COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

General comments

Candidates must ensure that they read question stems carefully and consider all detractors before choosing their answers.

Comments on Specific Questions

Biology

Question 2

Candidates should be aware that diffusion occurs down a concentration gradient.

Question 3

Careful reading would have enabled a greater proportion of the candidates to realise that statement 1 was in fact incorrect; the activity of enzymes does not always increase at a higher temperature as above a certain temperature the enzyme is destroyed.

Question 4

The question states that the leaf has been in the dark for 48 hours; many candidates answered as if the leaf had been left in the light for 48 hours.

Question 6

That water enters a plant as a liquid and leaves as a vapour was well known by most candidates.

Question 8

Candidates were required to appreciate that exercise increases both the rate and depth of breathing, Many candidates selected the graph that showed an increase in rate but not in depth of breathing.

Question 10

Candidates should appreciate that a plumule grows away from gravity.

Chemistry

Question 15

Many candidates chose an option that included the arrangement of laboratory apparatus for simple distillation rather than for fractional distillation as stated in the stem.

Question 18

A significant minority of candidates chose the only option that contains no products of combustion.

Question 19

This was the best-known of the Chemistry questions. Candidates had no difficulty in deriving the formula of phosphoric acid from the information supplied.

Question 23

This was the Chemistry question that the candidates found the most difficult. Candidates are expected to know how metal salts can be produced by acid/base reactions, and that copper, being relatively unreactive, will not react with dilute acids.

Physics

Question 28

The question asked about the speed; the information was given in the form of a distance / time graph. Many candidates chose the option describing changes in distance rather than speed. Candidates should be aware that speed is the gradient of a distance / time graph.

Question 30

Most candidates answered this correctly. However, a few candidates did not realise that decreased power is indicated by doing less work in the same amount of time. It is possible that some of these candidates believed that the response in each of the two columns must be different, and they should be warned that this is not necessarily the case.

Question 32

Many candidates believed that the contents of the sealed container would be entirely liquid after several hours, not appreciating that there would also be vapour in the space above the liquid, even though the temperature was below the boiling point of the liquid.

Question 34

The selection of relevant information is sometimes required to derive the correct answer. The majority of candidates realised that all that was needed here was the distance travelled by the wave in one second.

Question 36

This was a recall question on syllabus examples of the use of electromagnetic waves, and the commonest mistake was to opt for distractor C, incorrectly linking satellite-to-Earth communication to radio waves.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

General comments

Candidates must ensure that they read question stems carefully and consider all detractors before choosing their answers.

Comments on Specific Questions

Biology

Question 6

Candidates should know that atria beat together, and ventricles beat together but differently to the atria.. A significant number of candidates selected the option where atria and ventricles beat simultaneously.

Question 7

This question was very well answered.

Question 11

This question was also very well answered. Candidates are clearly aware of the methods of transmission of HIV.

Question 13

Candidates demonstrated a sound grasp of the terms *producer* and *consumer*.

Chemistry

Candidates generally performed very well on the Chemistry questions in this paper.

Question 14

Many candidates chose an option that included the arrangement of laboratory apparatus for simple distillation rather than for fractional distillation as stated in the stem.

Question 15

Candidates demonstrated a good knowledge of atomic structure, and in particular, nuclear structure.

Question 18

Candidates were easily able to determine molecular formula from information provided.

Question 19

Candidates understand the information implied within a molecular formula.

Question 22,

Candidates are aware of the factors affecting reaction rates.

Question 24,

The relative reactivities of metals is well known and understood.

Question 25,

The identities and electrical conductivities of metals and non-metals are well-known.

Question 26,

The composition of air is well known by candidates.

Physics

Question 28

Although this question on speed/time graphs was well answered, a common mistake was to believe that a horizontal line (i.e. constant speed) always means that the bus is stationary

Question 33

A large proportion of candidates chose distractor B here, not appreciating that convection would only carry thermal energy upwards.

Question 36

This was a recall question on syllabus examples of the use of electromagnetic waves. Candidates found this question challenging. Candidates should be reminded that sometimes the correct response is the same in both columns of a table.

Question 39

Candidates need to be able to recognise the electrical symbol for a fuse.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

General comments

Candidates must ensure that they read question stems carefully and consider all detractors before choosing their answers.

Biology

Question 1

Most candidates were able to recognise that photosynthesis was not a characteristic of all living things, limiting their choices to the key and one distractor.

Question 3

The question states that the leaf has been in the dark for 48 hours; many candidates answered as if the leaf had been left in the light for 48 hours.

Question 5

Candidates were required to appreciate that exercise increases both the rate and depth of breathing. Many candidates selected the graph that showed an increase in rate but not in depth of breathing.

Question 9

Candidates readily linked thunder and lightning with an increased adrenaline flow.

Question 10

Candidates need to be able to identify and state the function of the sepals.

Question 11

Some of the candidates who appreciated the effect of gravity on the growth of the plumule did not realise that the growth curvature already present in the seedling would remain when the seedling reacts to changed conditions.

Chemistry

Question 14,

Some candidates may have been confused between the terms *compound* and *molecule*.

Question 15

Candidates clearly understand atomic structure well, and in particular nuclear structure.

Question 18

Determining molecular formula from information provided caused no difficulty for most.

Question 23

The electrical conductivity of metals and non-metals is well-known and understood, as is the method for testing electrical conductivity.

Question 17

Many candidates chose an option that included the arrangement of laboratory apparatus for simple distillation rather than for fractional distillation as stated in the stem.

Question 20

Candidates need to be clear about which products appear at the anode and which at the cathode in the electrolysis of molten lead bromide.

Question 22

Candidates are expected to know how metal salts can be produced by acid/base reactions, and that copper, being relatively unreactive, will not react with dilute acids.

Question 27

While candidates recognised that magnesium is more reactive than iron, they failed to realise that iron oxide is reduced, not oxidised, by magnesium in the specified reaction.

Physics

(Physics section)

In the physics section, **Questions 28** and **33** were very well answered, but **Questions 29**, **31**, **32** and **34** caused problems.

Comments on Specific Questions

Question 28

This was well answered

Question 29

The question asked about the speed; the information was given in the form of a distance / time graph. Many candidates chose the option describing changes in distance rather than speed. Candidates should be aware that speed is the gradient of a distance / time graph.

Question 31

Most candidates believed that the contents of the sealed container would be entirely liquid after several hours, not appreciating that there would also be vapour in the space above the liquid, even though the temperature was below the boiling point of the liquid.

Question 32

Distractor A was a popular choice in this convection question. The arrangement shown in this option would involve hot water from the solar panel entering the water tank near its base, and then rising in the tank before being quite quickly returned to the panel. Candidates should remember 'top to top' and 'bottom to bottom' connections.

Question 33

This was also well answered

Question 35

This was a recall question on syllabus examples of the use of electromagnetic waves, and the commonest mistake was to opt for distractor C, incorrectly linking satellite-to-Earth communication to radio waves.

COMBINED SCIENCE

Paper 0653/21

Core Theory

Key Messages

Candidates should be encouraged to pay particular attention to words in heavy print. They are key words to guide candidates in understanding the question or in what to focus on in their answers.

Some candidates need to improve their understanding of the characteristic reactions of groups of chemicals, for example metals and acids, so that whenever these two types of chemicals react, candidates will understand what the products will be.

General Comments

There were some very good performances in this paper, with several candidates showing a very good understanding of the Core syllabus.

Candidates should be encouraged, when they have completed the paper, to review their answers and spend a further few minutes on answers to questions that they may have found challenging.

There was little evidence that candidates had a problem in completing the paper, in the time allotted.

In the Physics questions, where a formula was required, some candidates are still giving the triangle of variables. This is not equivalent to the actual formula and does not gain the mark.

Comments on Specific Questions

Question 1

(a) (i) This was quite well answered, with the correct gas *hydrogen.* Other candidates gave answers which were not elements or gases.

(ii) Many candidates who had given the incorrect answer for the first part, found problems with giving a test for an incorrect gas, such as chlorine. Some candidates did not describe the splint as being *lit*. The correct sound of *pop* was sometimes given as *boom*.

(iii) Many lists included a name for the metal X, which was sometimes incorrect. However this gained credit if it was in the correct position in the list. Other answers indicated that candidates did not have a thorough understanding of the connection between the number of bubbles in each test tube and the reactivity of the metal. The correct list was: *magnesium, X, G, copper,* with magnesium as the most reactive and copper the least reactive.

(iv) This was quite well answered. Many candidates correctly stated either *zinc,* or *iron.* Steel could not gain credit as it is not an element. Many other metals were allowed and occasionally given by candidates, such as *calcium, lead, aluminium, nickel etc.*

(b) (i) Candidates need to understand that the definition of the term *reduced* in the context given in this question requires more than something “being taken away”. In this context, *reduced* refers to the removal of oxygen. Other candidates incorrectly stated that oxide had been taken away.

(ii) The correct answer *carbon dioxide* was frequently given by the higher achieving candidates. Wrong answers included *carbon oxide* or sometimes *carbon monoxide*.

(c) (i) Few candidates indicated clearly the correct position of the first appearance of lead. The arrow needed to be on the negative electrode and below the surface of the molten lead bromide.

(ii) Many candidates attempted this question, although some gave the answer *bromide* rather than the correct answer *bromine.*

Question 2

(a) The majority of candidates gave *oak trees* as their answer, rather than the correct term *sun.*

(b) (i) This was very well answered across the ability range.

(ii) This was also well answered. The most usual correct answer given was *rabbits.*

(c) Almost all candidates gave correct answers here. Occasionally some credit was lost when candidates left off the arrow heads. Others correctly described food chains which were not from the food web in the question. These answers were able to gain partial credit if the arrows were drawn correctly.

(d) Almost all candidates gained marks for this question. The first marking point needed some reference to *fewer animals* or *animals dying*. *Extinction* or *dying out* was too drastic an outcome, unless qualified by the area around the oak trees.

The second marking point needed some reference to *food shortages or animals losing their habitat.* The result of these would then be that *animals find another food source or animals move to another area.*

Answers describing the breakdown of the food web, did not gain credit.

(e) There were many very well-reasoned answers to this question, which incorporated the *reduction in photosynthesis* as well as the resulting *increase in carbon dioxide concentration.* Other candidates wrongly used the term respiration for the "changing" of carbon dioxide to oxygen. Some candidates incorporated in their answers the effect of the increase of carbon dioxide on global warming. These did not gain credit, since this was not asked for in the question.

Question 3

(a) Most candidates attempted this question. Candidates needed to know the correct symbols for all three components for credit. Batteries need an even number of electrodes (2, 4 etc.), for example. Some candidates used an out-of-date symbol for the lamp. A circle containing a cross is the recommended symbol. Credit was given for the older symbol, but the cross is preferred.

(b) (i) Most candidates showed a good understanding of the need for *2 cells* and were able to explain the reason clearly.

(ii) Correct answers referred to the *current.* Some only explained that 1.2 A represented 1.2 Amperes. The question was well answered by the higher achieving candidates.

(c) Most candidates correctly placed the ammeter in series with the other components. The voltmeter needed to be placed across the battery, rather than the lamp.

