COMBINED SCIENCE

Paper 0653/11
Multiple Choce

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

General comments

Candidates were generally able to make significant and meaningful attempts at all the questions in the Biology section of the paper. Only one question appeared to expose an area of confused understanding.

Of the Chemistry section, **questions 16, 21** and **27** proved to be easiest and **question 22** proved to be the most difficult.

Candidates found **questions 29**, **33** and **37** of the Physics section particularly challenging.

Comments on specific questions in Biology

Question 1

This was one of the easier questions on the paper, in part because very few candidates believed that the cytoplasm of a cell is found outside the cell wall.

Question 3

Even though this was one of the more difficult Biology questions, over a significant proportion of the candidates were able to recognise the graph showing the effect of temperature of the rate of enzyme activity. Many, though, did not appreciate that at temperatures above 70 ^{o}C, the rate would be zero, and thus opted for graphs **B** and **D**.

Question 6

This was the question that was found to be the easiest on the Biology section, with the majority of candidates secure in the knowledge that haemoglobin is found in red blood cells. However, a significant proportion of candidates thought that it is found in alternative parts of the blood.

Question 12

The most difficult of the Biology questions, it presented candidates with what, for many, would be an unfamiliar ecosystem. They appeared to deduce the correct sequence, but then made the error of failing to begin their food chain with a producer, a significant proportion selecting a chain that started with the decomposers.

Comments on specific questions in Chemistry

Question 17

Candidates knew that the reaction was exothermic and that oxygen was, in some way involved, but did not understand the process of combustion

Question 22

Candidates were confused about trends in the periodic table groups and mixed the trends in groups 1 and 7.

Question 24

Candidates realised that the metal was unreactive but did not know how alloying affects metal properties.

Question 25

Candidates thought that the proportion of carbon dioxide in the air was much higher than it is.

Question 26

Candidates knew that carbon dioxide was produced but did not consider what the other product of hydrocarbon combustion must be.

Comments on specific questions in Physics

Question 29

This question concerned the density of two solid cubes. Although just over one in three candidates gained the mark here, option D was very popular; the result of dividing mass by the length of one side, rather than by the volume of each cube.

Question 31

Distractor D was also a popular choice in this question about melting point, these candidates believing that ice only melts when its temperature rises above 0 °C.

Question 33

Many candidates chose the incorrect option A. This suggests that a large proportion of candidates were not aware of the nature of a transverse wave.

Question 36

Only around half the candidates knew that a filament lamp emits infra-red waves in addition to light, rather than microwaves, radio waves or ultraviolet waves.

Question 37

A significant number of candidates made the classic mistake of failing to double the distance to the reflecting surface, leading to option B as a popular choice.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

General comments

Candidates were generally able to make significant and meaningful attempts at all the questions in the Biology section of the paper. Only one question appeared to expose an area of confused understanding.

Candidates performed well on the Chemistry section. No questions proved to be particularly easy with candidates finding **Question 25** the easiest.

Of the Physics questions, **questions 30**, **36** and **37** were found particularly challenging by the candidates.

Comments on specific questions in Biology

Question 1

Although a significant proportion of candidates selected the correct answer, those that did were almost uniquely of higher ability. The distinguishing feature was an understanding of the difference between 'total' and 'net' movement of molecules.

Question 2

This was one of the easier questions on the paper, in part because very few candidates believed that the cytoplasm of a cell is found outside the cell wall.

Question 4

Even though this was one of the more difficult biology questions, a significant proportion of the candidates were able to recognise the graph showing the effect of temperature of the rate of enzyme activity. The majority, though, did not appreciate that at temperatures above 70 ^{o}C the rate would be zero, and thus opted for graphs **B** and **D**.

Question 8

This was one of the more difficult questions, and like **Question 4**, involved the interpretation of graphs. Amongst the less able, there was a degree of guesswork, though some candidates of reasonable ability were attracted by the possibility that, immediately after a meal rich in carbohydrate, blood sugar levels would fall.

Question 13

The most challenging of the biology questions, it presented candidates with what, for many, would be an unfamiliar ecosystem. They appeared to deduce the correct sequence, but then made the error of starting a food chain with the decomposers.

Comments on specific questions in Chemistry

Question 16

Candidates realised that the reaction was exothermic but did not understand the process of combustion.

Question 26

Candidates did not realise how little carbon dioxide is present in the air. This is a common error.

Comments on specific questions in Physics

Question 30

This question concerned the density of two solid cubes. There was evidence of widespread guessing here.

Question 32

Distractor D was a popular choice in this question about melting point, these candidates believing that ice only melts when its temperature rises above 0 °C.

Question 35

In this question, fewer than half the candidates knew that a filament lamp emits infra-red waves in addition to light, rather than microwaves, radio waves or ultraviolet waves.

Question 36

The incorrect option A was a popular choice. This suggests that a large proportion of candidates were not aware of the nature of a transverse wave.

Question 37

Many candidates made the classic mistake of failing to double the distance to the reflecting surface, meaning that they chose option B

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

General comments

Candidates were generally able to make significant and meaningful attempts at all the questions in the Biology section of the paper.

The candidates performed quite well on the Chemistry sections. Questions **16, 18, 20, 21, 23, 24** and **27** proved to be easiest being answered correctly by the vast majority of the candidates. **Question 15** proved to be the most challenging.

Of the Physics questions, **questions 28**, **30** and **38** were particularly well answered, with **question 40** being found challenging by many.

Comments on specific questions in Biology

Question 1

This was one of the easier questions on the paper, in part because very few candidates believed that the cytoplasm of a cell is found outside the cell wall.

Question 2

It appears that candidates were generally unfamiliar with the fact that both ventricals contract together, and thus some otherwise competent performers did not realise that both atrio-ventricular valves would be closed and both aortic valves would be open, simultaneously.

Question 3

It was evident that over half the candidates did not appreciate the fact that antibodies that protect against disease are protein in nature.

Question 7

The relatively straight-forward subtraction and division posed few problems for the vast majority of candidates.

Comments on specific questions in Chemistry

Question 15

This was a challenging question, requiring candidates to select a soluble and an insoluble salt from those they knew from qualitative analysis. The majority chose the two precipitates with which they were most familiar.

Question 17

Candidates either misinterpreted the graph or were unsure of the different meanings of exothermic and endothermic.

Question 26

Candidates knew that carbon dioxide was produced but seemed to stop reading the responses when they found that word.

Comments on specific questions in Physics

Question 28

Interpretation of a speed / time graph was well understood by the great majority of candidates.

Question 29

This question concerned the density of two solid cubes. Although well over half the responses were correct, option D was also popular; possibly this was as a result of dividing mass by the length of one side, rather than by the volume of each cube.

Question 30

This required simple recall of the unit for work, and caused little difficulty.

Question 35

Fewer than half the candidates could identify the angles of incidence and refraction, with many confusing the latter with the angle of emergence.

Question 37

Although well answered, a significant proportion of the candidates made the classic mistake of failing to double the distance to the reflecting surface, and as a result chose option B for this question about echoes.

Question 38

This concerned the electrical forces between positive and negative ions, and was well understood.

Question 40

A sizeable majority of candidates were unaware that the combined resistance of two resistors in parallel would be lower than the lower value of the two resistors.

COMBINED SCIENCE

Paper 0653/21

Core Theory

Key Messages

Candidates need to be able to produce discursive answers that give information additional to that provided in the stem of a question. When a candidate is asked to produce such a response, candidates are advised to read through the question a second time after writing their answer, and then their answer again, to make sure that the question set has been answered.

General Comments

The examination produced a wide range of marks. Some very good scripts were seen from candidates who had mastered many of the aspects of the syllabus and examination techniques.

There was no evidence that candidates had difficulty in completing the paper in the available time. In a few cases candidates wrote unnecessarily extended answers.

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

Comments on Specific Questions

Question 1

(a) All candidates gained a mark for *insulation* and most candidates gained marks for *electron* and *ammeter.* The third part caused problems for many candidates, who gave *ohm* rather than the correct answer, *volt.*

(b) (i) Many of the candidates who gained the first mark for '*the light went out',* missed the second mark by referring to the '*current being unable to get to the other lamp'.* They should have explained why this could not happen, that is, because '*the circuit was broken'.* Some candidates gave as their explanation that '*it was a series circuit'.* This was not considered a sufficient answer.

(ii) Whilst many candidates gained a mark for this question, very few gained two marks. Candidates either referred to the lamp being independently controlled or stated something similar to *'the failure of one would not cause all to go out'.* Candidates should be encouraged to carefully check how many marks are allotted to each question; this question had two marks, therefore required two explanations. No candidate referred to each lamp getting the full mains voltage, although a few did refer to the lamps being brighter.

(iii) This question was quite well answered across the ability range. However many candidates missed the mark for the formula by using *R x 2,* rather than the correct *R + R = R total.* Other candidates used omega rather than R.

Question 2

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

(ii) Most candidates gave *E* correctly. However all three answers had to be correct for the mark.

(iii) There were many answers allowed; however many candidates found this a challenging question.

(iv) This was quite well answered. Some candidates gave the percentage for oxygen or nitrogen rather than the percentage for carbon dioxide.

(b) (i) Many candidates missed the first marking point by referring to the removal of '*digested food'*, rather than '*undigested substances'. C*andidates needed to describe where the removal takes place, or the name of the material, faeces.

(ii) Most candidates attempted this question and many underlined the correct term, *herbivore'.* However many underlined the incorrect *producer,* rather than the correct term *consumer.*

(iii) This question was attempted by most candidates. Many answers referred to the improved soil, usually by the addition of plant nutrients**;** some candidates successfully described the improvement of the soil structure. Some candidates referred to food chains or ecosystems; they needed to explain what the effect of the earthworms on the ecosystems would be to gain the mark.

Question 3

(a) (i) There was a wide variety of answers to this question; some of them excellent. Some candidates gave large numbers, outside the range 0 to 14.

(ii) Nearly all candidates had a view on the advantage of digital pH meters and gave well-reasoned answers. Some however did not gain the mark since they referred to '*how quick they were'* or said that '*the meters can be used again and again, unlike litmus paper'.* Those candidates who referred to the *precision or accuracy* of the meter were awarded the mark, as were those who explained that the meter can '*distinguish between the strength of different acids'*.

(b) This question proved challenging for some candidates and many did not attempt it. Of those who did, many needed to explain that the two liquids should be mixed and so missed the first mark. Generally, only the higher scoring candidates referred to the product of the reaction correctly as a '*white precipitate'.*

(c) (i) Candidates had to give the name of a correct metal in order to gain another mark for a correct explanation. Many who referred to a Group 1 metal described the reaction as *vigorous* and this was not allowed, as generally all Group 1 metals are described as reacting with water vigorously. Many incorrect metals were given as answers; candidates were then not awarded marks for referring to their reaction with acid being e.g. *explosive.*

(ii) This was quite well answered. Some candidates need to be aware of the observations made from a positive test for hydrogen.

