COMBINED SCIENCE

Paper 0653/04
Coursework

General Comments

This was the last examination series in which Coursework was available, and there was only a very small number of entries.

Coursework assessment involves identifying activities that involve learners in developing and demonstrating their abilities in each of the components of AO3, Experimental skills and observations. Learners are assessed against the criteria in the syllabus, and given focused, individual feedback on their performance. This helps them to identify what they can do to improve their skills within each area. This approach – Assessment for Learning – will continue to be of great value for learners who enter for Paper 5 and Paper 6.

There is also considerable benefit in the use of relatively unstructured tasks, where learners are required to make decisions for themselves rather than following a series of numbered steps. Such approaches encourage deeper understanding and confidence in various aspects of practical work, such as planning experiments involving variables, deciding what to measure and how to record and display results, drawing conclusions and evaluating the reliability of results. Learners who have had this type of experience will be well prepared for Paper 5 and Paper 6, as well as developing a secure foundation in experimental skills on which they can build beyond IGCSE®.

COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

General comments: Biology

There was evidence of candidates rushing into an answer without reading the question carefully in the biology section of the paper – particularly with reference to **Question 8**.

Comments on individual questions

Question 1

As long as candidates knew that movement is a characteristic of all living organisms, and that eating meat, hearing and growing hair are not, then selecting the correct answer posed few problems.

Question 7

The better candidates knew the function and position of xylem tissue in a stem, a root and a leaf, but it was evident that a sizeable majority had no clear idea of this, and, with large numbers selecting each of the options, guesswork was very much in evidence.

Question 8

X on the diagram was carefully positioned to show the structure (bronchiole) leading to the alveolus. It appears that a majority of candidates saw a diagram that they recognised as an alveolus and, without a careful examination of the requirements of the question, unwisely selected alveolus as their answer.

Question 9

Those who had not seen a clinostat in operation were required to apply their knowledge of tropisms to arrive at the answer. Unfortunately, candidates did not appreciate that rotation of the seedling would have the effect of the light source acting equally on all sides of the shoot allowing it to grow vertically upwards, and thus were attracted by the answer showing the shoot having developed a spiral pattern of growth.

General comments: Chemistry

Candidates performed very well on **Question 15**, **Question 18** and **Question 25**.

Question 17 and **Question 24** proved most difficult for the candidates.

Comments on individual questions

Question 15

Candidates understood chromotography well with most candidates having no problem interpreting the chromatogram.

Question 17

The incorrect **C** was chosen more often than the correct answer, **D**. Candidates did not understand well enough that metals and non-metals combine by the loss and gain of electrons, instead thinking that the electrons are shared.

Question 20

Most candidates correctly identified the reaction as exothermic with only a few candidates choosing **A** or **B**. However, **C** was a popular incorrect answer.

Question 24

Option **D** was chosen more often than the correct answer, **A**. Candidates had not learned well enough the trend in the physical properties of the Group VII elements.

Question 25

Candidates had very little problem identifying option **C** as a useful property of an alloy used to make coins.

General comments: Physics

In the physics section of this paper no questions were found to be particularly easy, but **Question 33** and, particularly, **Question 34** proved difficult.

Comments on individual questions

Question 28

This question concerned a speed-time graph and there was some confusion with a distance-time graph, leading to a choice of option **C**.

Question 30

More candidates chose distractor **B** here than the correct **A**, believing that a battery stores electrical energy.

Question 33

The topic here was thermal energy transfer. There was considerable guessing, and many chose option **A**, perhaps not reading the question carefully and giving the methods that were *reduced* by the vacuum.

Question 34

For this question on wave frequency, many candidates correctly divided the number of wavelengths by the time taken, but overlooked the fact that the time must be changed to seconds, therefore choosing **C**.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

General comments: Biology

Question 2 was found to be very difficult and underlines an almost universal misapprehension amongst the candidates about the nature of diffusion.