Question 4

(a) (i) This was quite well answered. However some candidates missed the mark by omitting *fractional* before *distillation.*

(ii) A few candidates gave a well-reasoned answer to this question. Many others did not understand that the cooler part of the tower is higher up. This misunderstanding then lead them to say that the fractions with the higher boiling points condensed higher up the tower.

(iii) Many candidates gained the first marking point, usually with the answer petrol but did not go on to explain that this was used in cars as fuel**.** There were correct answers for other products such as *kerosene* or *fuel oil.* Some candidates misunderstood the question and gave a product already displayed in Fig. 4.1.

(b) This question proved challenging to many candidates. Many gave *large* or *small* rather than the percentages required.

(c) (i) Most candidates gained part credit for this question, usually for reference to *increased water vapour or humidity.* A reference specifically to temperature increase was required.

Some candidates misunderstood the question, which only related to the atmosphere in the greenhouse, and described the increase in global warming and its effects.

(ii) The answers to the first part were generally good. The terms *produces heat* or *creates heat* were not precise enough.

The meaning of *chemical change* was more challenging for many candidates. Many answers used the words *chemical* and *changes* without adding anything else. The idea that a *new substance* is formed was needed.

Question 5

(a) The correct phrase for the exchange of right and left in an image in a mirror is *lateral inversion*. Reference to *the image being the opposite way round* was accepted if the candidate had given *right hand* to the first part of the question.

(b) (i) Most candidates gave the second energy correctly as *sound*. However, it was necessary to give the first energy as *electrical* in order to gain the mark. A few candidates gave *electronic* in the first space. This did not gain a mark.

(ii) This question was attempted by most candidates. Reference to the human hearing range of 20 Hz to 20 KHz was required for the mark.

(c) (i) This was a well answered question with many candidates across the ability range gaining all three marks. There were some who gave the triangle instead of the formula. A few missed the second marking point by incorrectly rounding the correct answer *0.625* to *0.62*. Some candidates converted the speed into other units for example, km / hour and these answers were allowed if the correct numerical value was given.

(ii) Candidates need to understand that a swimmer is able to move forward at constant speed if the driving and frictional forces are equal and opposite. Most gave a smaller value than 100N for the frictional force.

Of those candidates who gave the correct numerical answer of *100N,* some gave an insufficient explanation.

(iii) Most candidates answered this question. Some lost marks through careless drawing or labelling of the line marking a complete wavelength.

(iv) Many candidates focused on the change in the water depth in Fig. 5.3. rather than the change in the wave properties.

(d) The marking points for this question were independent. Candidates were asked to identify which part of the spectrum was used by the remote control; candidates filling in more than one box did not identify which part was used by a remote control, and lost credit but could still get the second mark by correctly identifying where infra-red is located within the spectrum.

Question 6

(a) (i) Only a few candidates were able to name a diploid cell from the diagram.

(ii) This was quite well answered. Candidates were asked to name the term *fertilisation*; some gave a description of the process of the sperm entering the egg cell.

(b) Most candidates gained a mark for stating *uterus or womb.* Fewer gave the extra detail needed by referring to the *lining or walls* of the organ.

(c) This was quite well answered across the ability range. Although a range of vitamins was allowed, most gave *vitamin D.* Most candidates also gave a correct reference to *helping bone growth* or *prevention of rickets.*

(d) The marks allocated should have indicated to candidates that a more complex calculation than 37 x 100 = 3700 was required.

Question 7

(a) A few candidates gave the different physical states at room temperature without describing how these changed as they go down the Group. Other candidates gave similarities based on the elements "chemical" properties and did not gain a mark. Candidates should be made aware of the meaning of the word trends, particularly with reference to trends in Group VII.

(b) (i) This question was not well answered. Many candidates gave the colour of chlorine from the table instead of the colour that would occur as a result of the reaction.

(ii) The reactant boxes were quite often correct, with the appropriate – *ine* ending for *chlorine* and – *ide* ending for *bromide.* Some candidates attempted to use formulae and could not be awarded credit if the formulae were incorrect. Other candidates used two boxes for the name of the compound potassium bromide, writing potassium in one box and bromide in the next.

(c) This question was quite well answered across the ability range. The most commonly seen incorrect answer was *ionic bonding*.

(d) Good attempts were made by the majority of candidates. Most referred to *killing bacteria or microorganisms* and gained credit. Some lost credit by using the term *germs*. Others lost credit by referring to *clean water* or *drinkable* instead of as *safe to drink.*

Question 8

(a) This question was very well answered across the ability range. A few candidates drew two lines from water and from metal to two different boxes in each case.

(b) (i) This proved a challenging question for many candidates.

The best answers referred to the most energetic water molecules escaping the liquid surface or stated that only the water molecules with the most energy will escape into the air, then going on to explain that the water molecules left behind have less energy and are therefore cooler.

Most candidates omitted terms such as *molecules or particles,* simply referring to *water.* They also omitted terms such as *energy,* referring to *cold* or *hot*. They also repeated the term *evaporation*, contained in the question, rather than explaining the evaporation as *particles escaping from the surface or escaping into the air.*

(ii) This was another challenging question for most candidates. Answers needed to refer to the relative temperatures of the air and water and the transfer of heat from the hotter to the cooler.

(c) Most candidates attempted this question and some well-reasoned answers were seen. Other answers missed the mark by referring to the window frame *getting bigger in hot weather* and this was not considered sufficient; the term *expansion* was required. Some candidates simply referred to *expansion and contraction of materials in different temperatures*. This was not precise enough for the context given.

(d) (i) Most candidates gained credit for the correct answer, *4 500* (units were given). Many made use of the space on the paper and presented their working. Errors occurred where candidates, having calculated the volume, then divided the answer by the mass of the brick. A few candidates added the dimensions instead of multiplying.

(ii) This question was quite well done, most candidates gaining 2 marks. Some lost credit by using the triangle formula, whilst others used units in their equation rather than the correct *mass/volume.* In a few cases candidates used the term *weigh*" rather than mass. This was not allowed as weight is a different quantity to mass.

Some candidates missed the final mark by rounding their calculated answer, 1.6666… to 1.6, rather than the correct *1.67 or 1.7*.

Question 9

(a) This was well answered with few candidates giving no response. The function of the white blood cell was least well understood.

(b) This was quite well answered across the ability range. The most frequent correct answer was *valves,* the third missing word. Some candidates stated that ventricle blood left the heart from the left ventricle. Others stated that the blood vessel P was the pulmonary vein, rather than the correct *pulmonary artery.*

(c) (i) The most commonly-seen wrong answer was *carbon dioxide*.

(ii) Most correct answers gave *carbon dioxide* and *water*. The most common incorrect answers were *oxygen* and *nutrients*.

COMBINED SCIENCE

Paper 0653/22

Core Theory

Key Messages

Candidates should be encouraged to pay particular attention to words in heavy print. They are key words to guide candidates in understanding the question or in what to focus on in their answers.

Some candidates need to improve their understanding of the characteristic reactions of groups of chemicals, for example metals and acids, so that whenever these two types of chemicals react, candidates will understand what the products will be.

General Comments

There were some very good performances in this paper, with several candidates showing a very good understanding of the Core syllabus.

Candidates should be encouraged, when they have completed the paper, to review their answers and spend a further few minutes on answers to questions that they may have found challenging.

There was little evidence that candidates had a problem in completing the paper, in the time allotted.

In the Physics questions, where a formula was required, some candidates are still giving the triangle of variables. This is not equivalent to the actual formula and does not gain the mark.

Comments on Specific Questions

Question 1

(a) (i) Most candidates gained credit here.

(ii) This question was well answered, particularly by candidates who used the standard calculation for *speed = distance/time,* then substituted *5 m for distance and 0.2 seconds for time. O*thers started with the speed of 25 m/s and worked backwards to calculate either the time or the distance. In several cases correct units were not given and the credit was lost.

(iii) This question was best answered by a straight forward change of units from m/s to km/hour. This involved dividing by 1000, (to change metres into kilometres) then multiplying by 3 600 (to change seconds into hours). Most candidates who used this method gained full credit. Others worked backwards from 80 km/h and did not come out with a correct proof.

(b) (i) Most candidates attempted this question and drew two arrows close to the van. The arrows needed to be labelled in order to gain the mark. The question had asked for forces which acted to slow the van down, so both arrows should have pointed backwards. A few candidates drew arrows pointing downwards; labelling them *gravity*.

(ii) Some good answers were given here, which included reference to the brakes of the van gaining *heat energy as the kinetic energy was converted.*

Question 2

(a) This was well answered by most candidates. Some candidates however confused the products with the reactants.

(b) Many referred correctly to the air pockets helping the leaf to float. Most incorrect answers stated that the pockets allowed storage of gases for photosynthesis.

(c) This was well answered by the higher achieving candidates. Many other answers referred to the accessibility of sunlight to the upper side of the leaf and this did not gain credit. Answers referring to the *lower surface being under water* gained partial credit.

(d) Almost all candidates gained credit for *the plant grows in water.* Although many referred to "root hair cells absorbing water from soil", they did not clearly enough state that the root hair cells increased the surface area, enabling **more** water to be absorbed.

(e) Most candidates attempted this question. Most gained credit for writing that the fish died through lack of oxygen. Some candidates confused bacteria in the sewage with the bacteria using up the oxygen in the pond. Answers saying that sewage was poisonous to fish were not allowed

Question 3

(a) (i) This question was well answered by the higher achieving candidates, who often gave the answer *salt and water.* Other candidates need to develop a better understanding of the characteristic reactions between acids and bases.

(ii) This was generally well answered with correct *hydrochloric acid*, the formula was also allowed as was *hydrogen chloride.* Answers simply stating *chlorine* were not allowed.

(b) Many candidates did not give a response to this question. Some of the answers lost credit by using incorrect symbols or by using 2 as a prefix rather than incorporating it in the actual formula.

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

(ii) Most candidates who answered this question gained at least one mark and many higher achieving candidates gained both marks. Many gave the explanation, *to exclude air/ oxygen or water from the surface of the iron.*

Question 4

(a) This question was quite well answered. Some candidates gave *carbon dioxide* correctly, but then gave *energy* as the second product.

(b) Most candidates correctly identified the *cell membrane. Cytoplasm* was less well known.

(c) Many candidates simply repeated the term digested given in the stem of the question; candidates needed to present an interpretation of digested, such as *broken down.*

(d) This question was very well answered.

(e) This question was quite well answered. Most candidates recognised tha the pulse rate increased. Others lost credit by referring to *more exercise*, implying that the exercise lasted longer, instead of *more vigorous exercise* (or similar wording referring to an increase in intensity).

Candidates who simply listed the exercises and the pulse rates did not gain credit as the question asks for a trend.

Question 5

(a) (i) Candidates needed to state the nature of the property for the metal and the non-metal. It was not enough to simply state, for example, that metals are conductors. In this example, candidates would need to state additionally that non-metals are insulators or poor conductors.

(ii) Candidates need to be familiar with the term *metallic character*.

(b) (i) This was not a well answered question. Some candidates wrote *sodium* in one box and *hydroxide* in the second box, failing to add the other product, hydrogen.

(ii) Candidates were able to refer to physical or chemical properties in their answers; most candidates gained credit for stating that the reactivity increased going down the group. Some candidates referred to the decrease in melting point going down the group. Candidates needed to refer to a trend rather than simply restating melting points and reactivities from the table.