Question 4

(a) This proved a challenging question for many candidates, although most attempted it. Many candidates referred to the different energy forms, often in the correct positions, of the jumper, however their explanations of the actual changes of energy were often incorrect. The following is an excellent example of an answer which gained all three marks.

'*Chemical energy changes to Kinetic energy as she runs. This changes to Gravitational Potential energy as she jumps. As she falls, this changes to Kinetic energy, which, when she lands changes to sound energy'.*

(b) (i) Many candidates had difficulties explaining evaporation. Some candidates, incorrectly, referred to the skin *drying*, rather than the '*water particles turning into water vapour'.* Some of the higher scoring candidates gained both marks with an explanation similar to '*the sweat is heated and evaporates turning into a gas'.*

(ii) This question was even more challenging for most candidates. Many candidates gave answers lacking detail such as '*liquid on the skin cooling them down'* or the '*temperature of the body was falling'.* Neither of these types of answers gained marks.

Question 5

(a) (i) Some candidates showed confusion between food and nutrients and gave a letter of a food rather than the correct nutrient names, *sugar* and *starch.*

(ii) A similar error was commonly seen in this part question. A letter of a food was given rather than the correct nutrient, *protein.*

(iii) The reverse error did not occur in this part and letters were used in the answers. The most common correct answer was *A;* far fewer candidates gave the correct answer *C.* Both letters were required for the mark

(iv) This was a challenging question, as it included both a negative result for sugar and a positive result for protein. Only foods *A* or *C* contained protein but no sugar.

(v) Many candidates appeared to have focused on the high sugar content of the foods, as the most frequent wrong answers given were *B* and *E.*

(b) (i) This was quite well answered, with candidates often referring to *rickets.* Some missed the mark by describing the bones as *soft or brittle.* Without the inclusion of the word *rickets*, these answers did not gain the mark.

(ii) This part question was less well answered. Some candidates referred to *ammonia,* which was not allowed. Others gave symptoms of *weakness* rather than the correct *tiredness.*

(c) Most candidates wrote extended answers to this question which described decaying teeth but did not answer the question asked, and therefore could be awarded credit. Many candidates wrote that '*sugar contains acid',* which could not gain credit. Some candidates did then go on to say that '*acid damages the tooth enamel',* for which they gained a mark'. It was pleasing to see that all candidates correctly referred to *bacteria* rather than *germs*. However, many explained that '*sugar contains bacteria'* rather than giving a correct reference to *bacteria feeding on the sugar.*

Question 6

(a) (i) This was a well answered question across the ability range; a small minority incorrectly referred to chemical energy and gravitational potential energy being released.

(ii) Some candidates missed the mark by referring to a *fast* rather than a *faster* reaction.

(b) (i) Some candidates gave the correct letter, *B,* for the particle but offered no explanation. The mark was awarded for a correct explanation. Some missed the mark by referring to B as '*having the same number of electrons,* and not completing the answer to say what the number of electrons was the same as. Candidates needed to say either that the '*number of electrons was 13'* or '*the number of electrons was equal to the number of protons'.*

(ii) This was a very challenging question for candidates across the ability range. Many who chose the correct particles, *A* and *D* tried to explain their choice by using data from the table, referring to the number of electrons and/or the number of protons in these particles.

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

(ii) This part was often left unanswered. Most candidates who gained a mark correctly referred to oxygen being needed for burning or the oxygen being released by potassium perchlorate when heated.

Question 7

(a) Many candidates across the ability range had difficulties drawing the correct waveform. Many candidates labelled the axes with the words amplitude and wavelength, rather than the actual wave. Of those who did label the wave, many struggled to label amplitude correctly, some candidates labelling this from the top to the bottom of the wave. Candidates had a better idea of the wavelength; many needed to start and end the label line with greater precision.

(b) (i) This was quite well answered, although some candidates did not make it clear which was the louder sound wave. Some referred to being able to hear the sound from further away. This did not gain the mark.

(ii) Candidates across the ability range found this question much more difficult than the previous one. Some missed the mark by referring to Y as having a *high* pitch rather than a *higher* pitch.

(c) Most candidates gave the correct transfer of energy as *radiation.* However many did not explain that there was a *vacuum* in space*;* referring, instead, to radiation having to pass '*through space'.* This was not considered sufficient for credit.

Question 8

(a) (i) This question was quite well answered. Some candidates referred to *testis* and *penis* instead of the specific parts indicated.

(ii) The function of part *A*, was well answered. Many candidates explained part *B* as '*where the sperm are stored'* or a *'means of separating urine and sperm'.*

(iii) This was quite well answered, although a substantial number labelled the bladder.

(b) Candidates showed, in general, a good knowledge and understanding of the transmission of HIV. Most candidates gained at least one mark. A few candidates referred to the danger of '*handling infected blood'* without adding that the infected blood had to enter the body to transmit HIV. A few candidates referred to kissing being a means of transmission, without reference to open wounds, so did not get the mark. Some candidates referred to transmission from mother to child without mentioning '*in the uterus'* or *'during childbirth'* or *'by breastfeeding',* so did not get the mark.

Question 9

(a) (i) Candidates generally found this a challenging question. Many missed marks because they referred to elements containing only one atom rather than one type of atom. Others also missed the mark in the explanation of a compound, by referring to the *elements* being bonded together rather than the *atoms* being bonded together. Some candidates used their Periodic Table and referred to chlorine being in the Periodic Table.

(ii) This was a challenging question for all but the higher scoring candidates. Many did not attempt to answer it. The few who referred to *litmus paper* did not usually add that, if the gas is chlorine, the paper is bleached.

(b) (i) This question was not well answered. Those who stated that the anode is positive rarely added the additional defining term; electrode. More often the anode was referred to as a rod, pole, or particle. Of those answers which referred to *electrode,* many used the term *negative.* The complete phrase *'positive electrode'* was required for the mark.

(ii) No mark was given for the correct answer, sodium chloride; the mark being awarded for the correct explanation; many candidates' explanations needed to be more detailed to be awarded credit. Candidates need to take care to use *chlorine* when referring to the gas (released) and *chloride* when referring to the ion present in the compound.

(c) (i) Candidates need to know the state of the Halogens at room temperature; many said bromine was a *solid* and iodine a *liquid,* possibly being confused by the iodine solution used in Biology labs.

(ii) Many candidates gained the first marking point, for the '*reaction of chlorine and sodium bromide'.* Some candidates referred to the orange colour of bromine and gained the last marking point. The very best candidates referred to the displacement of bromine, or that chlorine is more reactive than bromine.

COMBINED SCIENCE

Paper 0653/22

Core Theory

Key Messages

Candidates need to be able to produce discursive answers that add information additional to that provided in the stem of a question. When a candidate is asked to produce such a response, candidates are advised to read through the question a second time after writing their answer, and then their answer again, to make sure that the question set has been answered.

In the Physics questions, where a formula was asked for, some candidates gave the triangle of variables; candidates need to be aware that the triangles of variables is not equivalent to a formula and does not gain a mark

General Comments

The examination produced a wide range of marks. Some very good scripts were seen from candidates who had mastered many of the aspects of the syllabus and examination techniques.

There was no evidence that candidates had difficulty in completing the paper in the available time. In a few cases candidates wrote unnecessarily extended answers.

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

Comments on Specific Questions

Question 1

(a) Whilst most candidates gained marks for the presence of cell membranes in both cells, and the nucleus in the root hair cell, many candidates found difficulties with the absence of the nucleus in the red blood cell and the absence of chloroplasts in the root hair cell.

(b) (i) Most higher scoring candidates gained the mark here and mostly with the correct spelling.

(ii) More candidates attempted and gained marks for this question. The most common error was to state that the red blood cells carried blood around the body.

(c) Very few candidates were able to answer this question correctly.

(d) (i) Most candidates attempted this question. Those who were precise in their answers, stating that roots absorb water, gained credit. Candidates that wrote that '*plants absorb'* or '*roots drink'* the water needed to be more precise in their answers.

(ii) Candidates need to be aware of the difference between, the function and the position of phloem and xylem.

Question 2

(a) (i) Most candidates attempted this question, but generally it was the higher scoring who gained the mark for *9.* The most common wrong answer was *19.*

(ii) There was no mark given for the prediction *insulator,* the mark being awarded for a correct explanation. Candidates offering no explanation gained no credit. The question asks the candidates to predict **and** explain.

(b) (i) Candidates need to be aware of the trend in reaction with water of the alkali metals. Only a few candidates gave an explanation referring to the increase in reactivity down the Group. Most candidates gave sodium as the most reactive, although a few referred to potassium burning when placed in water. Some explanations referred to potassium being at the top of the Reactivity Series.

(ii) This was well answered by the higher scoring candidates, but many others did not attempt to give the test.

(iii) This proved a very challenging question for the whole ability range; many candidates did not attempt to answer it. Candidates needed to describe the *transfer* of electrons. Most candidates described *covalent* rather than *ionic* bonds.

(c) A few of the higher scoring candidates gained credit here. Many of those who attempted the question referred to change of colour, without specifying the colour.

Question 3

(a) This was well answered by the higher scoring candidates. Many others gave the answer *gravity* rather than *gravitational energy.* Another commonly seen wrong answer was *heat energy.*

(b) (i) This was quite well answered across the ability range. Most candidates appeared to understand that a sound of the same pitch required the same wavelength, but were less familiar with the idea that a louder sound has a greater amplitude.

(ii) Candidates found it more difficult to keep the same amplitude whilst shortening the wavelength.

(iii) Although a range of values was allowed for the minimum and maximum frequency, most candidates found this question very challenging and many did not attempt the question. Candidates need to be aware of the approximate human range of audible frequencies.

(c) Mainly high scoring candidates gained marks here. Many of these showed correct working but they made an error in locating the decimal point in the final answer. This should have been *0.0012.*

Candidates who gave an incorrect formula, or substituted data incorrectly did not gain credit.

(d) Candidates continue to find it challenging to produce discursive answers explaining phenomena. Some candidates referred to the chlorine in the water leaving the skin. Another quite common error was to refer to the skin '*getting dry'*, rather than the water leaving it. Some candidates incorrectly abbreviated '*heat from the Sun'* to *Sun* or *'Sunlight'*. An example of an answer that would gain credit could be '*as the water is heated, the particles get further apart, so it evaporates and turns into a gas'.*

Question 4

(a) (i) Almost all candidates showed an understanding of the characteristic of a food web that a producer is necessary as the starting point; many did not articulate the idea that a producer '*makes its own food'*.