Comments on individual questions

Question 2

It was clear that candidates were unaware that the movement of molecules during diffusion is a random process, but with the greater majority moving from a high to a low concentration. Unaware of this, candidates overwhelmingly opted for the answer that *all* movement of molecules is in that direction.

Question 3

This question discriminated extremely well between candidates of differing abilities, with a very large proportion of those who gave the correct answer being among the more able performers in the test as a whole.

Question 4

This question tested two pieces of knowledge: the chemical nature of enzymes, and then how to test for that particular chemical. Again, the better candidates managed both steps successfully, but there appeared to be a degree of guesswork amongst the remaining candidates.

Question 12

This was a case of the necessity to read the question carefully before answering. Candidates were asked for the source of the energy *in both cases* – heat from a fire and heat from muscular action. It seems that it was the muscular action that caught candidates' attention and thus that fact that the Sun is the initial supplier of energy was overlooked.

Question 13

It is reassuring to see that ecological/global issues are so well understood, and that a question on the dangers of deforestation proved to be the easiest in the biology section of the paper.

General comments: Chemistry

Question 16 and **Question 18** were the most straightforward for the candidates. **Question 23** gave candidates the most difficulty.

Comments on individual questions

Question 16

Candidates demonstrated that they understand well the difference between physical changes and chemical changes.

Question 17

Option **C** was chosen more often than the correct answer, **D**. Candidates did not understand well enough that metals and non-metals combine by the loss and gain of electrons, instead thinking that the electrons are shared.

Question 18

Candidates demonstrated that they clearly understand what changes word equations represent.

Question 23

Option **B** was a popular incorrect answer. This may have arisen if a significant number of more able candidates had recognised that carbon dioxide can be derived from carbonates, although incorrectly so in this question in which the conditions are basic rather than acidic.

General comments: Physics

In the physics section of this paper no questions were found to be particularly easy, but **Question 35** and, particularly, **Question 30** proved difficult.

Comments on individual questions

Question 29

The fact that only the weight of the samples must be identical eluded many candidates, who appeared to resort to guessing.

Question 30

A very large proportion of candidates were unable to deduce that the parachutist must be transferring gravitational energy to thermal energy since her kinetic energy was constant.

Question 33

The centrally-placed heater in this question caused difficulty for almost half the candidates. Almost one in four chose the familiar-looking diagram **C**.

Question 34

The topic here was wave amplitude, and **D** was a popular choice (being twice the correct value). This is a common misconception that needs to be stressed in teaching.

Question 35

The incorrect **D** was chosen by more candidates than the correct option **B**, these candidates probably looking for a familiar ray pattern on the right of the lens.

Question 39

More than a third of candidates chose the 13.0 A fuse, mistakenly believing that a wire capable of carrying a current of up to 10.0 A must always carry that current.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

General comments: Biology

The biology section of the paper included one or two questions that candidates were able to take comfortably in their stride, but also exposed a few areas where knowledge was rather less than secure. Also, there was evidence that a little more careful thought before answering might have paid dividends for some candidates.

Comments on individual questions

Question 1

This question provided an encouraging welcome to the paper, with candidates having little difficulty identifying the characteristic as sensitivity.

Question 5

It is always tempting for a candidate to opt for a correct statement – in this case 'The stomach does not produce a starch-digesting enzyme'. However, it is essential that the question is read carefully and then one's biological knowledge is applied to the situation. If this had been the case, then candidates might have realised that there will be plenty of amylase present, but the pH will be unsuitable for its action.

Question 7

Candidates are to be congratulated here as there was a pitfall many managed to avoid by reading the question. By so doing, they remembered to divide the loss in mass by 2 in order to arrive at the loss per hour.

Question 12

It was significant that the most popular belief was that stage 4 in the diagram produces oxygen even though the diagram indicated that stage 4 is releasing carbon dioxide. However, this served to exemplify the common confusion that exists between the gaseous exchange involved in the processes of respiration and photosynthesis.

Question 13

This question served to expose a fairly common gap in the candidates' knowledge of deforestation with many candidates not appreciating that deforestation can lead to soil erosion.