(c) Candidates need to be careful with their terminology when answer questions which ask how ions are formed. Some candidates described the ions losing or gaining electrons rather than the atoms losing or gaining electrons.

Question 6

(a) This question was very well answered.

(b) There were some very good answers to this question which included both reference to the rough surface and how this surface would make the grain stick to the insect's body or to the stigma. Other candidates did not use the information available in the drawing, referring instead to the colour or scent of the pollen which would attract the insects.

Question 7

(a) This was quite well answered. Some candidates used the older symbol for the lamp, but this was allowed.

(b) (i) This question was well answered across the ability range. A few candidates used the equation for multiple resistors in parallel.

(ii) Candidates need to understand that, for a given voltage, if the total resistance of the circuit is less, more current will be taken from the battery. Some candidates stated that the *current is weaker* because it has *split in two*. The question asks about the effect on the current taken from the battery.

(iii) There were some well explained answers to this question. Most gained the mark for referring to the fact that each lamp can be switched off or on independently.

(c) The hazard shown in the drawing was damaged or unsafe insulation. Some gave answers, such as *fire could start* or *electric shock* which were consequences or explanations of the hazard.

(d) Most candidates recognised that the hazard shown was having too many appliances in one socket. However many found it difficult to describe it in terms of *overloaded socket or overheating.* Candidates need to understand **how** a fuse breaks a circuit by melting.

Question 8

(a) (i) Most candidates recognised magnesium carbonate as a base/alkali. However, many candidates wrote that *the magnesium carbonate lowered the pH of the stomach contents*. The best answers stated that *the* pH is raised and the contents made less acidic.

(ii) This question was quite well answered by the higher achieving candidates. Candidates need to develop an understanding of the characteristic reaction of acids and carbonates.

(b) This was well answered by many candidates who drew either the gas syringe or the inverted measuring cylinder in a water trough with delivery tube. Some candidates did not get full credit because they did not use a calibrated collection vessel.

(c) (i) Candidates struggled with this question. Many drew a line below the given line and labelled it "0.5 g". The best answers showed the graph to be steeper initially (faster rate due to a smaller particle size / greater surface area to volume ratio) meeting the same final volume earlier (the mass of the reactant remains the same).

(ii) Some candidates gave well-reasoned answers and gained marks for *an increased surface area and a greater rate of reaction.* Others referred to the tablet being "easier to swallow" if broken down. Yet others described the tablets "working faster or reacting more easily". These were not allowed.

(iii) Many candidates repeated factors already described in the stem as being controlled. The best answers referred to the pH or the concentration of the acid and explained that a more concentrated acid would cause a greater rate of reaction. Others used information from earlier in the question and referred to the size of the tablets or their surface area as a larger surface area gives a greater rate of reaction.

Question 9

(a) (i) Many candidates described places in the house where heat might be lost rather than the correct answer *conduction.*

(ii) Although many candidates referred to the polystyrene stopping heat escaping through the wall, they did not explain how the polystyrene achieves this.

(b) Candidates were told that the heat loss was greater when the temperature difference is greater; this is around 6.00 a.m. Many candidates gave the time when the temperature inside the house is greatest.

(c) (i) Many candidates were distracted by the word *window* in the rubric of the question, the question, asked for the process by which heat was lost, which was *convection.*

(ii) The question asked candidates to identify both infra-red as the main part of the electromagnetic spectrum causing the house to be heated and the position of this part in the spectrum. Candidates that labelled all the boxes were not identifying which part was responsible for the heating.

(d) This question required some careful drawing. Candidates need to use rulers in questions such as this.

(e) (i) This was quite well answered. Most candidates indicated a wavelength from one peak to the next. However some labels were not precise enough. Some answers would have gained the mark if a small vertical line at the start and end of the wave had been used.

(ii) The best answers referred to *wavelengths* rather than *vibrations or oscillations.* Some candidates explained frequency in terms of pitch. Others referred to *how frequently a wave travelled*.

COMBINED SCIENCE

Paper 0653/23

Core Theory

Key Messages

Candidates should be encouraged to pay particular attention to words in heavy print. They are key words to guide candidates in understanding the question or in what to focus on in their answers.

Some candidates need to improve their understanding of the characteristic reactions of groups of chemicals, for example metals and acids, so that whenever these two types of chemicals react, candidates will understand what the products will be.

General Comments

There were some very good performances in this paper, with several candidates showing a very good understanding of the Core syllabus.

Candidates should be encouraged, when they have completed the paper, to review their answers and spend a further few minutes on answers to questions that they may have found challenging.

There was little evidence that candidates had a problem in completing the paper, in the time allotted.

In the Physics questions, where a formula was required, some candidates are still giving the triangle of variables. This is not equivalent to the actual formula and does not gain the mark.

Comments on Specific Questions

Question 1

(a) (i) This was quite well answered, with the correct gas *hydrogen.* Other candidates gave answers which were not elements or gases.

(ii) Many candidates who had given the incorrect answer for the first part, found problems with giving a test for an incorrect gas, such as chlorine. Some candidates did not describe the splint as being *lit*. The correct sound of *pop* was sometimes given as *boom*.

(iii) Many lists included a name for the metal X, which was sometimes incorrect. However this gained credit if it was in the correct position in the list. Other answers indicated that candidates did not have a thorough understanding of the connection between the number of bubbles in each test tube and the reactivity of the metal. The correct list was: *magnesium, X, G, copper,* with magnesium as the most reactive and copper the least reactive.

(iv) This was quite well answered. Many candidates correctly stated either *zinc,* or *iron.* Steel could not gain credit as it is not an element. Many other metals were allowed and occasionally given by candidates, such as *calcium, lead, aluminium, nickel etc.*

(b) (i) Candidates need to understand that the definition of the term *reduced* in the context given in this question requires more than something “being taken away”. In this context, *reduced* refers to the removal of oxygen. Other candidates incorrectly stated that oxide had been taken away.

(ii) The correct answer *carbon dioxide* was frequently given by the higher achieving candidates. Wrong answers included *carbon oxide* or sometimes *carbon monoxide*.

(c) (i) Few candidates indicated clearly the correct position of the first appearance of lead. The arrow needed to be on the negative electrode and below the surface of the molten lead bromide.

(ii) Many candidates attempted this question, although some gave the answer *bromide* rather than the correct answer *bromine.*

Question 2

(a) The majority of candidates gave *oak trees* as their answer, rather than the correct term *sun.*

(b) (i) This was very well answered across the ability range.

(ii) This was also well answered. The most usual correct answer given was *rabbits.*

(c) Almost all candidates gave correct answers here. Occasionally some credit was lost when candidates left off the arrow heads. Others correctly described food chains which were not from the food web in the question. These answers were able to gain partial credit if the arrows were drawn correctly.

(d) Almost all candidates gained marks for this question. The first marking point needed some reference to *fewer animals* or *animals dying*. *Extinction* or *dying out* was too drastic an outcome, unless qualified by the area around the oak trees.

The second marking point needed some reference to *food shortages or animals losing their habitat.* The result of these would then be that *animals find another food source or animals move to another area.*

Answers describing the breakdown of the food web, did not gain credit.

(e) There were many very well-reasoned answers to this question, which incorporated the *reduction in photosynthesis* as well as the resulting *increase in carbon dioxide concentration.* Other candidates wrongly used the term respiration for the "changing" of carbon dioxide to oxygen. Some candidates incorporated in their answers the effect of the increase of carbon dioxide on global warming. These did not gain credit, since this was not asked for in the question.

Question 3

(a) Most candidates attempted this question. Candidates needed to know the correct symbols for all three components for credit. Batteries need an even number of electrodes (2, 4 etc.), for example. Some candidates used an out-of-date symbol for the lamp. A circle containing a cross is the recommended symbol. Credit was given for the older symbol, but the cross is preferred.

(b) (i) Most candidates showed a good understanding of the need for *2 cells* and were able to explain the reason clearly.

(ii) Correct answers referred to the *current.* Some only explained that 1.2 A represented 1.2 Amperes. The question was well answered by the higher achieving candidates.

(c) Most candidates correctly placed the ammeter in series with the other components. The voltmeter needed to be placed across the battery, rather than the lamp.

Question 4

(a) (i) This was quite well answered. However some candidates missed the mark by omitting *fractional* before *distillation.*

(ii) A few candidates gave a well-reasoned answer to this question. Many others did not understand that the cooler part of the tower is higher up. This misunderstanding then lead them to say that the fractions with the higher boiling points condensed higher up the tower.

(iii) Many candidates gained the first marking point, usually with the answer petrol but did not go on to explain that this was used in cars as fuel**.** There were correct answers for other products such as *kerosene* or *fuel oil.* Some candidates misunderstood the question and gave a product already displayed in Fig. 4.1.

(b) This question proved challenging to many candidates. Many gave *large* or *small* rather than the percentages required.

(c) (i) Most candidates gained part credit for this question, usually for reference to *increased water vapour or humidity*. A reference specifically to temperature increase was required.

Some candidates misunderstood the question, which only related to the atmosphere in the greenhouse, and described the increase in global warming and its effects.

(ii) The answers to the first part were generally good. The terms *produces heat* or *creates heat* were not precise enough.

The meaning of *chemical change* was more challenging for many candidates. Many answers used the words *chemical* and *changes* without adding anything else. The idea that a *new substance* is formed was needed.

Question 5

(a) The correct phrase for the exchange of right and left in an image in a mirror is *lateral inversion*. Reference to *the image being the opposite way round* was accepted if the candidate had given *right hand* to the first part of the question.

(b) (i) Most candidates gave the second energy correctly as *sound*. However, it was necessary to give the first energy as *electrical* in order to gain the mark. A few candidates gave *electronic* in the first space. This did not gain a mark.

(ii) This question was attempted by most candidates. Reference to the human hearing range of 20 Hz to 20 KHz was required for the mark.

(c) (i) This was a well answered question with many candidates across the ability range gaining all three marks. There were some who gave the triangle instead of the formula. A few missed the second marking point by incorrectly rounding the correct answer *0.625* to *0.62*. Some candidates converted the speed into other units for example, km / hour and these answers were allowed if the correct numerical value was given.

(ii) Candidates need to understand that a swimmer is able to move forward at constant speed if the driving and frictional forces are equal and opposite. Most gave a smaller value than 100N for the frictional force.

Of those candidates who gave the correct numerical answer of *100N,* some gave an insufficient explanation.

(iii) Most candidates answered this question. Some lost marks through careless drawing or labelling of the line marking a complete wavelength.

(iv) Many candidates focused on the change in the water depth in Fig. 5.3. rather than the change in the wave properties.

(d) The marking points for this question were independent. Candidates were asked to identify which part of the spectrum was used by the remote control; candidates filling in more than one box did not identify which part was used by a remote control, and lost credit but could still get the second mark by correctly identifying where infra-red is located within the spectrum.

Question 6

(a) (i) Only a few candidates were able to name a diploid cell from the diagram.

(ii) This was quite well answered. Candidates were asked to name the term *fertilisation*; some gave a description of the process of the sperm entering the egg cell.

(b) Most candidates gained a mark for stating *uterus or womb.* Fewer gave the extra detail needed by referring to the *lining or walls* of the organ.