(ii) This was a question very well answered by the whole ability range.

(iii) Only a small minority gained the mark; generally answers referred to what an animal was eating.

(b) (i) Most errors were in the first word, where generally candidates gave *asexual* rather than the correct *sexual.* Most candidates correctly gave the third word, *stigma.*

(ii) This was quite well answered; some candidates gave *light* or *sunshine* as necessary environmental conditions and did not refer to *air* or *oxygen.* Some candidates also said that *soil* was necessary.

Question 5

(a) This was generally well answered, although some candidates simply described the bubbles leaving the mixture and entering the limewater. No candidate referred to the solid precipitate or calcium carbonate formed.

(b) Most candidates found this question challenging and listed reactants rather than products, or did not attempt an answer. Of those candidates who understood what was required, most gained both marks.

Question 6

(a) (i) This question was quite well answered, but a large number of candidates gave *wind* energy. Candidates need to be aware of the difference between forms of energy and energy resources.

(ii) This was much better answered question.

(iii) A very well answered question across the ability range.

(b) (i) Most candidates showed a good understanding of the importance of **not** handling electrical appliances with wet hands. However some candidates missed the mark by referring to precautions taken after having used an appliance or by making general statements about not using the appliance near water.

(ii) Many candidates gained the mark by referring to the conductivity of water, although some lost the mark by using phrases such as '*water and electricity do not mix'.*

(c) This was generally a well answered question; a number of candidates placed the *A* and *V* incorrectly. A few candidates attempted to draw the ammeter and voltmeter in the positions of the variable resistor and the bulb.

(d) (i) This was a very well answered question. Candidates that had drawn lines on the graph to find the current general gave the correct answer.

(ii) Candidates found this a very difficult question. It was not sufficient to state simply that the current rises or the lamp is brighter. The best answers gave the observation that the curve was levelling off, stating, for example, '*current is not increasing as much'.* Some candidates noticed the change in gradient, but incorrectly described it as *'current decreasing'.*

(e) (i) Candidates need to be able to label the angles of incidence and reflection. Many candidates labelled the given rays as incidence and reflected.

(ii) Candidates found this question easier and generally attempted it. The most common errors were multiples of 45, that is 90 and 135 for the angle.

Question 7

(a) (i) This question was very well answered. Most candidates attempted the question, with only a few missing the second mark by referring to '*long'* or '*small intestine'.*

(ii) This was also very well answered.

(b) Most candidates made quite good attempts at this question. The idea that teeth break the food into small pieces, making it more quickly digested was commonly given. Some candidates used *molecules* rather than *pieces* and were not awarded that mark. There were very few references to enzymes.

(c) (i) Many candidates found this a challenging question. There was a wide variety of incorrect answers; candidates often referred to both test tubes containing the same solution rather than to the effect of lipase on the liquid fat.

(ii) There were some well-reasoned answers to this question. Many candidates referred to the difference in temperature; fewer went on to give details of the difference, explaining that test-tube B was at a higher temperature. Some candidates missed this mark by using the imprecise term '*higher degrees'* rather than '*higher temperature'.*

Question 8

(a) (i) Many candidates left this question unanswered. Of those who did attempt the question, the most common error was to refer to carbon monoxide rather than carbon dioxide. Some candidates gave methane oxide rather than carbon dioxide.

(ii) The better candidates were able to answer this question correctly. The most common wrong answers were '*combustion'* and '*burning'.*

(b) (i) Many candidates did not attempt this question. Only the higher scoring candidates gave the full name of the process, fractional distillation.

(ii) The better candidates were able to select the compounds found in oil correctly; fewer were able to give the correct explanation, that they were hydrocarbons.

(iii) This was quite well answered. Many candidates gave answers relating to cooking with the gas.

(iv) Many candidates found this a challenging question.

Question 9

(a) This was quite well answered and many candidates gained the mark for the cause of the friction, although some did not actually refer to *friction*. Very few candidates gave an explanation including a reference to the transfer of electrons from car to surface.

(b) (i) Most candidates attempted this question; many interpreted the first horizontal part of the graph (from B to C) as zero speed. Candidates need to take care to use units where they are not given on the question paper.

(ii) This was a well answered question. Many candidates identified the correct part of the graph; some gave only one point on the graph, *B* or *C*, and could not be awarded credit. Most candidates were able to read the speed from the graph correctly as *0.4 m/s.*

COMBINED SCIENCE

Paper 0653/23

Core Theory

Key Messages

Candidates need to be able to produce discursive answers that add information additional to that provided in the stem of a question. When a candidate is asked to produce such a response, candidates are advised to read through the question a second time after writing their answer, and then their answer again, to make sure that the question set has been answered.

In the Physics questions, where a formula was asked for, some candidates gave the triangle of variables; candidates need to be aware that the triangles of variables is not equivalent to a formula and does not gain a mark

General Comments

There were some very good performances on this Paper, with several candidates showing a good understanding of the Core content of the syllabus.

There was no evidence that candidates had difficulty in completing the Paper in the available time.

Comments on Specific Questions

Question 1

(a) (i) This question was quite well answered. Almost all candidates attempted to complete the sentences, and many entered the correct term, *zygote*, in the second place. Many candidates however, incorrectly described the offspring as *similar.*

(ii) Only the higher scoring candidates gained this mark. Some candidates used a word from the bank of words in **part (a)(i)**; others referred incorrectly to *reproduction.*

(b) (i) This was quite well answered, most candidates attempting at least one of the parts. One of the common errors was using the term *pollen,* rather than *anther/stamen.*

(ii) This was also quite well answered, some candidates incorrectly gave *D and C*, possibly because these were the parts of the flower left over from **part (b)(i)**

(c) (i) This was a very well-answered question across the ability range. The table needed to be completed correctly for two of the tubes in order for a mark to be awarded.

(ii) There were many very well argued answers to this question. No candidate missed the third mark by omitting the term *germinate* from their answer. A few candidates summarised the results without drawing conclusions.

Question 2

(a) (i) This question was not generally well answered. Many candidates gave the correct numbers in reverse order.

(ii) The higher scoring candidates generally gained marks here. Many candidates missed marks because they referred to '*elements containing only one atom',* rather than '*only one type of atom'.* Many also missed the mark awarded for referring to the *elements being bonded together,* by instead referring to '*the atoms being bonded together'.* Some candidates used their Periodic Table and referred to '*nitrogen being in the Periodic Table',* gaining credit.

(iii) This was a challenging question across the ability range. Most marks were gained for a reference to the ratio of nitrogen to oxygen as 1:1.

(iv) The higher scoring candidates gained the mark here. Many candidates used incorrect terms such as *covalent or chemical bonding or oxide.*

(b) (i) The higher scoring candidates gained marks here. Many gave the correct answer to the first part, *ionic;* fewer then went on to identify the reactants as a metal bonding with a non-metal, and instead described the reaction.

(ii) There were some good answers to this question describing the alkalinity of the solution; fewer candidates explained that the magnesium oxide had dissolved or reacted with the water. Many candidates did not show a clear understanding of the pH scale and described the solution as acidic.

Question 3

(a) This was a very well answered question across the ability range. Very few errors were seen in the unit to symbol section. A few candidates showed some confusion between units for power and work.

(b) All candidates attempted this question and many gained both marks.

(c) This was a well answered question. Many of the candidates wrote the formula clearly in the correct space and gained both marks.

(d) (i) This was less well answered. Candidates need to be aware that units are not a substitute for symbols in an equation. For example, the symbol for current is I and the unit of current is A.

(ii) Some candidates gave the formula as R X 2 = R total and this was not allowed. Some others again used the unit of resistance, Ω, instead of the correct symbol for resistance, R. A few candidates used the formula for resistances in parallel.

Question 4

(a) This was a very well answered question. Some candidates lost marks by underlining only one word instead of the specified **two** words.

(b) Candidates need to be aware of the approximate limits to human hearing, and needed to deduce that ultrasound has a higher frequency than the upper limit of human hearing. Most candidates gained the mark for *longitudinal.*

(c)(i) Most candidates gave better answers to the first part of the question; generally they found it difficult to describe the reflection from a smooth surface. Some candidates did not describe the actual scattering; instead they compared the number of rays which returned to the bat and this did not gain the mark.

(ii) Many candidates referred to the bats using how much ultrasound they received back without concluding that the more they received, the rougher the surface.

(d) Most candidates showed some good understanding of this aspect of the syllabus. However many candidates gave both *extinction* and *'loss of habitat'* and only gained one mark for the two. There were some good explanations of why flooding and soil erosion would occur.

Question 5

(a) This was a well answered question; almost all candidates showed some knowledge of water treatments. In answers referring to *chlorination,* some candidates did not gain the second mark because they used the term *germs* rather than *bacteria.* In answers referring to filtration, some candidates did not gain the second mark because they did not clearly enough explain it was solids which were removed. Instead they referred to *substances* being removed. Some candidates gave *evaporation* as a process; however their explanations of how this worked tended to refer to killing bacteria rather than removing water from the impurities.

(b) (i) This was quite well answered across the ability range. Some of the candidates who gave *red* as the colour of the sweet then missed the second mark by referring to red as *a* primary colour. Others referred to the red dye as '*not having gone up the paper much',* rather than comparing the spot to the red spot in the mixture, P.

(ii) This was very well answered across the ability range. The most common wrong answer was *yellow*.

Question 6

(a) This was quite well answered across the ability range.

(b) (i) Many candidates gained marks for stating that water turns into a gas and that heat causes evaporation; some candidates referred to particles expanding, rather than the space between particles expanding, or referred to particles becoming lighter and could not gain credit. The best candidates referred to particles getting further apart or more energetic particles escaping.

(ii) **C**andidates generally found this question challenging. Candidates who gave answers similar to '*hot water, having evaporated, leaves the cold water'* would have gained the mark if they had included the term *particles* in their answers.

(c) Most candidates attempted this question and usually gained a mark for the diagram of the particles in the solid. In the liquid diagram, candidates needed to show that the particles were touching as well as randomly arranged to gain the mark.

(d) Candidates found it difficult to explain the term efficiency. Many referred to how much energy the machine uses without commenting on the amount of energy wasted. Others referred to how quickly the machine washed clothes.

Question 7

(a) (i) This was a well answered question particularly by the higher scoring candidates.

(ii) Most candidates made quite good attempts at this question. Most candidates understood that teeth break food into smaller pieces that are digested more easily. Some candidates used the term *molecule* rather than *piece* and did not gain the mark. The best answers made references to enzymes

(b) Many candidates gained the mark for the stomach's processes; candidates need to be aware of which processes occur in the mouth and the small intestine.