General comments: Chemistry

Question 15, **Question 18**, **Question 19** and **Question 24** were the most straightforward for the candidates. It is clear that candidates understand well chromatography, word equation representations, the terminology associated with electrolysis and the relationship between the position of the elements in the Periodic Table and the nature of these elements. **Question 17** proved to be the most difficult question.

Comments on individual questions

Question 20

Candidates had little difficulty identifying the larger temperature ranges, but a significant number of candidates incorrectly identified option **A** as endothermic.

Question 17

The incorrect **C** was chosen just as often as the correct answer, **D**. Candidates did not understand well enough that metals and non-metals combine by the loss and gain of electrons, instead thinking that the electrons are shared.

Question 26

Very few candidates chose option **A** or **C** suggesting that candidates have a good knowledge of the constituents of air, although substantially more candidates were unsure of the proportions of the gases.

General comments: Physics

In the physics section of this paper no questions were found to be particularly easy, but **Question 30** proved difficult.

Comments on individual questions

Question 30

This question concerned a falling stone transferring energy as it hits a soft surface without bouncing. Fewer than one in three candidates realised that the energy transferred into thermal energy.

Question 31

Although this question was generally well answered, weaker candidates frequently thought that evaporation has no effect on the remaining water.

Question 33

Many candidates missed the significance of the rapidity of thermal energy transfer to the man, indicating that radiation was the process involved.

Question 34

Straight recall of the amplitude and wavelength of a wave was required here, but less able candidates were often unable to answer correctly, often resorting to guessing.

Question 39

More than a quarter of candidates chose the 13.0 A fuse, mistakenly believing that a wire capable of carrying a current of up to 10.0 A must always carry that current.

COMBINED SCIENCE

Paper 0653/21
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and take care to answer exactly the question that is being asked.

Care should be taken to use precise language when giving answers, especially when using scientific terms.

General comments

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

When a question asks candidates to 'explain' something, it is important that they do more than just 'describe' what happens. Examiners are looking for an answer that explains 'why' using their science knowledge.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly identified 'kinetic' energy here. Fewer candidates answered 'light' energy correctly.

(ii) The majority of candidates correctly recalled and used the formula for speed here, to gain full marks.

(iii) Candidates found the multiple stages required in this calculation difficult. They often gained some credit for knowing that the volume (per second) could be found by multiplying speed × cross-sectional area. Only the strongest candidates were able to go from there to find the volume of water flowing into the trough in one minute.

(b) (i) The most popular choice for an alternative energy source was wind. Any renewable source was accepted. To gain full marks candidates needed to describe how their resource would be used and some candidates either didn't describe this or only described this very vaguely and without the required precision to gain credit.

Question 2

(a) (i) This question was answered well. A few candidates correctly identified the particles as proton and electron but put the label with the wrong particle.

(ii) Some candidates correctly worked out the nucleon number as 23. There was some evidence of miscounting as a few answers of 22 and 24 were seen.

(b) (i) Stronger candidates were able to gain full credit here by stating clearly that one electron is lost from sodium. Weaker candidates stated that the sodium and oxygen share electrons and a few candidates incorrectly stated that sodium gains electrons.

(ii) A good number of candidates correctly recalled the term oxidation here. 'Redox' was too vague for credit here and was seen a few times.

(iii) A good number of candidates answered this well. The common mistake was to think this is an endothermic reaction.

(iv) There were few correct responses here. Candidates found it hard to use the information to deduce the formula.

(c) (i) A good number were able to express the correct trend clearly.

(ii) Fewer candidates than in **(i)** were able to identify this trend correctly.

Question 3

(a) (i) Few candidates gained full credit here. Many candidates repeated the condition of moisture given in the question stem and many candidates thought the seeds needed light to germinate. A number of candidates thought that carbon dioxide would be needed.

(ii) Many candidates wrongly identified the response as phototropism.

(b) Hardly any candidates realised that this response was to maximise, or even get more light. Only the odd candidate even mentioned photosynthesis for growth. Some candidates described the response rather than answering the question to describe the advantage of this response.