(c) This was quite well answered across the ability range. Although a range of vitamins was allowed, most gave *vitamin D.* Most candidates also gave a correct reference to *helping bone growth* or *prevention of rickets.*

(d) The marks allocated should have indicated to candidates that a more complex calculation than 37 x 100 = 3700 was required.

Question 7

(a) A few candidates gave the different physical states at room temperature without describing how these changed as they go down the Group. Other candidates gave similarities based on the elements "chemical" properties and did not gain a mark. Candidates should be made aware of the meaning of the word trends, particularly with reference to trends in Group VII.

(b) (i) This question was not well answered. Many candidates gave the colour of chlorine from the table instead of the colour that would occur as a result of the reaction.

(ii) The reactant boxes were quite often correct, with the appropriate – *ine* ending for *chlorine* and – *ide* ending for *bromide.* Some candidates attempted to use formulae and could not be awarded credit if the formulae were incorrect. Other candidates used two boxes for the name of the compound potassium bromide, writing potassium in one box and bromide in the next.

(c) This question was quite well answered across the ability range. The most commonly seen incorrect answer was *ionic bonding*.

(d) Good attempts were made by the majority of candidates. Most referred to *killing bacteria or microorganisms* and gained credit. Some lost credit by using the term *germs*. Others lost credit by referring to *clean water* or *drinkable* instead of as *safe to drink.*

Question 8

(a) This question was very well answered across the ability range. A few candidates drew two lines from water and from metal to two different boxes in each case.

(b) (i) This proved a challenging question for many candidates.

The best answers referred to the most energetic water molecules escaping the liquid surface or stated that only the water molecules with the most energy will escape into the air, then going on to explain that the water molecules left behind have less energy and are therefore cooler.

Most candidates omitted terms such as *molecules or particles,* simply referring to *water*. They also omitted terms such as *energy,* referring to *cold* or *hot*. They also repeated the term *evaporation*, contained in the question, rather than explaining the evaporation as *particles escaping from the surface or escaping into the air.*

(ii) This was another challenging question for most candidates. Answers needed to refer to the relative temperatures of the air and water and the transfer of heat from the hotter to the cooler.

(c) Most candidates attempted this question and some well-reasoned answers were seen. Other answers missed the mark by referring to the window frame *getting bigger in hot weather* and this was not considered sufficient; the term *expansion* was required. Some candidates simply referred to *expansion and contraction of materials in different temperatures*. This was not precise enough for the context given.

(d) (i) Most candidates gained credit for the correct answer, *4 500* (units were given). Many made use of the space on the paper and presented their working. Errors occurred where candidates, having calculated the volume, then divided the answer by the mass of the brick. A few candidates added the dimensions instead of multiplying.

(ii) This question was quite well done, most candidates gaining 2 marks. Some lost credit by using the triangle formula, whilst others used units in their equation rather than the correct *mass/volume.* In a few cases candidates used the term *weigh*" rather than mass. This was not allowed as weight is a different quantity to mass.

Some candidates missed the final mark by rounding their calculated answer, 1.6666… to 1.6, rather than the correct *1.67 or 1.7*.

Question 9

(a) This was well answered with few candidates giving no response. The function of the white blood cell was least well understood.

(b) This was quite well answered across the ability range. The most frequent correct answer was *valves,* the third missing word. Some candidates stated that ventricle blood left the heart from the left ventricle. Others stated that the blood vessel P was the pulmonary vein, rather than the correct *pulmonary artery.*

(c) (i) The most commonly-seen wrong answer was *carbon dioxide*.

(ii) Most correct answers gave *carbon dioxide* and *water*. The most common incorrect answers were *oxygen* and *nutrients*.

COMBINED SCIENCE

Paper 0653/31
Extended Theory

Key Messages

Candidates should be aware of the command words contained in the question when considering their answers; for example, the word 'describe' requires a different type of response to the word 'explain'.

When describing what is seen during a chemical reaction, precise detail is required. A description of a colour change should include the actual colour change, not just the simple statement 'It changed colour'.

Physics formulae and chemical equations should be written with the correct symbols or words, and should not include units or be a combination of symbols and words.

General Comments

There were some excellent scripts seen from candidates who had mastered all aspects of the syllabus and who demonstrated good examination technique. There was no evidence that candidates had difficulty in completing the paper in the required time. In general, candidates had prepared themselves equally well for all of the Science disciplines, and they usually suggested sensible answers to questions that were set in unfamiliar contexts and required understanding of Science rather than straight recall of facts.

The majority of candidates used the available space on the examination paper appropriately. Centres should continue to make it clear to candidates that the space allocated for a response, along with the marks available, indicates the length of response and level of detail expected. Handwriting was legible in the vast majority of scripts; a few candidates needed to take more care with their writing so that their responses, particularly the key words, could be read clearly.

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

Comments on specific questions

Question 1

(a) (i) Many candidates successfully gave the required balanced equation. Common examples of incorrect formulae seen were HCl_2 used as the formula for hydrochloric acid and 2H for the hydrogen molecule. Candidates should be aware that words or a combination of words and symbols will not be awarded marks when a question specifies a balanced symbol equation.

(ii) This question was very well answered by most candidates who correctly placed the metals in their order of reactivity.

(b) (i) Many candidates wrote that copper metal was produced. Fewer candidates correctly described the colour change of the solution to a colourless. The question asked for a description of what is seen, and not an explanation.

(ii) A comparison of the reactivity of magnesium and metal **X** was required here. Many candidates successfully did this and so gained credit. Both metals had to be mentioned in the response for the comparison to be made correctly; a minority of candidates discussed the reactivity of magnesium chloride, not magnesium.

(c) (i) Many candidates gave the correct definition for reduction. Candidates are reminded of the meaning of the word reduction within a chemical context. Answers describing reduction as 'getting less of a compound' or 'the removal of oxygen from an element' could not be credited.

(ii) Many candidates correctly identified the cathode as the negative electrode, able to attract the opposite charge on the metal ion. Some candidates gave explanations referring to positively charged metallic ions present in electrolytes. It was important to emphasise the ionic form of the metallic particles in an electrolyte. Statements such as 'Metals are positively charged' did not gain credit.

Question 2

(a) Many of the higher-scoring candidates correctly gave 'ecosystem' as their response. Candidates should remember that the community of organisms does not include the woodland.

(b) Many candidates gave the correct definition of a consumer. Although carnivores and herbivores are consumers, definitions of carnivores and herbivores were too specific to gain credit.

(c) The great majority of candidates correctly drew a food chain from the food web; some candidates gave food webs including organisms not contained in the given web and lost marks.

(d) Many candidates successfully described two methods of energy loss in food chains. Others responded in terms of competition between members of the food web.

(e) This question was generally well answered. Most candidates correctly described the ability of trees to reduce the carbon dioxide concentration and increase the oxygen concentration of the air. Candidates who correctly related this to the process of photosynthesis gained full credit. Answers such as *Trees absorb carbon dioxide and give out oxygen* and *Trees convert carbon dioxide to oxygen* did not include sufficient detail.

Question 3

(a) (i) The majority of candidates obtained this mark.

(ii) Most candidates correctly stated that 1.2 A is a measure of the current that will flow through the bulb when it is lit. A simple statement that 1.2 A means 1.2 amperes was insufficient for credit to be gained.

(iii) This question was well answered by most candidates who gave the correct formula, calculation and units. Candidates are reminded that formulas should be given using either correct symbols or words; units in place of symbols or words are not credited.

The majority of candidates correctly gave Ω as their unit of resistance.

(b) A few of the stronger candidates gained full credit in this question. The energy transfer from chemical energy (in the battery) to electrical energy in the torch was correctly identified by some candidates; only a few gave the second energy transfer of electrical energy to both light and thermal energy. Incorrect answers included the statement that electrical energy is transferred to light energy which is then turned into thermal energy.

(c) (i) There were many well-drawn diagrams that gained full credit. Candidates are reminded that light rays travel in straight lines and should be drawn with the aid of a ruler. Candidates who took care over their diagrams made sure that the ray of light met the mirror before being reflected, showing the ray as a continuous line, with no gaps.

(ii) This question required the candidates to link the fact that light travels very fast with the inability of the human eye to detect the time delay.

Question 4

(a) (i) Most candidates successfully identified fractional distillation as the process.

(ii) The relationship was correctly described by many candidates who wrote that the boiling point of thee fraction reduces as you go up the tower. Many other candidates described the boiling point as increasing as you ascend the tower. Some candidates gave a general description of how the separation occurs without mentioning the fact that temperature of condensation decreases higher in the tower.

(iii) Many candidates successfully described the relationship between the boiling point and size of molecule; fewer went on to explain the reason for this relationship. Candidates were also required to explain this relationship. Answers that were awarded full credit stated clearly that intermolecular bonds are broken at the boiling point. Statements such as *There are more bonds to be broken* could not gain credit since these bonds could have been covalent bonds within the molecules.

(b) There were some excellent explanations of the greenhouse effect of increased carbon dioxide in the atmosphere. A description of the effect of carbon dioxide in the atmosphere on the absorption of radiation from the sun was needed to gain this mark, rather than the simple statement that *Carbon dioxide is a greenhouse gas*. References to the ozone layer were frequently given and were not relevant to this question.

(c) (i) Many candidates successfully drew the structural formula of ethane. Methane was a common error.

(ii) A few of the stronger candidates responded by stating that the double bond formed during cracking making the molecules more reactive. Candidates should be aware that some of the smaller molecules produced by cracking are more reactive because they are unsaturated.

Question 5

(a) (i) Many candidates correctly identified the energy transformation.

(ii) Many candidates answered this correctly.

(b) (i) Many candidates scored full credit in this question. Other candidates need to remember that the formula should not be given as a combination of words and symbols.

(ii) Many candidates successfully calculated the kinetic energy of the boy. A few candidates forgot to square the velocity so did not gain credit.

(c) There were many correct responses given showing infra-red in the correct box. Candidates who filled in all of the boxes on the spectrum without indicating which part of the spectrum is utilised by remote control devices could not get the mark. Other candidates gave radio waves as their response.

Question 6

(a) (i) Some candidates correctly gave zygote as their answer. Many others wrote the names of either the sperm or egg.

(ii) Some of the descriptions were excellent, describing the ball of cells continuing its development in the lining of the uterus. Other descriptions mentioned the uterus and did not mention the lining. Candidates are reminded to read the question carefully, as it required them to describe in detail where the development continues.

(b) (i) There were several acceptable responses to this question so a wide variety of responses gained credit. There were many responses that were not acceptable since they could apply equally well to bottle-feeding. Examples of these are *It is more convenient*; *It is quicker*; *It is best for the baby*.

(ii) There were several acceptable responses to this question so, again, a variety of responses gained credit. As in **(b)(i),** reponses that applied equally well to breast-feeding were not acceptable without further explanation.

(c) (i) This question was well answered by the majority of candidates who successfully subtracted the mass of the nutrients from 100 g. Some candidates did include the masses of vitamin C and calcium in their calculations; this often caused arithmetic errors. A small number of candidates successfully added the ingredients but then did not subtract them from 100 g.

(ii) This question was well answered by most of candidates who calculated the amount of energy that could be released by both the carbohydrate and fat and wrote a relevant conclusion.

Question 7

(a) Correct diagrams were drawn by many candidates. A few candidates drew just a single atom with eight electrons in its outer shell.

