** Many candidates gained credit.

**(b) (i)** Many candidates read the measuring cylinders correctly but some did not record the values to $0.5\,cm^3$.

**(ii)** Many candidates gained credit with a few reversing the order.

**(c)** More able candidates gained partial credit with a few gaining full credit. The chemical tests given included drinking the water or using an indicator. The physical tests included boiling (with no temperature) or seeing if it is a colourless liquid.

**(d) (i)** Some candidates gained partial credit, usually for mass, and a few gained full credit. Common incorrect responses included beaker, ruler or cylinder for volume and rule or beaker for mass. Some thought density could be measured directly with a balance or a cylinder.

**(ii)** Many gained credit. A small number inverted the division.

# COMBINED SCIENCE

**Paper 0653/63**
**Alternative to Practical**

## Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques 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. Candidates should have performed identification tests on the range of substances detailed in the specification. Candidates need to enter data into tables to the same number of significant figures as the data already there.

## General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. The standard of graph drawing was generally high but drawing of curves proved challenging for some candidates. Evaluation of experimental methods proved to be very difficult for many candidates.

## Comments on Specific Questions

### Question 1

**(a)** Most candidates knew the correct units. A common incorrect response was 2 minutes.

**(b)** Many candidates labelled the axes with the quantity but far fewer included the correct units. A significant number of candidates incorrectly used m for minute. The majority of candidates correctly plotted both sets of data. The curves proved to be more difficult for many candidates. A best fit curve should be smooth, close to as many points as is appropriate and be one continuous line.

**(c)** Many candidates discussed the huddling penguins but far fewer made reference to the results of the experiment.

**(d) (i)** More able candidates were able to identify a source of inaccuracy.

**(ii)** Most of the candidates who identified a source of accuracy in **(d)(i)** could suggest a suitable improvement. Many candidates discussed repetition and reliability and so didn't gain credit. A significant number incorrectly suggested performing the experiment on live penguins or using the temperatures found at the Pole.

**(e)** Reliability was well known.

### Question 2

**(a) (i)** The vast majority of candidates read the temperatures correctly. A small number read the temperatures to integer values rather than to the required nearest 0.5 °C.

**(ii)** Although most candidates could accurately calculate the temperature changes the vast majority did not give all of the values to one decimal place.

**(b)** Some candidates answered the questions in terms of the required temperature change but many answered in terms of the temperature decreasing and so didn't gain credit.

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**(c)** More able candidates could name solution X. Common incorrect responses included: copper hydroxide, sulfuric acid, zinc, zinc nitrate and zinc sulfate.

**(d)** Many candidates gained credit but many discussed cracked or exploding glass beakers and so did not gain credit.

**(e)** Candidates found this very difficult.

**Question 3**

**(a) (i)** Most candidates measured the height correctly.

**(ii)** Most candidates understood how a shadow is formed. However, a small but significant number had the light bending around the object.

**(b)** Most candidates measured the shadows correctly but some measured to the edge of the blurred part of the shadow.

**(c) (i)** The vast majority of candidates plotted the points correctly but many found drawing the curve more challenging.

**(ii)** Most candidates marked the relevant line on the graph but few used the numbers to explain their conclusion.

**(d) (i)** The majority of candidates extrapolated the line and read the value correctly. A small number didn't extend the line but gave a height and so didn't gain credit.

**(ii)** Many candidates understood the consequences of the smaller distance. Incorrect responses included blocking the light completely so that no shadow is formed or the shadow not fitting onto the graph.

**Question 4**

**(a)** Most candidates gained credit.

**(b) (i)** Many candidates read the scales correctly.

**(ii)** More able candidates gained credit**.** Many candidates added the distances together.

**(c) (i)** Few candidates appreciated the possible temperature change but many answered in terms of the soda lime absorbing the carbon dioxide already in the air.

**(ii)** Few candidates gained credit. Many suggested removing the bag of soda lime or removing the air altogether and so didn't gain credit.

**(d)** Many candidates gained at least partial credit here with some candidates gaining full credit. Some candidates thought incorrectly that the woodlice taking in the oxygen would be the reason for the oil drop moving.

**(e)** Most candidates gained credit. Some candidates referred to carbon dioxide rather than the oil drop.

**Question 5**

**(a) (i)** Most candidates read the scales correctly. 135 $cm^3$ was a common error.

**(ii)** Most candidates gained some credit and the more able candidates gained full credit. The drawing of the curve proved difficult for many. Common misplots were 90 $cm^3$ and 112.5 $cm^3$.

**(b)** Few candidates gained credit. Most candidates discussed the lightness or low density of hydrogen and so didn't gain credit.

**(c)** Most candidates gained at least partial credit with the most able gaining full credit.

**(d)** Many candidates gained credit. Some candidates answered in vague terms such as magnesium reacting better or more.

**Question 6**

**(a)** Most candidates read the scales correctly.

**(b) (i)** More able candidates gained credit. Candidates often referred to looking at the difference in volumes at the two temperatures or allowing the water bath to warm up.

**(ii)** The majority of candidates gained credit. Some candidates put the ice and / or salt into the syringe.

**(c)** Many candidates appreciated the gain in energy and so gained partial credit but few could explain a consequence of this. Commonly candidates discussed the particles expanding or stated that the pressure would increase with increasing temperature.

**(d)** More able candidates gained credit. Many discussed the particles coming closer together or an increase in density without reference to the state change.

**(e)** More able candidates gained at least partial credit. Many candidates discussed the absence of clamping and so didn't gain credit.

**(f)** More able candidates gained credit. Many candidates put the clamp on the barrel of the syringe or below the level of the beaker or the water. Many candidates omitted this part altogether.