Question 8

(a) (i) The higher scoring candidates gave some good answers to this question; some candidates referred to the shape with answers such as *thin* whilst others referred to used vague terms such as *bendy*; these answers were not awarded credit. A few candidates referred to the *cheapness*. Cheapness is not a chemical property.

(ii) The high scoring candidates gave some good answers to the first part of the question. Some candidates missed the mark by referring to alloys as *made from two metals*; candidates needed to specify that the metals are mixed together.

In the second part there were many allowable answers and generally candidates gave a relevant answer.

(iii) Many candidates missed copper from the products.

(b) (i) A common error was to write copper chloride without specifying that it must be in solution. Some candidates gave graphite, the description of the electrode in the stem. A few candidates referred to the power supply.

(ii) This was a challenging question for many candidates. Some candidates confused the two electrodes and referred to copper being the product at the positive electrode. Some of the candidates who correctly specified that copper would be a product at the negative electrode needed to describe clearly what they would have observed at that electrode. Some missed the mark for the product at the positive electrode by referring to *chloride*.

Question 9

(a) This was a quite well answered question, with most candidates gaining a mark for the symbol for ammeter. A common error in the symbol for fuse, was a discontinuation of the line through the rectangle. In general, the fuse was the component which gave candidates most trouble. Some simply wrote *F.*

In the symbol for the variable resistor, some candidates missed the mark by not putting an arrowhead on the diagonal.

(b) In the first part, most candidates gave the correct number of cells *3.* The position and the symbol for the voltmeter proved more challenging. Candidates need to be aware that voltmeters are attached in parallel to the component that they are measuring.

(c) (i) This question was not well answered and often candidates left it unanswered. Many candidates labelled the rays as incident and reflected, rather than the angles as asked for in the question.

(ii) Candidates found this easier and generally most attempted it. The most common wrong answers were multiples of 45 such as *90 or 135 degrees* rather than 45.

COMBINED SCIENCE

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Extended Theory

Key Messages

Colleagues should remind candidates that their knowledge and understanding may be tested in unfamiliar contexts. Practice of these types of questions would be very useful.

Candidates should be reminded to use the number of answer lines and the mark allocation to decide how much they really need to write to obtain credit. Usually, the number of answer lines is greater than required for the most concise answer which could score all of the available marks. Candidates should also be advised that it is not necessary to re-write large sections of the question in order to obtain full credit. This wastes time and candidates may find it difficult to fit their answers onto the answer lines provided. Candidates should be advised to ask themselves whether their answer contains information that is not already stated in the stem of the question.

General Comments

There were some excellent scripts from candidates who showed a sound knowledge and understanding of the syllabus, and demonstrated good examination technique.

Candidates tended to write the correct unit with numerical answers to calculations. Others should remember that the correct unit is necessary to obtain the mark. Regrettably there were many examples of candidates working through calculations correctly only to lose credit for incorrect or missing units. Care should be taken not to use units instead of symbols in the formulae of physics calculations, and the use of a mixture of words and symbols should be avoided.

As is usual in this examination, the paper contained some questions which required candidates to apply their knowledge in relatively unfamiliar contexts. Although this type of question can be challenging, it was encouraging to see most candidates making good attempts to apply their knowledge.

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

Comments on specific questions

Question 1

(a) Most candidates correctly gave circuit and electron. *Ammeter* was the most common substitution for voltmeter and watt was least well recognised.

(b) (i) It was not sufficient for candidates to state that the bulb went out '*because it is a series circuit'*. Credit was gained only if it was made clear that removal of one bulb caused a break in the circuit.

(ii) Many candidates gained credit for stating that the lights in the house could be individually switched on and off, or that if one light failed the remainder would still operate. Some answered the question in terms of the simple circuit shown in the question rather than in the context of lighting in a house. Consequently they suggested that all the lights in the house would be equally bright. This would not necessarily be true within the context of house lights.

(iii) Many candidates knew and applied the formula for calculating the combined resistance of parallel resistors. Many candidates from across the ability range carelessly wrote down $R = 1/R_1 + 1/R_2$. Although they then obtained the required numerical answer they could not be awarded full marks.

Question 2

(a) (i) Only a minority of candidates recognised that three respiration processes were shown in the diagram. In this case, all three were required for the mark.

(ii) A specific carbon compound was required and consequently answers such as *proteins* did not gain credit. The majority of candidates gave an acceptable answer to this question.

(b) Candidates were required to describe how decomposers used carbon containing compounds in dead organic material to obtain energy through respiration, and that at the end of this process, carbon dioxide is returned to the air. A common misconception was that decomposers convert organic material into bacteria and fungi. Candidates should be warned about the careless use of the term *carbon*. While this is all too often used by the media, it should not be used in Science examinations when carbon dioxide is intended.

(c) (i) The essential point to make here was that the graph shows a maximum, and many candidates successfully did this, even if they did not use the specific word *maximum*. Credit was also given for identifying the frequency of vibration at which the maximum occurs.

(ii) Higher-scoring candidates realised that this question concerned survival of the earthworms, who would be alerted by vibrations to move away from the moles. Large numbers of candidates thought that the question was about the survival of moles that could easily catch the earthworms when they emerged from the soil.

Question 3

(a) (i) Candidates generally knew how pH values related to acidity.

(ii) Most candidates correctly referred to the greater accuracy or quantitative nature of the pH meter. Credit was not gained for references to greater reliability or convenience.

(iii) This was a challenging question with an unfamiliar application of ion tests in the context of two acids. It had been hoped that candidates would be guided towards the answer by the contents of the table showing the ions present in hydrochloric and sulfuric acids. Only a very small number of the higher-scoring candidates suggested silver nitrate to show chloride. A large number of candidates simply suggested using either litmus paper or a pH meter. A few candidates showed that they had thought about the problem and realised that electrolysis would give different results for each acid. Answers involving electrolysis were accepted as an alternative to the points in the mark scheme. Other commonly seen attempts to answer the question included trying to observe bleaching by the ‘chlorine’ in hydrochloric acid, or testing for hydrogen, both of which suggest that these candidates did not appreciate that the properties of free elements are lost when combined.

(b) (i) Many gave the correct equation. Only one mark was available and consequently candidates giving a symbol equation instead of a word equation did not gain credit even if the equation was correct.

(ii) Higher-scoring candidates worked through this question successfully and gave well-reasoned answers. For the majority the question proved too challenging, and many wrote answers that were the opposite of the correct one.

Question 4

(a) Candidates generally had learned that work done = force x distance and so gained credit. Full credit was awarded when candidates remembered to convert the mass of the athlete to his weight and wrote the correct units of the answer. Correct units in this case were joules or J. Neither Nm nor j was accepted as a correct unit.

(b) This question was far simpler than many candidates realised as suggested by the short answer line and absence of working space on the paper. They needed to recall that the work done in raising the athlete would be equal to his gain in gravitational potential energy. There was no particular pattern to the variety of incorrect answers seen. Some candidates were unsuccessful in part **(a)** but carried out a correct calculation to score the mark in part **(b)**.

(c) The formula relating power to work and time was well known and many gained credit for recalling it. An error carried forward from part **(a)** was allowed, although many candidates lost a mark because of errors in stating the correct units

Question 5

(a) (i) Some candidates had learned the respiration equation perfectly. Others regrettably gave the photosynthesis equation. The question was challenging for many candidates.

(ii) A common tendency was for candidates to reword the question rather than explain why the liquid would not move. Thus the statement '*soda lime absorbs carbon dioxide'* is true but not an explanation of why the liquid does not move. Only the higher scoring candidates described why the total gas volume inside the apparatus would not change in the absence of soda lime. One mistake was to suggest that if the soda lime is absent then the seeds would not respire because the excess carbon dioxide would prevent it.

(b) (i) Candidates need to be familiar with the concept of a control experiment. A very common mistake was to suggest that a check was needed to make sure that dead seeds do not respire. Candidates needed to show that they understood the need to check that liquid movement is caused by respiration and nothing else.

(ii) Most candidates were able to state that the rate of respiration increased with temperature. Credit was available for linking temperature data from the table to the rate of respiration; it was not enough simply to quote data linking temperature to distance moved by the liquid. Many candidates referred to rate of germination rather than respiration.

(iii) The effect of high temperature on the processes in living systems is very commonly tested. Well-prepared candidates discussed the denaturation of enzymes and that there would be no liquid movement. Some candidates realised that there would be no liquid movement but lost credit by discussing the denaturation of seeds or killing of enzymes. Many candidates gave an answer based on the kinetic theory and gained no credit.

Question 6

(a) This question was generally well answered.

(b) (i) Only the highest-scoring candidates gained full credit for this ionic bonding question, although most candidates gained partial credit. Marks were very often awarded for some reference to filled outer electron shells. Even though aluminium oxide was described in the stem of the question as an ionic compound, there were not many correct references to ions or ion formation. Many candidates attempted a purely covalent model for aluminium oxide.

(ii) Most candidates had learned the essential idea of a balanced equation and very many identified oxygen as being out of balance.

(c) Some candidates gained full credit here, although many others suggested that the potassium chlorate was needed to relight the firework if it went out.

Question 7

(a) Many very good drawings of waves were seen. In order to gain full credit, candidates needed to be very careful in labelling both amplitude and wavelength. This did not mean drawing and labelling axes on the graph paper, as many did. Candidates needed to be particularly careful in labelling wavelength. Careless label lines that fell short of connecting the same point on consecutive waves were penalised. The use of the symbol λ instead of the word wavelength was not accepted.

(b) (i) Many candidates correctly stated that **A** would be louder than **B**. Candidates gained no credit for simply stating 'it is louder'.

(ii) Many candidates correctly referred to the higher pitch of **X**. A common mistake was to suggest that **X** would be *faster*.

(iii) This proved a challenging question for many candidates. The most common misconception was that the denser the medium the slower the speed of sound.

(iv) Candidates need to know the meanings of the terms *compression* and *rarefaction* in the context of sound waves. The context of the question concerned sound waves moving through air, which required explanations in terms of air particles. Some candidates drew diagrams which represented longitudinal waves schematically without reference to changes in particle spacing or pressure.

(c) The majority of candidates gained credit for knowing that energy transfers from the sun by radiation, and many of these could also link this to the lack of a medium in space.

(d) The unusual shape of the segment of optical fibre meant that only those candidates who paid close attention to the equality of angles of incidence and reflection gained full credit. Most candidates gained partial credit for a straight line pattern of totally internally reflected rays. Candidates should be advised to avoid drawing arrowheads on the ends of light rays. The acceptable location for arrows is midway along the ray.