(b) The physical state of a gas was correctly stated by most candidates and the colour correctly predicted by the stronger candidates.

(c) This question required both a description of what is seen and an explanation. Correct responses gave a detailed description of what is seen when chlorine solution is added to potassium bromide solution. Candidates are reminded that *It changed colour* does not include enough detail to gain credit. Some candidates incorrectly described the displacement of potassium and its subsequent reaction with water.

The explanation had to include a reason for the colour change in terms of displacement of bromine by the more reactive chlorine. Candidates should be aware that it is the element that is displaced, not the ion. Those who wrote that bromide was displaced could not gain credit

(d) (i) Uses of noble gases had generally been well learned by most candidates.

(ii) This question was generally well answered. The majority of candidates correctly stated that the elements of Group 0 are unreactive. Fewer described this in terms of outer shell electrons. Statements such as *They have a stable structure of electrons.* did not have enough detail to gain credit.

Question 8

(a) (i) Some candidates correctly described how the arrangement of molecules changes during evaporation. Others described how the energy or speed of molecules changes so no credit could be awarded.

(ii) Candidates found this question challenging. What was required was a description of the energy transfer from the air molecules to the water molecules inside the swamp cooler. Many candidates attempted explanations based on convection and these could not gain credit.

(b) Candidates needed to make clear that white colours reflect radiation from the sun. Many candidates did not address the question, instead referring to black surfaces as being good absorbers of heat energy.

(c) (i) Some candidates correctly wrote that the sound was produced by vibration of the fan causing the sound wave to be generated in air. Others did not mention that vibrations are needed to create sound.

(ii) Many candidates stated that sound travels as a wave.

Question 9

(a) The majority of candidates answered this well. A statement that blood goes to two different places was insufficiently detailed for credit.

(b) (i) Many candidates successfully completed this question. Many incorrect answers were from candidates confusing the functions of the different sides of the heart.

(ii) Stronger candidates gave good descriptions of the reason for a higher pressure in **Q** than **P**. Weaker candidates needed to say which vessel contained blood of a higher pressure. Some candidates confused the functions of vessels **Q** and **P**.

(c) (i) Stronger candidates realised that the cells in the tissues of the small intestine will still need a supply of oxygen for respiration which cannot be absorbed from the digestive system.

(ii) This question was well answered by many candidates. Candidates who referred to molecules in their undigested form, for example starch or protein, did not gain credit for these responses.

COMBINED SCIENCE

Paper 0653/32
Extended Theory

Key Messages

Candidates should be aware of the command words contained in the question when considering their answers; for example, the word 'describe' requires a different type of response to the word 'explain'.

When describing what is seen during a chemical reaction, precise detail is required. A description of a colour change should include the actual colour change, not just 'It changed colour'.

Physics formulae and chemical equations should be written with the correct symbols or words, and should not include units or be a combination of symbols and words.

General Comments

There were some excellent scripts seen from candidates who had mastered all aspects of the syllabus and who demonstrated good examination technique. There was no evidence that candidates had difficulty in completing the paper in the required time. In general, candidates had prepared themselves equally well for all of the Science disciplines, and they usually suggested sensible answers to questions that were set in unfamiliar contexts and required understanding of Science rather than straight recall of facts.

The majority of candidates used the available space on the examination paper appropriately. Centres should continue to make it clear to candidates that the space allocated for a response, along with the marks awarded, indicates the length of response and level of detail expected. Handwriting was legible in the vast majority of scripts; a few candidates needed to take more care with their writing so that their responses, particularly the key words, could be read clearly.

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

Comments on specific questions

Question 1

(a) (i) Candidates were well-prepared for this type of calculation.

(ii) This question also produced large numbers of correct. Candidates found various methods of showing that the speed of the van was 90 km/h. One common source of error was misinterpretation of the diagram showing the distance moved by the van.

(b) (i) The formula $\frac{1}{2}mv^2$ was well-known and candidates generally were able to make the correct substitutions and obtain the expected answer. Some candidates omitted to square the velocity in their calculation even though they had stated the correct formula. Another mistake made by several candidates was to use the term *mv* for the kinetic energy.

(ii) Many candidates were able to state that the kinetic energy would be converted into other energy forms. A few candidates stated that total energy would be conserved.

(c) The relationship *wave speed = frequency x wavelength* was well-known. A few candidates used incorrect symbols in their formula. The most common mistake was the use of *speed = frequency / wavelength*

Question 2

(a) The balanced equation for photosynthesis was very well-known.

(b) (i) Candidates were required to recognise that the air pockets would cause the leaf to float. Many candidates wrote highly detailed discussions of efficiency of gaseous exchange, respiration or transpiration. Candidates should take note of the marks available for a question when preparing their answers.

(ii) Candidates needed to show that they understood the function of root hair cells in land plants and refer to the submersion of the root hair cells in water in their answers. General statements such as *The plant is in water* were insufficiently detailed.

(c) (i) Many candidates had a good understanding of the eutrophication processes. Weaker candidates suggested that the increased population of lilies would overcrowd the submerged aquatic plants.

(ii) Credit was gained by those candidates who recognised that oxygen levels would be reduced as oxygen was removed by respiration of decomposing bacteria. A common mistake was to assume that reduction in oxygen would arise from respiration of the increased lily population. Others went in the opposite direction and suggested that the increased lily population would enrich the oxygen through increased photosynthesis.

(iii) Candidates needed to state that small aquatic animals would die rather than that their populations would decrease, and they had to link this directly to oxygen depletion.

Question 3

(a) Credit was given for sensible statements referring to differently sized atoms in the alloy and the effect this has on the ability of atoms to move with respect to one another. Some answers contained confused statements such as *brass has more strength and better malleability*. There appeared to be confusion over the term *malleability*.

(b) (i) This was answered correctly by most candidates.

(ii) This was very well answered and the majority of candidates produced the correctly balanced equation. Candidates need to take care that they write chemical formulae properly, for example writing C*l* instead of CL to represent chlorine.

(c) More-able candidates responded very successfully to this question. A majority of candidates correctly gave the formula as Cu_2O, although fewer were able to provide an acceptable explanation for their answer. Logically correct discussion of balance of electron loss and gain was sufficient. What was not accepted were statements such as *use the swap and drop method*, which is usually fine as a check on the formula but does not serve as an explanation.

Question 4

(a) (i) This was correctly answered by the great majority of candidates. The most common mistake was to state the pulse rate for running (163) rather than working out the change in pulse rate (89).

(ii) Candidates were required to draw a general conclusion from the data in the table. Most did this correctly although weaker candidates simply repeated the table information in sentence form.

(b) This was very well answered by candidates from across the ability range, and most gained full credit. There was no particular pattern in the few mistakes that were seen although mistakes tended to occur in the first and second positions.

Question 5

(a) (i) More able candidates usually understood the term *metallic character* but it was clear that many others did not and answered the question in terms of a specific metallic property such as electrical conductivity or, more commonly, in terms of reactivity. Many candidates answered in terms of electron configuration which was tested in part **(ii)**.

(ii) The success of candidates in this question was closely linked to that in part **(i)**. Some fully correct answers were seen from many of the more able candidates but the chemical principles tested in the whole of question **(a)** proved challenging for the majority. Some candidates discussed the relationship between outer shell electrons and group number without referring to metallic character.

(b) (i) Candidates could either use their knowledge of the chemistry of rubidium or use the information in the table to produce their predictions. Many candidates from across the ability range did this very successfully. Candidates should be advised that while they are not expected to know unfamiliar data they do need to be able to make sensible predictions based on supplied trends. The wording that they used to predict the characteristics of the reaction with water had to imply that the reaction would in some way be faster or more violent than the reaction with potassium. Some simply repeated the wording used for either sodium or potassium and did not gain credit.

(ii) There were several ways in which candidates could explain how they had used the information in the table, and the majority gained credit for their responses. Some gave a detailed analysis of the decreasing intervals between the melting points, which was not strictly required, and then omitted to mention how they made their predictions about the reaction with water.

(c) (i) This was well-answered and large numbers of candidates gained full credit.

(ii) Large numbers of candidates were familiar with the process of ion formation in ionic bonding. Some lost credit because of inappropriate use of vocabulary. Candidates had to make it clear that the sodium atom (not ion) loses an electron and that a chlorine (not chloride) atom (not ion) gains an electron.

(iii) This proved a challenging question. The most common answer referred to the completed outer shells of the ions which made them and / or the compound stable. Some candidates came close with answers such as *the sodium is positive and the chloride is negative* but they needed to refer to the resulting attractive force in addition to gain the mark.

Question 6

(a) The diagram given in this question emphasises the anthers and stigmas in the plant. Candidates were required to indicate the direction of pollen transfer in terms of these parts of the flower. Many candidates confused pollination with fertilisation or seed dispersal.

(b) (i) A wide range of terms describing the shape of the stigmas was accepted and the majority of candidates gained credit here. Some candidates described the location rather than the shape of the stigmas.

(ii) Some gave a non-specific answer such as *they are where the wind can catch them*. Some described the shape rather than the location of the anthers and others suggested answers that related to ease of self-pollination.

(c) To gain the credit here candidates had to identify pollen grain **X** and describe how its surface characteristics would allow it to attach to an insect's body. Many gave only a partial explanation. Large numbers suggested **Y**, stating that the lack of a spiky exterior would enable insects to carry it more easily.

Question 7

(a) In general, candidates were able to complete the circuit diagram correctly. Some candidates did not gain full credit because careless drawing left gaps in otherwise correct circuits. Other common mistakes included drawing either one or two lamps in a series arrangement and inserting symbols for ammeters and/or voltmeters.

(b) This proved to be a challenging question for candidates across the ability range. The first energy transformation was the one that most candidates missed, and of those who did not leave it blank the most common suggestions included *heat, solar* and *potential*.

(c) (i) This type of calculation had been very well prepared by most candidates and large numbers gained full credit. The most common incorrect suggestion for the units was J.

(ii) This proved a challenging question for candidates across the ability range. Candidates need to understand how current flow differs between simple series and parallel circuits. Where candidates gained partial credit it was usually for observing that the lamps in series would be dimmer, or that the failure of one lamp in a series arrangement causes the failure of the whole of the series circuit.

Question 8

(a) This was answered well by most candidates, and full credit was frequently awarded. Relatively few candidates made the mistake of associating reduced acidity with reduced pH. Candidates had to refer to a chemical reaction between magnesium carbonate and the acid in the stomach and they could use the word *neutralisation* to do this. However, the suggestion that the stomach contents would become neutral or attain pH 7 was not accepted.

(b) (i) Many excellent diagrams were seen from candidates. A relatively large number did not attempt this question. Partial credit was awarded if the suggested apparatus was partially correct even if the whole assembly may not have been able to produce useful data.

(ii) This was a very challenging question for candidates across the ability range and only a minority of candidates gained full credit. Large numbers answered in a way that showed they were interpreting the graph as rate against time.

(iii) The question instructs candidates to draw their sketch graph on the existing diagram in order to show how the two rates would compare. Candidates who drew another graph underneath the answer lines were not usually showing the comparison. Other candidates missed the point that *two* of the 5 g tablets were involved and drew graphs that would have been correct if only one of the smaller tablets had been used.