(c) (i) The majority of candidates correctly recalled the name of the tissue here.

(ii) Almost all of the candidates identified that the water didn't move because there were no leaves, but very few were able to make the connection that this was because of a lack of transpiration. A lot of candidates connected the lack of leaves with a lack of photosynthesis and hence water not needed, rather than focussing on why the water doesn't move; because of a lack of transpiration.

(iii) A number of candidates correctly identified conditions such as temperature or sunlight, but in order to gain credit they needed to describe how those conditions would be different for beaker C.

Question 4

(a) (i) Almost every candidate correctly recalled the process of evaporation to gain credit here.

(ii) Only the strongest candidates were able to recall that the thermal energy from the sun comes in the form of infra-red radiation.

(iii) Candidates found this question difficult. Some were able to express the idea that molecules moved faster/had gained kinetic energy, but were not able to explain evaporation in terms of the molecules at the surface having enough energy to escape.

(iv) This question required candidates to show a number of molecules touching each other and in a random pattern. Most candidates showed the random pattern but many did not show the molecules touching/very close together.

(b) Examiners accepted rays that looked by eye as though the angle of incidence was equal to the angle of reflection. Candidates should always use a ruler and a sharp pencil to draw rays and a ray should also be marked with an arrow to show where the light is coming from and going to. A number of candidates here drew lines without a ruler, or dotted lines. Some candidates showed the ray reflecting from the bottom of the trough or not reflecting at all but travelling straight from the sun to the eye.

(c) (i) Some candidates were able to apply their knowledge of refraction to show how the light ray would be refracted at the surface of the water. Quite a few candidates showed the light bending in the wrong direction.

(ii) This was poorly answered and it is possible that candidates did not understand the instruction to extend the rays from **(i)**. A number made no attempt at this question and many that did added new rays to their diagram.

(d) Many candidates were unable to recall the correct type of electromagnetic radiation. Radio waves were a frequent wrong answer.

Question 5

(a) (i) Many candidates correctly recalled 'fractional distillation' here.

(ii) Candidates demonstrated good knowledge of the different fractions in petroleum. A few weaker candidates did not use the labels given in the question.

(iii) Most candidates were able to gain some credit here. The most common correct link was petrol engines with gasoline.

(b) (i) A number of candidates left out the double bond C=C and so did not gain credit here.

(ii) Most candidates knew that the gas produced was carbon dioxide.

(iii) Only the strongest candidates were able to recall a test for water. Candidates who remembered the test also remembered the correct positive result. There were a few candidates who gave an answer which was a mixture of copper sulfate and cobalt chloride, which suggested they had some knowledge of the tests for water but were not able to recall it accurately.

Question 6

(a) (i) Most candidates identified vitamins or a specific vitamin and a good number of those were able to describe the importance of vitamins. Vague descriptions such as 'fight disease' were not given credit.

(ii) A good number of candidates correctly recalled 'respiration' here. There was a variety of incorrect responses such as digestion.

(iii) Many candidates were able to identify at least one substance from Table 6.1 that can release energy. For full marks, candidates needed to list all three correct responses and no incorrect responses. Quite a few candidates just identified one or two of the substances.

(iv) There were a broad range of acceptable answers and many candidates gained credit here. The most common incorrect answer was 'meat'.

(b) Almost all candidates gained some credit here. Global warming was the most frequent correct answer and 'methane' was the most frequent incorrect response, often replaced with 'sulfur dioxide'.

Question 7

(a) This question was well answered. The vast majority of candidates recognised that current is a flow of electrons. A few weaker candidates thought that the size of the current changed around the circuit.

(b) (i) A good number of candidates correctly identified a variable resistor. Weaker candidates sometimes put 'resistor' which was too vague and not given credit.

(ii) This question proved very tricky and only the strongest candidates were able to describe clearly how the variable resistor controls motor speed. Some candidates thought that the resistor controlled the speed of the current and a number of answers simply referred to the effect of resistance on current rather than on motor speed.