Question 8

(a) (i) Most candidates gained some credit in this question and many had learned this part of the syllabus very well. The least well-known part of the male reproductive system was **B**, the prostate gland, which several candidates assumed to be the bladder. Regrettably, a few candidates stated the names rather than the functions of the parts.

(ii) This was well-answered by the majority.

(b) Most candidates were able to state two differences between the male and female gametes.

(c) This proved to be the most challenging part of **Question 8**. Answers often showed confusion and incorrect use of biological terms. For example, candidates needed to be clear that the virus attacks white blood cells and not antibodies. It was not then sufficient to restate the question and say that the immune system would be compromised. Full credit for this question required candidates also to show that they understood the body would not be able to fight against other infections.

Question 9

(a) (i) Many candidates produced valid structural diagrams of alkane molecules and many were able to draw the correct structures of methane and ethane.

(ii) Most candidates had learned the uses of refinery gas and gained credit for their answer. Over-generalised answers such as 'for combustion' were not credited.

(b) The majority of candidates were able to match the names with the descriptions of all three processes.

(c) (i) This proved to be a challenging question for candidates across the ability range, and only a minority gained credit. Candidates needed to recognise that decane would undergo cracking on the aluminium oxide, and that the behaviour of bromine solution indicated an unsaturated hydrocarbon. Many suggested that bromine reacted with decane.

(ii) Most candidates answered this correctly.

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Key Messages

Colleagues should remind candidates that their knowledge and understanding may be tested in unfamiliar contexts. Practice of these types of questions would be very useful.

Candidates should be reminded to use the number of answer lines and the mark allocation to decide how much they really need to write to obtain credit. Usually, the number of answer lines is greater than required for a concise answer which could score all of the available marks. Candidates should also be advised that it is not necessary to re-write large sections of the question in order to obtain full credit. Candidates should be advised to check that their answers contain information that is not already stated in the question.

Candidates should be advised that some scientific theories might be useful in more than one section of the syllabus. In this examination, ideas contained in the collision theory of reaction rate could have gained credit in a Biology question.

General Comments

There were many excellent scripts from candidates who showed a sound knowledge and understanding of the syllabus, and demonstrated good examination technique.

Candidates tended to write the correct unit with numerical answers to calculations. Others should remember that the correct unit is necessary to obtain the mark. Care should be taken not to use units instead of symbols in the formulae of physics calculations, and the use of a mixture of words and symbols should be avoided.

As is usual in this examination, the paper contained some questions which required candidates to apply their knowledge in relatively unfamiliar contexts. Although this type of question can be challenging, it was encouraging to see most candidates making good attempts to apply their knowledge.

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

Comments on specific questions

Question 1

(a) Most candidates answered this correctly. A small minority wrote the abbreviated form Hb and this was also accepted.

(b) (i) This had been very well learned by the majority. The most popular answer referred to water absorption. 'Absorption of nutrients' was not accepted.

(ii) Some well-prepared candidates gained full credit for answers involving concepts beyond the syllabus requirements. A correct reference to the relatively large surface area of the root hair cell was made by many candidates. Full credit was then gained by describing how this maximises the uptake of water or minerals. Credit was not given for references to the root hairs penetrating the soil.

(c) (i) Candidates generally recognised that the inner parts of the schematic vascular bundles should be shaded. A minority of candidates shaded everything except the vascular bundles.

(ii) The great majority correctly sequenced the dyeing of the parts of the plant.

(iii) Many higher-scoring candidates wrote excellent accounts of the mechanism of water loss from the plant. The great majority of candidates gained some credit for their knowledge of this aspect of plant biology.

Question 2

(a) Candidates generally were not distracted by the context of an unfamiliar element. There were no noticeable patterns in the wide variety of incorrect suggestions seen.

(b) (i) Higher-scoring candidates were obviously very familiar with halogen displacement and gained full credit. Some candidates attempted to provide an explanation for the observations in terms of potassium, citing it as a reactive metal.

(ii) Those candidates gaining credit in earlier parts of **Question 2** also tended to gain full credit in this part. It was clear that most candidates were familiar with the chemistry of the alkali metals, but only as far as potassium. Many did not mention rubidium. A mistake which was seen more than any other was the assumption that the change in halogen reactivity down the group matched that of the alkali metals, leading candidates to suggest the rubidium + iodine would be the most vigorous reaction.

(c) Candidates gained credit for giving the formula of potassium bromide, the formula of a bromine molecule and if all else was correct, for balancing the equation. The majority gained credit for the formula of potassium bromide but only a minority scored any of the other points. The majority missed the formula of a bromine molecule.

Question 3

(a) (i) Any valid statement which described the relative proximity of particles in a liquid and a gas gained credit. Candidates then needed to develop their answer to explain how closer particles allowed sound energy to travel more quickly. Many candidates assumed that the opposite would be true.

(ii) This was answered very well, and many candidates showed that they understood frequency and amplitude.

(iii) This question was answered far more successfully by these candidates than has been seen in previous years. The majority gained credit.

(iv) There was only a single mark for getting these two wave types the correct way round. This meant that those candidates writing the same word for both light and sound did not score. The majority, however, had learned this aspect of physics and scored the mark.

(b) (i) Candidates generally knew and could apply the relationship time = distance/speed. Of those candidates working successfully through the calculation, most wrote the correct units.

(ii) The relationship speed = frequency x wavelength was not quite as well known as the relationship in part **(i)** and this question proved challenging to lower-scoring candidates.

Question 4

(a) (i) A clear and correct definition of ecosystem was not often seen and few candidates gained full credit for their answer. It was important to include the idea of interaction between organisms and their environment. This could be done in a number of ways but was missed by most candidates from across the ability range. Candidates were clearly familiar with a range of ecological terms but their precise meanings were not so familiar.

(ii) Many candidates from across the ability range gained the mark. The usual incorrect answer of 'it shows what eats what' was much less in evidence than in previous examinations.

(iii) The third trophic level was accepted as an alternative to the expected answer of secondary consumer. This was well-answered by most candidates.

(iv) Candidates tended to gain credit for a discussion of energy losses between trophic levels, and many wrote unnecessary details explaining the ways that energy is transferred. It proved to be less easy to explain why this limited the number of trophic levels, and so only a minority gained full credit. Candidates needed to say more than the vague statement 'there will be no energy left'. They needed to relate the inability of the small amount of energy remaining after four or five trophic levels being unable to support any more.

(b) Pollination had been learned very well by these candidates and many gave enough of the many marking points to gain full credit. Most candidates gained some credit for their knowledge of this part of the syllabus.

Question 5

(a) Almost all of the candidates described how the limewater would go cloudy, but not many explained that this was caused by the formation of solid particles. The simple explanation 'because carbon dioxide is bubbled through' was not accepted since this was given in the question.

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

(ii) Candidates tended to lose credit here because they did not match their conclusions to the specified experimental data. For example, for experiments **A** and **B**, some wrote general statements about the effects of temperature, concentration and surface area. Others simply described the data. For example some wrote 'when the temperature is 35 °C it takes 18 seconds for the gas to collect, but at 25 °C it takes 36 seconds'. Candidates should be advised to check to see whether they have added any new information to that provided in the question.

For experiments **C** and **D**, they needed to formulate a conclusion in terms of either acid concentration or at least in terms of the ratio of acid to water. Many made statements such as 'the rate of reaction is greater when more acid is used'. Statements like this were not credited.

(iii) Kinetic theory of reaction rate was generally well-known and many candidates gained full credit. It was encouraging to see candidates referring to 'greater collision frequency' rather than 'more collisions'. Candidates also referred to increased kinetic energy or speed of molecules rather than the vague idea of increased vibration which is not credited.

Question 6

(a) (i) Ohm's Law was generally very well known and most candidates gained full credit for their answers.

(ii) The most common mistake made by candidates who probably understood what this question was asking, was to suggest that above 2V the current decreased. If they had used the phrase 'the rate of increase in current decreased' then they would have scored the mark. Many candidates found acceptable ways of expressing the answer.

(b) (i) Most candidates gained this mark. The most common mistake was to label the angles between the mirror and the normal.

(ii) Most candidates gained this mark.

Question 7

(a) Most candidates gained the mark for identifying the liver; a few candidates confused the function of the large intestine and the small intestine.

(b) (i) Candidates generally gained credit for discussing the fact that fatty acids are produced. It was not so common to see references to the consequent lowering of pH causing the indicator to change colour.

(ii) Most candidates gained credit for stating that the higher temperature in tube **B** would increase the rate of reaction. Reference to the fact that the temperature in tube **B** would be closer to the optimum for the enzyme was seen from many candidates and was accepted. Candidates did not tend to discuss collision theory concepts as an explanation for the experimental results. It might be worth reminding candidates that collision theory is a useful idea in Science generally and not just in the rate of reaction section of the Chemistry section of the syllabus.

(c) Candidates seemed to be very knowledgeable about the consequences of too much fat in the diet and many gained full credit.

Question 8

(a) (i) Candidates from across the ability range tended to know that methane is the main component in natural gas, although a wide range of incorrect suggestions were seen. The name methane was required and so candidates giving only the formula of methane did not score. The equation for the complete combustion of methane needed to be a word equation. An error could be carried forward from the first part provided it was a valid combustible compound, and correct products were stated.

(ii) This question was generally well-answered, and many candidates showed good knowledge of the problems associated with combustion of sulfur. The most common reasons for loss of marks were to omit any reference to the combustion process which produces sulfur dioxide, and references to the reaction of sulfur rather than sulfur dioxide leading to acid rain. Full credit was gained by a good number of candidates.

(b) Dot and cross covalent bonding diagrams are usually done well by candidates across the ability range, and these candidates were no exception. Large numbers gained full credit.

Question 9

(a) This calculation had been learned very well and many candidates gained full credit. Several candidates successfully stated the kinetic energy formula but then made arithmetic errors or mistakes in the choice of unit.

(b) Few candidates gained full credit for their response to this question. Many discussed friction but could not go on to describe the transfer of electrons from the car to the plastic surface.

(c) (i) Most candidates showed good understanding of the speed/time graph. The majority gained this mark.

(ii) The majority gained this mark.

(iii) This was very well-answered and it was encouraging to see large numbers of candidates stating the correct units of acceleration.

(iv) Credit was gained if answers showed evidence that an attempt had been made to calculate the area under the relevant parts of the graph. Large numbers of candidates had done this and many went on to gain full credit for a correct calculation and unit. Lower-scoring candidates approached the problem by trying to apply distance = speed x time.

COMBINED SCIENCE

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Extended Theory

Key messages

There were some excellent scripts from candidates who had prepared well for this examination. They showed a sound knowledge and understanding of the syllabus, and demonstrated good examination technique.