Question 9

(a) (i) Only a small number of higher ability candidates gained credit here. Candidates need to understand that heat conduction occurs via the transmission of vibrations between molecules in a solid. The question gave clear guidance that answers needed to discuss the process of conduction in terms of molecules and that the key to answering this question was to consider molecules in the gas bubbles within the polystyrene insulator. Those who identified the gas as the main insulator usually did not go on to connect the insulating effect with the low collision rate between gas molecules.

(ii) Only an small number of candidates were aware that the presence of the polystyrene blocks would eliminate heat loss by convection.

(b) The majority of candidates across the ability range gained the credit here. The most common incorrect response was 17:00.

(c) Only a very small number of candidates gained full credit for their response here. Successful candidates realised that the question is about maintaining interior temperature in a cold environment and not about limiting interior temperature in a hot environment. Many candidates suggested black walls because these would be good heat absorbers, which is not relevant in the context of this question. Of those who did suggest white walls, many confused the context and discussed reflection of solar radiation.

(d) (i) The ray diagram was usually very well drawn and large numbers of candidates gained full credit. A minority of candidates ignored the given rays and drew their own. Some candidates drew their rays very carelessly without the aid of a ruler or drew dashed or sketchy lines and so lost credit unnecessarily.

(ii) Candidates were very well-prepared for this question. Candidates should be aware that in questions like this one, writing the required words in all the spaces will lose credit.

Question 10

(a) This was very well answered and most candidates gained full credit.

(b) The majority of candidates across the ability range correctly read the optimum temperature from the graph. The most common reason for loss of credit was to suggest body temperature (37 °C).

(c) (i) Most candidates gained at least partial credit here, stating correctly that the increase in temperature caused an increase in reaction rate. The reasons then given for this correlation were less secure. Incorrect suggestions included the idea that the enzyme shape becomes somehow altered to make it more efficient, or that the enzyme molecule vibrates more quickly.

(ii) Candidates were generally more likely to gain full credit for this question compared to part **(i)**. The decrease in reaction rate caused by the denaturing of the enzyme was frequently stated. Many candidates also showed good understanding of the meaning of denaturation in terms of molecular shape.

COMBINED SCIENCE

Paper 0653/33
Extended Theory

Key Messages

Candidates should be aware of the command words contained in the question when considering their answers; for example, the word 'describe' requires a different type of response to the word 'explain'.

When describing what is seen during a chemical reaction, precise detail is required. A description of a colour change should include the actual colour change, not just the simple statement 'It changed colour'.

Physics formulae and chemical equations should be written with the correct symbols or words, and should not include units or be a combination of symbols and words.

General Comments

There were some excellent scripts seen from candidates who had mastered all aspects of the syllabus and who demonstrated good examination technique. There was no evidence that candidates had difficulty in completing the paper in the required time. In general, candidates had prepared themselves equally well for all of the Science disciplines, and they usually suggested sensible answers to questions that were set in unfamiliar contexts and required understanding of Science rather than straight recall of facts.

The majority of candidates used the available space on the examination paper appropriately. Centres should continue to make it clear to candidates that the space allocated for a response, along with the marks available, indicates the length of response and level of detail expected. Handwriting was legible in the vast majority of scripts; a few candidates needed to take more care with their writing so that their responses, particularly the key words, could be read clearly.

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

Comments on specific questions

Question 1

(a) (i) Many candidates successfully gave the required balanced equation. Common examples of incorrect formulae seen were HCl_2 used as the formula for hydrochloric acid and 2H for the hydrogen molecule. Candidates should be aware that words or a combination of words and symbols will not be awarded marks when a question specifies a balanced symbol equation.

(ii) This question was very well answered by most candidates who correctly placed the metals in their order of reactivity.

(b) (i) Many candidates wrote that copper metal was produced. Fewer candidates correctly described the colour change of the solution to a colourless. The question asked for a description of what is seen, and not an explanation.

(ii) A comparison of the reactivity of magnesium and metal **X** was required here. Many candidates successfully did this and so gained credit. Both metals had to be mentioned in the response for the comparison to be made correctly; a minority of candidates discussed the reactivity of magnesium chloride, not magnesium.

(c) (i) Many candidates gave the correct definition for reduction. Candidates are reminded of the meaning of the word reduction within a chemical context. Answers describing reduction as 'getting less of a compound' or 'the removal of oxygen from an element' could not be credited.

(ii) Many candidates correctly identified the cathode as the negative electrode, able to attract the opposite charge on the metal ion. Some candidates gave explanations referring to positively charged metallic ions present in electrolytes. It was important to emphasise the ionic form of the metallic particles in an electrolyte. Statements such as 'Metals are positively charged' did not gain credit.

Question 2

(a) Many of the higher-scoring candidates correctly gave 'ecosystem' as their response. Candidates should remember that the community of organisms does not include the woodland.

(b) Many candidates gave the correct definition of a consumer. Although carnivores and herbivores are consumers, definitions of carnivores and herbivores were too specific to gain credit.

(c) The great majority of candidates correctly drew a food chain from the food web; some candidates gave food webs including organisms not contained in the given web and lost marks.

(d) Many candidates successfully described two methods of energy loss in food chains. Others responded in terms of competition between members of the food web.

(e) This question was generally well answered. Most candidates correctly described the ability of trees to reduce the carbon dioxide concentration and increase the oxygen concentration of the air. Candidates who correctly related this to the process of photosynthesis gained full credit. Answers such as *Trees absorb carbon dioxide and give out oxygen* and *Trees convert carbon dioxide to oxygen* did not include sufficient detail.

Question 3

(a) (i) The majority of candidates obtained this mark.

(ii) Most candidates correctly stated that 1.2 A is a measure of the current that will flow through the bulb when it is lit. A simple statement that 1.2 A means 1.2 amperes was insufficient for credit to be gained.

(iii) This question was well answered by most candidates who gave the correct formula, calculation and units. Candidates are reminded that formulas should be given using either correct symbols or words; units in place of symbols or words are not credited.

The majority of candidates correctly gave Ω as their unit of resistance.

(b) A few of the stronger candidates gained full credit in this question. The energy transfer from chemical energy (in the battery) to electrical energy in the torch was correctly identified by some candidates; only a few gave the second energy transfer of electrical energy to both light and thermal energy. Incorrect answers included the statement that electrical energy is transferred to light energy which is then turned into thermal energy.

(c) (i) There were many well-drawn diagrams that gained full credit. Candidates are reminded that light rays travel in straight lines and should be drawn with the aid of a ruler. Candidates who took care over their diagrams made sure that the ray of light met the mirror before being reflected, showing the ray as a continuous line, with no gaps.

(ii) This question required the candidates to link the fact that light travels very fast with the inability of the human eye to detect the time delay.

Question 4

(a) (i) Most candidates successfully identified fractional distillation as the process.

(ii) The relationship was correctly described by many candidates who wrote that the boiling point of thee fraction reduces as you go up the tower. Many other candidates described the boiling point as increasing as you ascend the tower. Some candidates gave a general description of how the separation occurs without mentioning the fact that temperature of condensation decreases higher in the tower.

(iii) Many candidates successfully described the relationship between the boiling point and size of molecule; fewer went on to explain the reason for this relationship. Candidates were also required to explain this relationship. Answers that were awarded full credit stated clearly that intermolecular bonds are broken at the boiling point. Statements such as *There are more bonds to be broken* could not gain credit since these bonds could have been covalent bonds within the molecules.

(b) There were some excellent explanations of the greenhouse effect of increased carbon dioxide in the atmosphere. A description of the effect of carbon dioxide in the atmosphere on the absorption of radiation from the sun was needed to gain this mark, rather than the simple statement that *Carbon dioxide is a greenhouse gas*. References to the ozone layer were frequently given and were not relevant to this question.

(c) (i) Many candidates successfully drew the structural formula of ethane. Methane was a common error.

(ii) A few of the stronger candidates responded by stating that the double bond formed during cracking making the molecules more reactive. Candidates should be aware that some of the smaller molecules produced by cracking are more reactive because they are unsaturated.

Question 5

(a) (i) Many candidates correctly identified the energy transformation.

(ii) Many candidates answered this correctly.

(b) (i) Many candidates scored full credit in this question. Other candidates need to remember that the formula should not be given as a combination of words and symbols.

(ii) Many candidates successfully calculated the kinetic energy of the boy. A few candidates forgot to square the velocity so did not gain credit.

(c) There were many correct responses given showing infra-red in the correct box. Candidates who filled in all of the boxes on the spectrum without indicating which part of the spectrum is utilised by remote control devices could not get the mark. Other candidates gave radio waves as their response.

Question 6

(a) (i) Some candidates correctly gave zygote as their answer. Many others wrote the names of either the sperm or egg.

(ii) Some of the descriptions were excellent, describing the ball of cells continuing its development in the lining of the uterus. Other descriptions mentioned the uterus and did not mention the lining. Candidates are reminded to read the question carefully, as it required them to describe in detail where the development continues.

(b) (i) There were several acceptable responses to this question so a wide variety of responses gained credit. There were many responses that were not acceptable since they could apply equally well to bottle-feeding. Examples of these are *It is more convenient*; *It is quicker*; *It is best for the baby*.

(ii) There were several acceptable responses to this question so, again, a variety of responses gained credit. As in **(b)(i),** reponses that applied equally well to breast-feeding were not acceptable without further explanation.

(c) (i) This question was well answered by the majority of candidates who successfully subtracted the mass of the nutrients from 100 g. Some candidates did include the masses of vitamin C and calcium in their calculations; this often caused arithmetic errors. A small number of candidates successfully added the ingredients but then did not subtract them from 100 g.

(ii) This question was well answered by most of candidates who calculated the amount of energy that could be released by both the carbohydrate and fat and wrote a relevant conclusion.

Question 7

(a) Correct diagrams were drawn by many candidates. A few candidates drew just a single atom with eight electrons in its outer shell.

(b) The physical state of a gas was correctly stated by most candidates and the colour correctly predicted by the stronger candidates.

(c) This question required both a description of what is seen and an explanation. Correct responses gave a detailed description of what is seen when chlorine solution is added to potassium bromide solution. Candidates are reminded that *It changed colour* does not include enough detail to gain credit. Some candidates incorrectly described the displacement of potassium and its subsequent reaction with water.

The explanation had to include a reason for the colour change in terms of displacement of bromine by the more reactive chlorine. Candidates should be aware that it is the element that is displaced, not the ion. Those who wrote that bromide was displaced could not gain credit

(d) (i) Uses of noble gases had generally been well learned by most candidates.

(ii) This question was generally well answered. The majority of candidates correctly stated that the elements of Group 0 are unreactive. Fewer described this in terms of outer shell electrons. Statements such as *They have a stable structure of electrons.* did not have enough detail to gain credit.

Question 8

(a) (i) Some candidates correctly described how the arrangement of molecules changes during evaporation. Others described how the energy or speed of molecules changes so no credit could be awarded.

(ii) Candidates found this question challenging. What was required was a description of the energy transfer from the air molecules to the water molecules inside the swamp cooler. Many candidates attempted explanations based on convection and these could not gain credit.

(b) Candidates needed to make clear that white colours reflect radiation from the sun. Many candidates did not address the question, instead referring to black surfaces as being good absorbers of heat energy.

(c) (i) Some candidates correctly wrote that the sound was produced by vibration of the fan causing the sound wave to be generated in air. Others did not mention that vibrations are needed to create sound.