(iii) This question required candidates to place the correct symbol for a voltmeter in parallel with the motor. There were a number of candidates who knew the voltmeter symbol but connected it in series or across one of the other components.

Question 8

(a) Candidates made a good attempt at this question. Most knew that metallic elements are on the left-hand side of the periodic table and non-metallic elements are on the right-hand side. Only a few candidates knew that transition elements have both high density and high melting points, with most opting for some combination of high and low. Some thought that elements are arranged in order of mass or nucleon number.

(b) (i) Many candidates gained at least some credit here. A number of answers were given in the order iron, magnesium, calcium and it is possible that some candidates were putting them in order of increasing reactivity rather than reading the question carefully looking at the descriptions given.

(ii) Candidates found this very difficult. Examiners were looking for a basic magnesium compound. The most common incorrect response seen was 'chlorine' and very few answers were magnesium compounds.

(c) It was only the strongest candidates that were able to identify chlorine correctly here.

Question 9

(a) Candidates found this question quite hard. A number labelled the correct places with ‘1’ and ‘2’ or the description given in the question but to gain credit the correct name was required.

(b) (i) A good number of candidates described the ball of cells travelling to the uterus but only some clearly described it attaching/developing in the wall/lining for full marks here.

(ii) To gain credit here, candidates needed to be more precise than just saying the ball of cells would be ‘safe’ or ’protected’.

(c) Candidates need to be encouraged to use correct scientific language in a science exam. A lot of candidates talked about sharing ‘sharp objects’ and this was only creditworthy if it was clear that the transmission was as a result of blood mixing.

COMBINED SCIENCE

Paper 0653/22
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and take care to answer exactly the question that is being asked.

Care should be taken to use precise language when giving answers.

General comments

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

When a question asks candidates to 'explain' something, it is important that they do more than just 'describe' what happens. Examiners are looking for an answer that explains 'why' using their science knowledge.

Candidates should be encouraged to learn definitions of terms in the syllabus so that they can recall them clearly and accurately.

Comments on specific questions

Question 1

(a) A number of candidates made no attempt at this question. A few candidates filled in the whole of the spectrum, even though the question asked for just one wave in the correct box. It is important that candidates do only what the question asks, since credit here was being given for knowing which waves are used for radio signals.

(b) (i) A good number of candidates identified a cell or battery as the component that provides energy. A few incorrectly suggested it was the switch.

(ii) Few candidates gave the required precise answer. 'Potential energy' was too vague to gain the mark here and 'electrical energy' was a common incorrect answer.

(c) (i) This question was well answered by most candidates, with many gaining full credit.

(ii) This proved a very tricky question with only the strongest candidates confident enough to answer A both times. There was evidence of candidates changing their minds, and deciding that one answer must be A and the other B.

(d) (i) Two popular answers here were the idea that water near electricity was hazardous and that an overload of current could cause a fire. A good number of candidates gained credit with these, or other acceptable answers.

(ii) Examiners were looking for the name of a component and so 'resistance' here was too vague. Some candidates did correctly identify a fuse and there was a wide variety of incorrect responses.

(e) (i) Candidates found this question extremely hard and many were unable to attempt rays at all. A few incorrectly thought the rays would come to a focus on the right hand side of the lens.

(ii) Only the strongest candidates were able to recall the term 'focal length' here.

Question 2

(a) A good number of correct responses were seen. The most common error was to include the number of atoms in front of the element symbol, rather than as a suffix.

(b) Candidates demonstrated good recall of this equation with many gaining full marks. A few put 'heat' on the left hand side, instead of oxygen.

(c) Many candidates made no attempt at this question, suggesting a very weak knowledge of the tests for gases. Only the very strongest candidates gained full marks here.

(d) This question was answered well. Some weaker candidates thought the temperature would drop.

(e) This proved a hard context for candidates to identify fractional distillation.

Question 3

(a) Candidate's knowledge of cell structure was good and all candidates attempted this question with a good number gaining full marks.