Candidates generally used the space provided wisely. It would be useful for candidates to remember that it is not necessary to repeat the question as part of their answer.

Many candidates provided good diagrams to illustrate chemical structures. When diagrams are included they do need to be as accurate as possible even though there may not be time for excessive neatness.

General comments

Most candidates usually provided the correct unit for physics calculations. Others should remember that the correct unit is necessary to obtain the mark. Care should be taken not to use units instead of symbols in the formulae of physics calculations.

In questions requiring the interpretation of a graph most candidates correctly took numerical information from the graph to illustrate their responses. Others would find it useful to quote meaningful information from the graph in their responses.

It is recommended that this report is read in conjunction with the Mark Scheme.

Comments on specific questions

Question 1

(a) (i) Candidates were required to describe diploid cells as those with two sets of chromosomes. Responses which were simply a rewording of the stem, for example *'Diploid cells are what result from the joining of haploid nucle*i', did not gain credit.

(ii) The correct answer, fertilisation, was given by the better scoring candidates. Incorrect answers included 'reproduction' and 'pollination'

(b) (i) The majority scored well in this straightforward question.

(ii) Responses to this question needed descriptions of the adaptations of the flower for insect pollination. Examples of these adaptations are the presence of petals, and the presence of anthers and stigma positioned inside them. Credit was also given for stating that wind-pollinated features are absent. An example of this is *'anthers do not hang out of the flower'*.

(c) The majority of candidates interpreted the results correctly to obtain full marks. Candidates should be reminded that simply describing the results without drawing a conclusion is not enough for credit. In addition to water and oxygen being needed for germination the evidence showed that light is not necessary, and this had to be stated in the answer.

Question 2

(a) Most candidates correctly showed the separated ions in a random formation. Joined pairs of ions were frequently shown in the solution which suggested that candidates understood a general particle explanation of the process of dissolving. Some candidates drew the lattice unchanged at the bottom of the beaker.

(b) This was well answered by the higher scoring candidates who correctly stated that the loss of electrons led to a greater number of protons than electrons, leading to the relevant positive charge. Most candidates obtained some credit for mentioning that sodium has one outer shell electron to lose, and calcium has two.

(c) Many candidates achieved full marks for this question. It was important that explanation included the need for charge balance in the formula. Explanations such as 'I did it by the swap and drop method' were not credited. Several candidates did not try to balance the charges and suggested that the formula should be $NaCO_3^-$.

Question 3

(a) The majority of candidates responded correctly. Incorrect responses included 'stationary' for the first graph and 'constant speed' for the second graph.

(b) (i) Many candidates scored well in this question which involved using two formulae. A few candidates failed to add the correct unit to the answer, so lost this mark.

(ii) The answer from part **(b)(i)** was used to calculate the power. An error carried forward was allowed if necessary. A significant number of candidates incorrectly attempted an efficiency calculation.

(c) The majority of candidates could apply the formula for acceleration correctly. Candidates should be reminded that the correct unit for acceleration is m/s^2 and not m/s.

Question 4

(a) (i) Any number above 20 000Hz was acceptable. Candidates were required to include the correct unit in their answer.

(ii) Many candidates scored well in this question, correctly identifying ultrasound as a longitudinal wave.

(b) (i) The preference shown by bats for drinking attempts from the smooth surfaces was correctly identified by the majority of candidates. Numbers taken from the graph to illustrate this point enabled candidates to obtain further credit.

(ii) Many candidates made correct comparisons between the nature of reflection of the waves from each surface, and the number of waves returning to the bat from each type of surface.

(c) Many candidates scored quite well in this question, explaining that the immediate consequence of the influx of nitrates and phosphates is an increase in growth of algae. The subsequent blocking of light for plants deeper in the water, with the effect on photosynthesis and their ability to survive was also correctly explained by many candidates. Fewer responses included the death of these plants and the role of bacteria in breaking down the dead plants, using the oxygen in the river for their respiration. A large number of candidates attributed the reduction in oxygen to the algal growth.

Question 5

(a) Some candidates answered this question well, attributing the difference in size of the atoms to the reduction of malleability when the copper and zinc are alloyed in brass. There were many incorrect answers, including diagrams of crystalline lattices of atoms of the same size and bonding diagrams, both ionic and covalent, between copper and zinc.

(b) The equation was correctly written by the higher scoring candidates. The most frequent cause of lost marks was giving Cu_2 instead of 2Cu on the product side.

(c) (i) This question was well answered by most of the candidates who identified the need for the cathode to be negative in order to attract the positive copper ions. Some candidates suggested that the cathode needed to be made of steel so that the copper layer would be visible.

(ii) Many candidates correctly responded to this question in terms of the copper ions gaining electrons to become neutral copper atoms. If candidates had developed this further to include the chemical bonding of the copper metal to the steel spoon further credit would have been obtained.

Question 6

(a) Generally well answered by most candidates.

(b) (i) The best candidates correctly described evaporation as the escape from the surface of the liquid of those particles possessing greater kinetic energy. Candidates should be reminded to state that the particles have a range of kinetic energy values, and only those with sufficient energy are able to leave the surface.

(ii) The best candidates correctly stated that the loss of the more energetic particles from the water causes the average energy of the remainder of the particles to decrease.

(iii) Many candidates across the range scored well, identifying that heat energy is passed through the metal by conduction. Candidates who then described the increased vibrations of particles near the heat source being passed from particle to particle gained further credit. Incorrect responses included reference to the metal conducting electricity and heat resulting from the resistance of the wire.

(c) Some candidates completed the diagrams of the particle arrangements of a solid and liquid correctly. Candidates should be reminded that the particles they add to the diagrams should be the same size as those already given in the diagrams. All the particles in the solid should be touching their neighbours and be shown in a regular arrangement. In the liquid, most particles should be touching although the arrangement should be random. Many diagrams had spaces between the particles of the solid, and some of the diagrams of the liquid showed the particles widely separated.

(d) The key idea needed for a correct response was a comparison of the useful energy given out compared with the total energy input. Many candidates successfully described this in a variety of ways.

Question 7

(a) (i) Generally well answered. Either 'incisor' or 'canine' were acceptable for A.

(ii) The majority of candidates correctly mentioned the role of molars in grinding or crushing the food. *'Breaking the food into smaller pieces'* was also acceptable for this mark, but *'breaks the food down'* was not credited, since it was not clear whether mechanical or chemical digestion was being described. Those candidates who then explained that the resulting increased surface area of the food provided better access for enzymes gained further credit. Common answers not accepted were *'It makes the food easier to swallow'* or *'It makes the food easier to digest'*.

(b) (i) Generally well answered; the mouth being the most popular choice of location.

(ii) Generally well answered; the small intestine being the most frequent choice.

(c) The majority of candidates correctly identified pH 7 as the optimum. Fewer candidates correctly explained the difference in reactivity between pH 5 and pH 7. Denaturation was mentioned by some candidates but very few explained that the shape of the active site changes, therefore preventing the substrate from fitting into it. Some candidates incorrectly described the difference in reactivity in terms of collision frequency. Others had interpreted the graph as a change in reactivity of a single test as pH is increased, rather that numerous separate tests at the different pH values.

Question 8

(a) (i) Generally well answered by most candidates. The most frequent incorrect answer showed an atom with 12 neutrons. Both the contents of the nucleus and the correct electron shells had to be labelled to obtain full credit.

(ii) This section was well answered by the majority of candidates. The most common mistake was the suggestion that **P** and **Q** showed compounds.

(b) (i) Many candidates obtained the mark here. Indication of change of state being a physical change was needed to score, so references to just heating and cooling were not enough. Reference to no new products being produced was also credited.

(ii) Many candidates correctly stated that gasoline has larger molecules than refinery gas. Those who expanded their response to include stronger bonds between molecules that would take more energy to separate scored full credit. Candidates should be reminded that explanations must make clear that they are referring to the bonds between molecules and not within molecules. Statements such as 'Gasoline has stronger bonds than refinery gas' do not make this clear.

(c) Most candidates correctly stated that burning gasoline produces carbon dioxide, but did not develop the point to address the question and indicate the contribution of carbon dioxide to global warming. The burning of hydrogen to produce water was mentioned by several candidates but others lost marks by not mentioning the product, merely stating that hydrogen burns cleanly, or without pollution.

Question 9

(a) (i) Generally well answered by the majority of candidates who correctly stated there were three cells.

(ii) Most candidates correctly placed the voltmeter in parallel across the bulb. The most common mistake was to place the voltmeter in series in the circuit.

(iii) The ohm's law calculation was done well by many candidates. Marks were lost due to using the incorrect formula, for example R = I x V, or for using units in the formula, as in R = V/A. It should be emphasised to candidates that it is essential to include units where required in numerical answers. In this case both ohms and Ω are acceptable.

(b) (i) This question was generally well answered. The two most common wrong answers were labelling the incident and reflected rays instead of the angles as requested, or labelling the angles between the mirror and the rays.

(ii) The correct answer of 45° was given by the majority of candidates.

COMBINED SCIENCE

Paper 0653/04
Coursework

(a) Nature of tasks set by Centres.

No Centres submitted component 04 coursework for November 2012.

(b) Teacher's application of assessment criteria.

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

(d) Good practice.

COMBINED SCIENCE

Paper 0653/51

Practical Test

Key message

When finding the gradient of a straight line graph candidates should use as big a triangle as possible to optimise accuracy.

General comments

Candidates organised themselves to complete this paper in the time available and the majority of candidates carried out the practical work well.

Comments on specific questions

Question 1

In part **(a)** where the seeds had been prepared according to the Confidential Instructions, most candidates gained credit.

Most candidates were able to gain some credit in part **(b)**. Some candidates responses were vague stating 'that water was helpful rather than necessary' so could not be credited.

In part **(c)** many candidates obtained a positive test for the radicle with Benedict's, with the most common colour being green. Fewer candidates obtained a positive test for the seed with iodine solution; in many cases dark brown was recorded instead of the expected blue / black. This obviously had an effect on a candidate's ability to answer part **(d)**. Some candidates did not make it clear which part of the germinating seeds they were referring to because they simply referred to **R1**, **R2**, **S1** and **S2**.

Question 2

The experiment was usually carried out well and consequently useful sets of results were obtained. Consequently full credit was often awarded for part **(a)**.

In part **(b)(i)** candidates were expected to calculate $1/m$ and round the answer appropriately. For this reason 0.016, 0.0142 and 0.012 were not creditworthy. A significant number of candidates recorded 1/60 as 0.016 recurring, which also was not credited, however most of these candidates went on to plot this as 0.016.