(ii) Many candidates stated that sound travels as a wave.

Question 9

(a) The majority of candidates answered this well. A statement that blood goes to two different places was insufficiently detailed for credit.

(b) (i) Many candidates successfully completed this question. Many incorrect answers were from candidates confusing the functions of the different sides of the heart.

(ii) Stronger candidates gave good descriptions of the reason for a higher pressure in **Q** than **P**. Weaker candidates needed to say which vessel contained blood of a higher pressure. Some candidates confused the functions of vessels **Q** and **P**.

(c) (i) Stronger candidates realised that the cells in the tissues of the small intestine will still need a supply of oxygen for respiration which cannot be absorbed from the digestive system.

(ii) This question was well answered by many candidates. Candidates who referred to molecules in their undigested form, for example starch or protein, did not gain credit for these responses.

COMBINED SCIENCE

Paper 0653/04

Coursework

(a) Nature of tasks set by centres.

Of the Centres that submitted coursework for the June examination most had provided coursework in previous years and acted on advice given.

Several Centres provided a very comprehensive portfolio of practical exercises. In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. Centres are reminded to select tasks that meet the requirements of the syllabus.

(b) Teacher's application of assessment criteria.

In most Centres the assessment criteria were understood and applied well for all of their activities. There has been a steady improvement in the Centres' application of assessment criteria. Centres are reminded that it can be difficult to assess candidates for following instructions and planning in the same assignment.

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

Tick lists remain popular with particularly skill C1.

Many Centres write brief summaries on each candidate's script. The use of annotations to indicate where and / or to justify how credit has been awarded, continues to be helpful.

(d) Good practice.

Many Centres have developed a booklet of tasks and dedicated assessment criteria.

COMBINED SCIENCE

Paper 0653/51

Practical Test

Key message

It is essential that candidates read through each question before carrying out practical work, constructing tables and in particular choosing scales for graphs.

General comments

Generally the exercises were carried out well and candidates were able to complete this paper in the one and a half hours allocated. Candidates should record their actual observations in the Chemistry question and not what they expect to see. A solid formed when one liquid is added to another should be referred to as a precipitate (ppt) and cloudy is not an alternative adjective for white or milky because clouds can vary in colour.

Comments on specific questions

Question 1

Most candidates were able to carry out this experiment and obtain viable results without having to write maximum next to their readings. The number of drops used for each concentration was very variable although the values could give a reasonable graph in most cases. Some candidates included fruit juice as part of the x-axis of the graph and clearly did not understand the meaning of part **(c)**. There were a small number of curves despite the instruction to draw the best fit straight line. Few scored full credit in part **(c)**, either because the result for the juice did not fit on the graph or no mark was made on the graph as instructed.

The most common answer in part **(d)** concerned the volume of a drop but unfortunately many candidates gave as an improvement the use of a measuring cylinder which was not accepted. Others appreciated the benefit of using more drops of DCPIP; few followed this up with the need for larger containers. Answers involving stirring were rarely seen.

Question 2

Generally this experiment worked well and those who followed the heating instructions in part **(a)** obtained useful results. Candidates should be reminded that the white precipitate produced by bubbling carbon dioxide through limewater may be described as milky, as in the Notes for use in Qualitative Analysis, but not as cloudy. Many assumed that something should have happened to the solid so made up a description with some candidates even saying that it had melted. Parts **(b)** and **(c)** were usually well answered although there were some poor descriptions of precipitates.

The last part proved to be highly discriminating, partly because insufficient heating in **(a)** to produce the carbonate affected the results in **(d) (ii)** and partly because of the dependence on the quality of their observations in the previous parts.

Question 3

The Physics exercise was well answered. The most common errors were: not recording length, breadth and height to the nearest 0.1 cm, and recording the density value to an inappropriately low or high number of significant figures. Rather pleasingly, the values of density given were invariably realistic.

Both reasons for inaccuracy were commonly seen and some candidates attempted a detailed description of why it was difficult to measure to the centre of the block on the balanced metre rule.

COMBINED SCIENCE

Paper 0653/52

Practical Test

Key message

When recording data from measuring instruments it is important to use an appropriate number of decimal places consistently.

General comments

Generally the exercises were carried out well and candidates were able to complete this paper in the one and a half hours allocated. In the Chemistry question, candidates should record actual observations and not what they expect to see. No reaction observed when using qualitative tests simply that a particular ion is not present and this should be recorded.

Comments on specific questions

Question 1

The times for the agar block to go colourless varied enormously; however all candidates obtained results which allowed them to proceed with this question. Tables were poorly drawn although the necessary figures were present. Many candidates need practice at this task which should include the use of a ruler. Most candidates understood that the alkali in the agar had been neutralised but far less understood or stated that the process involved diffusion.

All possible answers to part **(d)** were seen but the most common response involved the volume of acid used in the experiment. Answers to part **(e)(i)** were generally weak and many candidates thought this was just a surface area effect or just a volume effect rather than a surface area-volume ratio effect. Most candidates appreciated the need to repeat the experiment using different sizes of blocks in part **(e)(ii)**.

Question 2

A large range of colours was reported in part **(a)(i)** but despite this the experiment worked well and gave results which allowed correct conclusions to be made at the end. Part **(a)(ii)** gave a negative result but all too often candidates felt that that it should be positive and so made up a result. Negative results are important to eliminate ions in analysis. It was pleasing that candidates who recorded 'grey ppt' for the silver nitrate test concluded that a chloride was not present.

Some candidates do not use the word precipitate (ppt) for a solid formed by the addition of two liquids despite this being used throughout the Notes for Qualitative Analysis on the last page of the question paper. Some candidates confused residue and filtrate but were allowed this error carried forward to the conclusion. Conclusions that a cation was iron were not accepted. It is essential that the correct oxidation state of iron is used, for example iron(III).

Question 3

Generally this experiment was carried out well but marks were often not obtained due to poor recording, such as inconsistent use of significant figures and decimal places. For example, when a value is a whole number and data is being recorded to one decimal place, 2.0 should not be recorded as 2. Most candidates knew the unit of current. Values of *V* and *I* were sometimes unexpected but in the majority of cases this was probably recording due to the recording of current values in the voltage column and vice versa.

Power calculations in part **(b)** were done well but many candidates did not state that the lamp became dimmer.

COMBINED SCIENCE

Paper 0653/61

Alternative to Practical

Key Messages

Candidates are expected to have carried out experiments and be familiar with experimental techniques similar to those shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters etc.

General Comments

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

Candidates should be reminded that where handwriting is not clear, the Examiners are unable to award credit.

Comments on Specific Questions

Question 1

An investigation into the vitamin C content of a fruit juice.

(a) and **(b)** Some results were given showing how much vitamin C of various concentrations was needed to decolourise DCPIP. Candidates were instructed to plot a graph with the vitamin C concentration on the horizontal axis, but a large number of candidates plotted the graph with reversed axes. A significant number of candidates tried to plot the fruit juice as a fifth point (at a concentration of 1.25%). The correct way is to clearly draw lines on the graph from the number of drops to the line and then drop it down to the vitamin C value.

(c) The use of a 'control' experiment was not well known, candidates instead thinking this was a way of diluting the vitamin C even though there was no vitamin C present.

(d) A number of candidates realised that the adding of drops is not very accurate although few explained how a syringe for example could be used for increased accuracy. Many incorrectly thought that repeating the experiment would increase accuracy.

(e) The repeating of an experiment in itself does not improve the reliability (or repeatability) of the results. The results need to be studied and averaged or checked for outliers which could be ignored.

(f) Scurvy was expected as the response, however a number of candidates gave specific symptoms for example bleeding from the gums. Some responses were too general, for example feeling unwell, to be awarded credit and some candidates gave rickets, which is caused by a deficit of vitamin D.

Question 2

A study of sodium hydrogencarbonate and sodium carbonate.

(a) Candidates generally need to improve their drawing of diagrams; the diagrams drawn here were of a very poor quality. The information given was clear that the reaction vessel was a test-tube with a delivery tube to a test-tube containing limewater. Most candidates were aware that the carbon dioxide evolved produced a white precipitate with limewater, however only the most able were aware that the precipitate dissolves again as more carbon dioxide is bubbled into the limewater.

Finding the boiling point of water droplets is not practical, neither is distillation and Universal indicator would show the sample was neutral, but not that it was water. The use of anhydrous copper(II) sulfate or cobalt chloride was not very well known.

(b) As candidates were told that sodium hydrogencarbonate is a weak alkali in solution many knew that the Universal Indicator would turn blue, but a number gave purple as the final colour. The addition of an acid to the solution to produce carbon dioxide gas was not well known.

(c) A number of candidates seem to assume that the use of limewater mean would mean that it would produce a precipitate, but sodium carbonate is thermally stable and the limewater will remain colourless. When told that the solution is more alkaline than the previous one most candidates knew the Universal Indicator would reach a darker colour. Candidates struggled to name the blue precipitate formed when sodium carbonate solution is added to a solution of copper(II) sulphate; very few candidates suggested a copper compound.

Question 3

The density of a block of plasticine.

(a) The candidates were instructed to use a ruler to measure the lengths of the arrows in order to calculate the volume of a plasticine block. Many candidates measured the three dimensions accurately, and subsequently calculated the volume. Some candidates were rather careless in recording their measurements.

(b) Many candidates correctly used the diagram and information given to give the correct value for *x*. Others did not use the information and gave 69 cm or 4 cm. Most candidates correctly used their answers to calculate the density of the block.

(c) When asked to suggest two reasons for any inaccuracy, Examiners are expecting possible errors in the actual method used. In this question, responses such as the difficulty in moulding the plasticine into a regular block, the difficulty in finding the balance point of the rule or the difficulty in finding the centre of the block, would have gained credit. The general answer 'human error' is too vague to be creditworthy.

Question 4

A question looking at onion cells using a light microscope.

(a) Candidates were asked to make a drawing of cell **A** from the photograph, not a drawing of a cell they may have previously studied, therefore drawings with vacuoles, chloroplasts etc. were not credited. A cell membrane was expected and the nucleus should have been shown in a similar position as on the photograph.

(b) Many candidates correctly calculated the average length of the cell, but significant number were unable to state that the field of view of the microscope was 6 mm. Although most candidates correctly calculated the magnification, a number inverted the values.

(c) Many gained credit for this part, although some correctly stated that a vacuole was missing having drawn it in **(a)**.

(d) Most candidates knew that iodine stained starch blue-black.

Question 5

An investigation involving the cooling of a hot liquid.

(a) Almost all candidates gained full credit for the reading of the thermometers. The graph was generally well attempted, a few swapped the axes around and some did not fully label the axes with the name and unit. The biggest error however was not following the points and not drawing a plateau at 69 °C. Although candidates are expected to ignore one possible outlier, there were three points here and as such the curve should follow the points. Most candidates realised that the plateau (whether drawn or not) corresponded to the melting point of the liquid.

(b) This question proved difficult to all except the most able candidates. Some candidates did not appreciate the substance was cooling and therefore changing from a liquid to a solid, in fact many answers suggested that they thought it was a liquid throughout with the temperature rising.

Question 6

The relationship between voltage, current and resistance was investigated.