Candidates needed to take more care in drawing the graph in part **(b)(ii)**. Common errors were not giving the units with the label for the vertical axis; poor plotting of the points caused by difficulties in reading the horizontal scale; not drawing a straight line as instructed; and not drawing the best straight line. For a best fit straight line there should be a fairly equal spread of points above and below the line unless they all happen to lie on the line. It is still acceptable to ignore points that are clearly anomalous when drawing the best fit line.

Finding the gradient in part **(b)(iii)**, candidates had to use a triangle with a vertical distance of at least 4 cm (or a distance representing a change in d of at least 10 cm). Candidates should be encouraged to use large triangles when finding gradients. The most common mistake was not reading the coordinates correctly; very few candidates inverted the expression to calculate the gradient. A number of candidates incorrectly used the data from the table to calculate the gradient.

Part **(b)(iv)** was well done despite some incorrect gradients resulting in values for the mass of the rule close to 300 g.

Question 3

A large variation in the volumes of unused soil washings was seen, reflecting the difficulty of carrying out a titration with a dropping pipette. Despite this, many candidates were able to obtain two readings within 0.4 cm^3. Candidates should be reminded that when recording values to 1 decimal place 3 cm^3 should be recorded as 3.0 cm^3.

Those candidates who used all 10 cm^3 of soil washings each time, when no such problem was reported by the Supervisor, were unable to gain full credit in parts **(a)(i)** and **(ii)**.

Parts **(a)(iii)** and **(iv)** did not cause any difficulties for the majority of the candidates.

Most candidates were able to perform the calculation in part **(a)(v)**. Poor rearrangement of the equation was the most common mistake however inappropriate rounding of the answer was rarely seen.

Part **(b)** gave fairly consistent results provided the instructions had been followed carefully. Allowances were made for unusual colours when these were also recorded by the Supervisor.

COMBINED SCIENCE

Paper 0653/52

Practical Test

Key message

If an extended line of a graph goes off the grid for a required intercept, it is important to extend the relevant axis or grid line accurately and to measure the extension of the axis or grid line carefully to work out the value of the intercept.

General comments

Candidates were able to complete this paper in the time available and very few misunderstood the practical instructions.

Comments on specific questions

Question 1

Most candidates described bubbles or the absence of bubbles in part **(a)(i)** but, whereas the leaves in dish **A** usually behaved as expected, a wide variety of observations were seen for the monocotyledonous leaves in dish **B**.

Many candidates were able to relate carbon dioxide to the air in the leaves. Fewer could name the structures in part **(a)(iii)** which then affected their ability to fain further credit.

Part **(a)(iv)** depended on the candidate having a sensible set of results and knowing the structures in the surface of the leaf. Some candidates were not specific enough and simply referred to cuticles.

Generally there was a better understanding of loss of water in part **(a)(v)** although exposure to sun or heat was not always mentioned.

Part **(b)** was generally well answered. Common mistakes were to describe features that are invisible or features that have nothing to do with photosynthesis. Some candidates identified the correct features but did not explain how they help the leaf to photosynthesise efficiently so were unable to be awarded full credit.

Question 2

This experiment can be tricky to carry out well because of the friction between the thread and the rods. Despite this many candidates obtained good sets of results. Many candidates gained credit in parts **(a)(i)** and **(a)(ii)** and very few candidates read the scale with the higher numbers on the protractor.

A number of candidates recorded angles which only corresponded to angles in Table 2.2 rather than actual angles shown on the protractor. This may have been coincidence, misunderstanding or rounding angles up or down for the convenience of working out sine values. In most cases the sine value were worked out correctly. A number of candidates rounded sine values inappropriately whilst others worked out the sine values of mass *m* by mistake.

The graph in part **(b)(i)** was often well plotted. Candidates were awarded credit for a best-fit line through the origin. The origin is considered to be the most accurate point in this experiment.

In part **(b)(ii)** the candidate had to extend the line and read the value of mass *m* which corresponded with the sine θ value of 1.0 to within half a small square on the grid. This was done quite well but many candidates had to extend their line off the grid and this was generally carried out poorly. If an extended line of a graph went off the grid, it was important to extend the relevant grid line (sine θ value of 1.0 in this case) accurately to meet the line and to measure the extension of the grid line carefully to work out the value of the mass *m*.

Question 3

The 'pop' or 'explosion' was nearly always recorded in part **(a)(i)**. The presence of bubbles did not always accompany this observation and 'colourless solution' was rarely recorded, emphasising the need to record all observations to gain full credit.

Many candidates gave 'hydrogen' as the answer to **(a)(ii)** assuming that the identification of the gas would come next without reading the question. Those who did try to identify **A** often gave (incorrectly) Group 1 metals or unreactive metals such as copper.

Part **(b)** did not cause any problems but the reduction of **B** using **A** in part **(c)** varied in how far the reaction proceeded, depending on how much **A** was added.

A variety of colours was accepted for part **(c)(i)** but wrongly coloured precipitates were not credited. For most candidates enough reaction had taken place in **(c)(i)** to give a green precipitate (although grey or black was credited) in **(c)(ii)** due to the presence of iron(II).

For part **(c)(iii)** if a green precipitate was recorded most candidates went on to gain credit for writing iron(II). 'Iron' on its own was not awarded credit.

Part **(d)** did not cause any problems and was well answered. It was pleasing to see many more answers using the phrase 'white ppt' rather than 'milky' or 'cloudy'.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key Message

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

General comments

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

Comments on specific questions

Question 1

This question investigated some of the conditions required for seed germination.

(a) For full credit candidates had to notice that one seed had not geminated in dish **B**.

(b) Some candidates did not use the results from part **(a)** and were unable to be awarded full credit.

(c) Only a few candidates appreciated that with biological samples individual variation can occur and that some seeds could be dead or damaged. Answers with just 'get an average' were not creditworthy.

(d) Many candidates gave 'moisture', which was not credited as it was in the question. Answers such as temperature, concentration of oxygen and pH gained credit.

(e) Knowledge of the starch test, with iodine and the Benedict's test for reducing sugar were required for this part. Many candidates were unable to do this.

(f) The expected answer was amylase although the enzymes carbohydrase and diastase were credited.

Question 2

In this question candidates are using moments to calculate the mass of a metre rule.

(a) Many candidates did not read the question properly and tried to find *d* straight away. This and the fact that many candidates read the scales incorrectly meant that few candidates gained full credit. As candidates were instructed to record their values to three decimal places, other values were not credited.

(b) Most candidates plotted their points accurately and draw good straight lines. Some candidates plotted their incorrect readings from part **(a)** and joined the points with straight lines from point to point making it look like a mountain range. Candidates are instructed to show clearly on the graph how they obtained the values that they used when finding a gradient - a tiny pencil dot or two is not 'clearly'. Examiners are expecting a triangle below the line showing the horizontal and vertical values chosen.

(c) A correct calculation using the candidates own value for the gradient was credited. A value in the region of 110 g was expected.

Question 3

The pretext of a farmer's crop being poor was just a setting for some neutralisation experiments.

(a) Examiners were expecting references to the same mass of soil or the same volume of water used, instead candidates tended to discuss practical details picked out from information already given in the question for instance the fact they were all washed or all filtered, and were not credited.

(b) The expected answer, blue to red, was often reversed.

(c) A significant number of candidates were unable to read off the values from the measuring cylinders. Large number of candidates were unable to calculate the volumes used in the experiment, i.e. subtracting their value from 10. A number of candidates were unable to calculate the average.

(d) This was done reasonably well by those candidates who had followed the instructions to part **(c)** correctly.

(e) Few candidates realised that the ions form insoluble hydroxides in alkaline solution.

Question 4

Transpiration rates from upper and lower surfaces of leaves were investigated in this question.

(a) Few candidates followed the instruction to take the reading from the **left hand side** of the bubble. Candidates should be encouraged to check their calculations and appreciate that the average distance moved per minute must be in the range of the individual distances moved.

(b) A correct calculation using their average value was fully credited. When correctly calculated, candidates should have found that 75% of the water loss was from the lower surface. A method to confirm that the other 25% was lost from the upper surface would be to repeat the experiment with the lower surfaces of the leaves covered with grease.

(c) The majority of candidates gained partial credit. Suggestions such as temperature, air speed (wind), humidity or light were all seen and credited.

(d) Only a few candidates were able explain that the reason the leafy shoot was cut under water before putting in the apparatus, was to prevent air bubbles entering the shoot. For part **(ii)** many answers were too vague, creditworthy answers included it is used in photosynthesis; used to maintain cell turgor or some was produced by respiration.

Question 5

A candidate was given five solutions of sodium compounds and by using four tests was able to identify them. This question was set showing the candidates plan with some answers missing.

(a) Almost all candidates gained full credit for knowing that Universal Indicator turns green in a neutral solution and a purple / blue colour in alkaline solution.

(b) The sodium sulfate solution could be identified as on addition of aqueous barium chloride to one of the neutral solutions, a white precipitate was formed.

(c) The two remaining neutral solutions were tested with aqueous silver nitrate, the one forming a white precipitate was the chloride and the one without the precipitate was the nitrate.

(d) This part identified the hydroxide and carbonate. As dilute hydrochloride was added, the litmus in both solutions turned red, but the carbonate would also produce bubbles.

(e) Candidates had to name the precipitate formed in test two: barium sulfate, and explain what a precipitate was. There are many ways of defining a precipitate; the Examiners credited the idea that a solid was being formed in or from a solution. An answer of 'an insoluble solid' was also creditworthy.

Question 6

This question covered some aspects of electricity using a 240 V filament lamp.

(a) Most candidates were able to complete the energy change from electrical energy to heat and light. Fewer could name the gas inside the lamp that prevents the filament burning out, with a significant number of candidates incorrectly naming 'oxygen'. Any of the inert gases were credited or the group name.

(b) This part was omitted by a number of candidates. It may have been that candidates did not 'see' the mark allocation.

(c) Most candidates read the dials correctly and completed the table. However some candidates read 0.6 as 0.52 and 12 as 10.2. Candidates need to be reminded to carefully check dial scales.

(d) The calculation caused few problems.

(e) Few candidates realised it was the large amount of heat energy wasted by this type of bulb and that this requires an increase in electricity generated (often by the combustion of fossil fuels), that contributes to global warming.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key Message

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

General comments

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

Comments on specific questions

Question 1

This question compared transpiration rates from both surfaces of a holly leaf and a grass leaf.

(a) While the majority of candidates followed the instructions there was a significant number who did not measure just the leaf or did not have a ruler. The most able candidates correctly calculated the magnification.

For part **(ii)** many candidates said the holly leaf was larger despite being asked for differences other than size and so were unable to gain credit. A number of candidates stated one (leaf) was a monocotyledon and the other a dicotyledon; this was not awarded credit as this is not a **visible difference**.

(b) For part **(i)** an answer of 'carbon dioxide present' gained credit, but a significant number of candidates mentioned of oxygen, so were unable to be awarded any credit.

Many candidates did not mention stomata and few had any idea of why there are more on the lower surface than the upper. Candidates then needed to relate the structure of the leaf to their function using the information given, but only the most able candidates gained credit for their answers.

In part **(iv)** candidates were asked to compare the results of the two leaves and suggest a reason for this, again only the most able candidates gave creditworthy answers.

Question 2

In this question candidates investigated forces acting at various angles.

(a) Most candidates were able to read the angles correctly, but were then unable to convert this to a sine value, despite the values being presented in the table.

(b) Candidates had to plot a graph of the sine value against mass, five points. However a number of candidates plotted the values from an incorrect table (and thus plotted many more points which produced a curve). Candidates should check that they following the instructions. The best straight line had to be drawn, extended to the value of sine =1.0. Most candidates suggested friction for part **(iii)** gaining credit.

(c) Candidates were asked to suggest how the results would be different if the experiment was carried out on the moon. Only the most able candidates realised that there would be no difference to the results as the reduced force of gravity still exerts an equal force on all the masses.

Question 3

In the practical examination, solid **A** and solution **B** were analysed. The same tests are used in this question. Candidates must complete the descriptions of the test, results and conclusions. Candidates should be able to recall the standard tests for cations and anions and be able to deduce the composition of a mixture of ions using these logical steps.

Generally candidates who had experience of these analytical tests scored well, but a significant number gained little or no credit.

(a) When a metal reacts with a dilute acid effervescence occurs and the gas evolved, hydrogen pops with a lighted splint.

(b) The cation in solution **B** is iron(III), therefore on addition of aqueous sodium hydroxide a red / brown precipitate should be formed.

(c) The addition of metal **A** to solution **B** changed the iron(III) to iron(II), therefore a green precipitate of iron(II) hydroxide is formed.

(d) A chloride is detected by the use of silver nitrate in the presence of nitric acid, a white precipitate being produced.

(e) The metal in solid **A** could be magnesium or zinc.

(f) The formula of the compound in solution **B** is $FeCl_3$.

Question 4

This question was about the amount of reducing sugar in different flowers.

(a) Candidates were shown diagrams of four flowers and a colour chart to show the relative concentration of reducing sugar shown by the Benedict's test. For both parts candidates were able to gain credit for clearly expressing their ideas.

(b) Practical knowledge of the Benedict's was required to answer part **(i)**. Few candidates answered this well. Three steps were required, firstly the grinding up of the flower sample in a solvent, secondly separation by filtering or decanting before finally heating with the Benedict's solution.

For part **(ii)** only a few candidates gave two things that should be done to ensure a fair comparison and gained full credit. Some made references to the volume of Benedict's solution without stating it should be the same volume used each time.

Candidates were then given a results table showing the colour of the Benedict's solution for each of the four flowers and had to list the flowers in order of increasing amount of reducing sugar. Some candidates put two letters on one line and others listed colours rather than flowers.

(c) Candidates were shown diagrams of pollen grains under the microscope. A significant number of candidates were unable to answer this 'comparative' question.

Question 5

This question examined the effect that changing the temperature had on the rate of reaction between marble chips and dilute hydrochloric acid.

(a) Candidates had to count the number of marks made, representing bubbles seen, at various temperatures. A significant number of candidates were unable to count the number correctly.

(b) The graph was usually plotted correctly, but some candidates did not label the axes or state the units used and thus unable to gain full credit.

(c) Although many candidates realised that the rate of reaction would increase further if a higher temperature was used few suggested why this would prove difficult in this experiment.

For part **(ii)** Examiners awarded credit for comments such as 'the particles gain more energy' or 'move faster resulting in more frequent collisions'.

(d) Candidates were asked to construct a word equation for the reaction between carbon dioxide and limewater. Some tried to write a symbol equation. Few candidates knew the chemical name for limewater or that calcium carbonate was formed. Fewer still could say that the limewater turned milky due to insolubility of calcium carbonate.

Question 6

This question concerned the density of ice.

(a) Candidates were instructed to read the balance with the four ice cubes in the beaker. Some candidates did not read the question carefully and thought the balance reading was the mass of the ice alone, others had difficulty in reading the balance.

(b) The same four pieces of ice were placed in 50 cm^3 hexane in a measuring cylinder. This time candidates had to read the volume and calculate the volume of the ice. Even with a diagram of the ice and hexane in the cylinder some candidates again confused what had to be taken from what. Many candidates have trouble reading scales and a number read the scale as 90.5 instead of 91, despite being instructed to record the value to the nearest 1 cm^3.

(c) The density of the ice had to be calculated using the candidates' values of mass and volume. A correct calculation was awarded full credit. Partial credit was awarded if the correct values were used but the answer incorrect. Where a candidate divided volume by mass no credit was given.

(d) Candidates had to deduce two properties of hexane from the information provided in the question. Prior knowledge of hexane was not required to state that it is not as dense as ice, it has a melting / freezing point of less than –5 °C and it does not react or dissolve ice.

(e) Finally the properties of ice were linked to polar bears. For both parts, candidates the answers could be expressed in many ways, but a two part answer was expected. For example for part **(i)** the ice floats, so the animals have a dry habitat to live in and for part **(ii)** the ice will melt, destroying the habitat of the bears were creditworthy.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key Message

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

General comments

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

Comments on specific questions

Question 1

This was an investigation into water loss from a plant shoot.

(a) Experimental details of how the apparatus was set up were supplied. Candidates gained full credit for stating this was to allow the plant to settle or adjust to the conditions.

(b)(c) Candidates had to read off the position of the bubbles on scales and complete the table by calculating the distance moved and the average distance moved. The majority of candidates gained credit for these parts.

(d) The majority of candidates stated that the results showed that an increase in air movement brought about an increased water loss gaining credit.

(e) Candidates named a condition that needed to be kept constant during the experiment; any one of temperature, light intensity, humidity, air pressure and the plant was creditworthy.

(f) Most candidates knew the possibility of getting an anomalous result is lessened by conducting the experiment three times, or reliability is improved.

(g) Finally candidates were asked to suggest why the amount of water taken up by the shoot may not be exactly equal to the amount lost by transpiration. Many answers was too vague, creditworthy answers included it is used in photosynthesis; used to maintain cell turgor or some was produced by respiration.

Question 2

In this question, candidates were experimenting with samples of aluminium of different thickness.

(a) Candidates were told that aluminium is used to make containers for cooking food and to name two properties that made aluminium suitable for this use. The ability to conduct electricity or its low density are not creditworthy properties in this context.

(b) The ability to conduct electricity, however, can be used to prove that aluminium is a metal.

(c) Many candidates find drawing diagrams difficult. Perfection was not expected but a reasonable attempt was required to gain credit. Some candidates drew a test-tube and collected the gas by downward delivery; others had delivery tubes passing through the side of the trough.

Most candidates correctly read the values of the two measuring cylinders for part **(ii)**.

(d) A graph was provided that linked the volume of hydrogen evolved to the thickness of the foil. The first piece of aluminium foil evolved 20 cm^3 gas, which converted to a thickness of 0.06 mm. Candidates were instructed to do the same for the two other pieces of foil with many gaining full credit, however some did not follow the pattern shown, and were unable to be awarded credit.

Question 3

A trolley system was used to investigate the relationship between mass and time.

(a) Candidates named of a metal or plastic that could be used to make the trolley, with many gaining credit for aluminium or a plastic such as polystyrene.

(b) Two timers had to be read and the values entered in a table, only a few candidates were not awarded credit.

(c) Most candidates correctly plotted the points but a significant number did not label the axes or indicate the units used. Despite the instruction to draw a smooth curve a number tried to draw a straight line of best fit. Candidates were told that the curve would not pass (0,0) and many realised that the trolley or mass would still take time to travel the metre even if the mass was zero. This idea was explained in a number of creditworthy ways.

(d) Many candidates did not draw a curve which would be obtained if the mass of the weight was increased. A line drawn below the original line gained credit.

(e) Most candidates stated that the force was gravity and went on to explain that gravity acts on the weight. Where a candidate had answered 'tension in the string' for part **(i)** an answer of 'gravity acts on the weight so that the string pulls the trolley' was credited for part **(ii)**.

Question 4

This experiment studied the effect of pH on protease activity.

(a) The majority of candidates answered this correctly.

(b) Part **(i)** was carried out well by most candidates. A few did not measure accurately or did not use millimetres. Most candidates graphs were well drawn, however some did not label the axes and a number of curves were not smooth. The optimum pH value should be somewhere between 8.2 and 8.8. Most candidates thought that the point at 8.5 would be the maximum and were awarded credit.

For part **(iv)** candidates who suggested taking readings closer together, especially in the range pH 8 to 9 gained credit. Repeating the experiment at 0.5 pH intervals will not produce a more accurate value and so was not awarded credit.

(c) The protease enzyme is found in the small intestine, any reference to the stomach was not creditworthy.

Question 5

Five solutions had to be identified. The chemicals were known, but not which one was which. The question followed a candidates' notebook plan to identify them. Candidates should be able to recall the tests given in the syllabus for cations, anions and gases and use them to deduce the composition solutions.

Only the most able candidates gained credit for this question.

(a) By looking at the candidates plan the candidate should deduce that litmus turns red or pink if the solution was an acid, and blue if alkaline.

(b) For test 2 aqueous barium chloride was added to the three acids. Only the sulfuric acid produced a white precipitate.

(c) Test 3 used silver nitrate to distinguish between hydrochloric acid (white precipitate) and nitric acid.

(d) Test 4 used aqueous copper sulfate to distinguish between aqueous sodium hydroxide and aqueous ammonia. They both produce a blue precipitate which dissolves in excess to produce a dark blue solution with ammonia.

(e) Only the most able candidates were able to put together a plan to find which of hydrochloric acid and nitric acid was the more concentrated. Candidates need to be reminded that litmus is a qualitative indicator not a quantitative one and therefore cannot be used in isolation.

Question 6

A long shallow tank of water was used to investigate some properties of waves.

(a) Many candidates correctly calculated the wavelength, velocity and frequency of the waves by following the procedure. Candidates should be reminded that a mathematical error is only penalised once when an incorrect value is then used correctly in further calculations. However the Examiners were unable to work out how candidates arrived at some figures and so were unable to award credit.

(b) Few candidates realised that the waves would reflect in a similar manner to light with the reflected rays now parallel to the sides of the tank. Some had waves refracted behind the barrier.

(c) Most candidates knew the waves were transverse waves gaining credit.