(a) The majority of candidates knew the apparatus required to measure the potential difference and current but fewer could draw them correctly in a circuit. Incorrect symbols and arrangements were seen; voltmeters in series and ammeters in parallel being common errors. Although many candidates gave the correct formula for calculating resistance, a number gave the unarranged formula V = IR.

(b) Many candidates had an almost correct line but it did not always pass through or reach the origin. The unit of resistance was reasonably well known, but R, watts, and joules were also seen.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key Messages

Candidates are expected to have carried out experiments and be familiar with experimental techniques similar to those shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters etc.

General Comments

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

Candidates should be reminded that where handwriting is not clear, the Examiners are unable to award credit.

Comments on Specific Questions

Question 1

An investigation into the movement of acid into different sized agar blocks.

(a) Most candidates knew that the colour of the agar was due to the pH of the agar being above 8 or alkaline.

(b) Almost all candidates constructed a workable table, with a number of headings acceptable. The instruction to record the time in seconds was included twice, once in bold, but a number of candidates wrote their answers in minutes and seconds which was not creditworthy.

(c) Some candidates confused the process by which the acid moves into the agar, diffusion, with the reason the indicator turns colourless, neutralisation.

(d) Most candidates were able to link the faster time with the smaller dimensions of the cube, but not all were able to link this to the thin walls in the alveoli enabling efficient gas exchange.

(e) The extension to the experiment expected was to use a greater range of block size. Full credit was given to candidates specifying one other size block. The labels to the axes were not well done. Candidates were expected to label time on one axis and a dimension (volume, surface area, size etc) on the other. A line or points were not needed.

Question 2

An unknown solid, a mixture of two salts which have the same anion, was investigated.

(a) Candidates need to appreciate that negative results in chemical tests are just as important as positive tests. Therefore if there are no bubbles produced when an acid is added to the unknown solid we know that a carbonate ion is not present. Many candidates were able to name silver nitrate as one of the reagents required to identify chloride ions; fewer realised that nitric acid is also required. Most knew the term for the reaction that gives out heat.

(b) Many candidates were aware that the cations present were copper and iron, but did not indicate which iron ion. Any indication of '2' was acceptable. Most candidates realised that filtration will separate a precipitate but a few did not show a funnel and filter paper, thus being unable to gain credit. The majority of candidates realised that the precipitate darkens or turns brown, but fewer gave oxidation as the process that darkens the precipitate. Combustion, diffusion, rusting and 'the Haber process' were among the answers seen.

Question 3

An experiment with a resistance wire.

(a) Candidates are reminded that when completing tables their values should be quoted to the same number of decimal places as already shown. Therefore 1.3 has an insufficient number of significant figures in this case and 1.30 is expected. When calculating the power in part **(ii)** candidates were asked to record the values to an appropriate number of significant figures. Two or three were acceptable providing the same was used for all entries and any rounding required was done correctly. The observation that showed the power produced by the lamp decreases is that the lamp becomes dimmer or less bright. No credit was given to comments about the meter readings.

(b) Candidates had to calculate V / l. The results should have been recorded to a consistent number of significant figures. The suggestion by the teacher was incorrect. If the teacher's suggestion had been correct, the sketch graph should have been a straight line through the origin. As the values calculated were not constant, candidates should have disagreed with the statement.

Question 4

An investigation into water uptake of a plant.

(a) Many candidates thought that the process described was photosynthesis rather than transpiration. The evaporation of water creating a constant flow of water through the stem was not well known,

(b) While most candidates knew that the uptake of water would increase in windy conditions, few gave enough experimental details. Examiners needed to know how the conditions would be altered (for example the use of a fan or hair dryer), what would be recorded (the distance moved by the bubble in a set time), what would be kept constant and the use of repeats. The number of marks available for this part question should be a guide to candidates that more than one solid point needs to be made.

(c) Candidates had to measure the start and end point of an experiment. Candidates were not told from where to measure the bubble. Provided the candidate was consistent in which part of the bubble was used, credit was awarded.

(d) Most candidates gave humidity or temperature as an environmental factor that affects the rate of water uptake.

Question 5

(a) A large number of candidates did not read the question stem, where it was clearly stated that only solutions **A**, **B** and **C** were available, and no other reagents could be used. More able candidates realised if the solutions really were as labelled then, if hydrochloric acid was added to sodium carbonate solution, bubbles should be evolved. This does not prove the identity of either but means that the third solution must be barium chloride. Knowing that **C** was barium chloride this could be added in turn to the other solutions to identify them, barium chloride and hydrochloric acid showing no reaction.

(b) Most candidates knew that **A** and **B** were the solutions required and that evaporation was required although a significant minority thought the process was filtration. The diagrams were again variable. A watch glass heated on a beaker of hot water was expected, but any valid method was accepted.

(c) Most candidates knew the correct test for zinc ions, but not all remembered that the white precipitate dissolves in excess.

Question 6

The efficiency of a heating element was calculated.

(a) Many candidates had no difficulty following the instructions and gaining full credit. Some candidates failed to note that the experiment took an hour therefore the number of seconds was 3600 not 60 or any other made up figure.

(b) Most candidates correctly read the thermometer. A number gave 80.3 instead of 83. To complete the calculation, candidates had to refer to Fig. 6.1 which indicated 500 g of water present.

(c) Many candidates gave the correct answer. Candidates who had made previous errors in part **(a)** or **(b)** could still gain full credit in this section if they used their incorrect values correctly.

COMBINED SCIENCE

Paper 0653/63

Alternative to Practical

Key Messages

Candidates are expected to have carried out experiments and be familiar with experimental techniques similar to those shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters etc.

General Comments

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

Candidates should be reminded that where handwriting is not clear, the Examiners are unable to award credit.

Comments on Specific Questions

Question 1

A photograph of a flower in section was shown and candidates were asked to make a pencil drawing of it and answer questions on their drawing.

(a) A reasonable likeness detailing the petals, male and female parts was expected. Some candidates omitted this question. Candidates were asked to label a carpel and stamen. It was not sufficient to label parts male and female alone.

(b) A pre-drawn line on the photograph had to be measured in mm. Some candidates did not use rulers and others did not answer this part. Some gave their answer in centimetres. Candidates must read the question and follow instructions.

(c) Having measured the corresponding length on their drawing candidates had to calculate the magnification. Many found this challenging. Some subtracted one length from the other and a number divided the photograph length by their length rather than the other way around.

(d) The positioning of a **Z** on the stigma was very hit or miss.

(e) Candidates had to show that they knew from which part of the flower pollen is collected and how to view the pollen after collection; some candidates suggested the use of a telescope.

Question 2

This question involved the identification of some solutions of unknown chemicals.

(a) By studying the table of observations it should be possible to identify which pair of unknowns were sodium carbonate and hydrochloric acid. The only combination which produces bubbles is **A** and **F**. Sulfuric acid can be used to distinguish between the unknowns; the sodium carbonate producing effervescence and the hydrochloric acid showing no observable reaction. It should be noted that observations were asked for, not the names of products.

(b) The next pair of unknowns to identify were copper(II) chloride and sodium hydroxide. Candidates were asked for the observations when aqueous ammonia was used to distinguish between the pair. Again, observations were required and not the product names. A blue precipitate changing to a dark blue solution when excess was added was expected for copper(II) chloride. This answer was rarely seen.

(c) Hydrochloric acid cannot be used to distinguish between zinc sulfate and barium chloride as there would be no visible change. Candidates were asked to name a different acid. Despite this a number gave hydrochloric as their acid of choice. Sulfuric acid was expected as it will give a white precipitate with barium chloride, the test for sulfates.

Question 3

An investigation to find out if the rate of cooling of a beaker of hot water depends upon the temperature of the water.

(a) When given a table to complete candidates are expected to use the same number of decimal places as already given. Therefore a thermometer reading of 71 °C should be recorded as 71.0 (°C).

(b) When drawing graphs, candidates should be encouraged to use as much of the paper as possible. When told in the question that an axis need not start at 0 candidates should start elsewhere, in this case, at somewhere between 50 and 60. Other points to note are that the axes should be labelled with a name and unit and, if asked for a best fit curve, the line should not be drawn with a ruler. A smooth curve passing through as many points as possible, avoiding any obvious outliers is expected.

(c) Candidates were asked to calculate the rate of cooling during two different 90 second periods. This required two temperature falls to be found from the graph and then divided by 90. Many candidates managed this successfully, but others read their graphs incorrectly or divided by 390. Many incorrectly rounded 0.078888 to 0.078 rather than 0.079.

(d) Altering the temperature of the water was the most common response to this question, despite the question asking for factors other than the initial temperature of the water.

Question 4

An investigation into the effect of exercise on heart rate.

(a) Most candidates knew the effect of exercise on pulse rate.

(b) Candidates were given a table showing the number of beats in 15 seconds and told to complete the column to show how many beats per minute. Many candidates multiplied by 4 with no problem, others produced answers that bore no relation to the figures given. Reading column headings in tables carefully is as important as reading the question carefully.

(c) Candidates had to use their figure from above to calculate the aerobic fitness and hence the fitness rating of the candidate. Most managed this successfully whatever value was calculated in **(b)**.

(d) Results from identical twins were shown. The figures, although very close, gave the twins different fitness ratings. Candidates were expected to comment that although the table gave them different ratings in reality the figures were so close together that there was no real difference or there was an arbitrary cut off between 60 and 61.

Question 5

An investigation into the solubility of potassium nitrate.

(a) The size of the grid provided should enable the candidate to use the entire area. Some candidates reversed the axes. The points were carefully chosen so that a smooth curve could be drawn through all the points. The curve could then be extended to cross the vertical axis at about 15 g. Providing the candidate made a reasonable attempt at the extension, credit was awarded. An extension to the origin was not accepted as it was too far away from the pattern of the plotted points.

Candidates were told that a potassium nitrate solution was still a liquid at 0 °C. Many suggested that the effect was to lower the freezing point of water. Candidates were then asked to calculate the mass of solute that would be precipitated if a saturated solution was cooled from 65 °C to 25 °C. The candidate was instructed to show the working on the graph. Lines were expected to be seen at these temperatures linking to the mass of solute. Most calculated a value of about 90 g. Candidates that did not draw lines on the graph were not awarded full credit.

(b) Few candidates suggested valid reasons for the temperature to be measured as it cooled rather than when it was heated. Suggestions seen and credited included the fact that heating occurred at one position only or that as cooling was a slower process it was easier to concentrate and see when crystals started to form.

Question 6

The roles of current, voltage and resistance in a circuit were investigated.

(a) A circuit was drawn with three errors, Candidates had to redraw the circuit with the errors removed. Some seemed to redraw it with no changes or by simply moving the variable resistor. Others left the space blank. Two dials were shown and candidates had to read the current and voltage shown. The expected answers were often seen, but some candidates introduced an accuracy that was unavailable from the scales shown e.g. 0.325 A, or values that were a nonsense e.g. 1.5.5 V. Candidates were asked to calculate the resistance using their figures and provide a unit; Ω or 'ohms' were acceptable, but not R, V, A or joules.

(b) Finally candidates were asked to state what would happen when the variable resistor was turned to its highest setting and then explain the observations made when the resistor was set at its lowest resistance. Most correctly answered the former, but few gave full answers to the later, missing out that the lamp gets brighter due to more current before the filament melts or the lamp 'blows', as the current supplied gets too high.