(b) (i) This question proved tricky, with many candidates mislabelling the stoma in Fig. 3.2 as the cuticle.

(ii) Some candidates placed the cell in the palisade layer but in the wrong orientation. Overall this question was difficult with only the strongest candidates gaining credit and many not attempting the question at all.

(c) A good number of candidates were able to recall the word equation for photosynthesis. Weaker candidates were more likely to remember that oxygen is a product and not include glucose.

(d) The question asked candidates to describe how water and carbon dioxide are supplied to the cells. A number of candidates answered by explaining what the substances are used for. It is important to read the question carefully and answer exactly what is being asked.

Question 4

(a) Candidates found it hard to produce a circuit diagram from the information given in the question. Some did not seem to know that the circuit diagram had been started with the a.c. power symbol and drew completely separate diagrams. A number of candidates drew lines for the wires rather than using the resistor symbol asked for in the question.

(b) (i) This was poorly answered with many candidates putting a type of energy, rather than a method of energy transfer.

(ii) A good number of candidates were able to recall the correct formula here and rearrange it to get full marks.

(iii) This was generally less well answered than the previous part, with a number of candidates unable to rearrange the equation appropriately.

(c) This question was answered well by almost all candidates.

(d) Candidates were being asked to apply their knowledge of metals expanding when heated to this new situation. While a few realised that expansion was involved very few were able to express their ideas in a way that gained credit.

Question 5

(a) Many candidates gained at least some credit here. Quite often 'anode' and 'cathode' were in the wrong place and occasionally 'electrolysis' was written instead of 'electrolyte'. It is important to be precise with scientific terms.

(b) Confusion about which electrode is which continued in this question as a number of candidates gave the correct product names but at the wrong electrode. A few incorrectly identified 'chloride' as the gas released instead of the element 'chlorine'.

(c) (i) A common answer here was 'chlorine', which suggested that candidates did not realise that chlorine is coming from the hydrochloric acid. Examiners were looking for a basic copper compound, but very few copper substances were seen here at all.

(ii) Most candidates could suggest a suitable way of increasing the speed of a reaction, with an increase in temperature being the most popular response.

(d) A lot of candidates repeated the information given in the question stem or talked about the structure of copper and sodium atoms. Credit was given to candidates who identified physical properties beyond the scope of the syllabus. Very few candidates noted that copper forms coloured compounds or that copper compounds act as catalysts.

(e) Some candidates identified that the alloy is stronger. A number incorrectly thought that copper would rust.

Question 6

(a) Few candidates were able to draw an arrow coming from the plasma into the alveolus. A number incorrectly showed carbon dioxide coming from red blood cells.

(b) (i) This required a very careful reading of the scale on the y-axis, which started at 2.0 and not 0. Many candidates did not notice this.

(ii) A good number correctly noticed that the graph showed 3 breaths and so were able to calculate total volume.

(c) This was well answered with many candidates stating that breathing would be faster and deeper.

(d) Answers often lacked required precision. A common mistake was to link the answer specifically back to breathing rather than recognise different uses of energy that the body makes.

Question 7

(a) (i) Stronger candidates correctly identified the unit of force as newtons. Some weaker candidates suggested a type of force or energy, such as 'pull' or 'kinetic'.

(ii) Again, stronger candidates identified the correct response. A common incorrect response was 'pulling force'.

(b)(i) Most candidates plotted points correctly. The most frequent error was to plot the point at 50 N instead of 45 N.

(ii) This question was well answered by many candidates. A few who did not gain credit had not extended their best-fit line up to 90 N and so were not able to make a good prediction.

(c) A number of candidates made no attempt at this question. Some were able to identify that the upward force would be 100 N but very few were able to explain why.

Question 8

(a) Candidates found it difficult to explain why this was a physical and not a chemical change. A number incorrectly said it was a physical change because no chemical had been added.

(b) A good number of candidates gained some credit here, with most realising that only hydrogen and carbon were involved. For full marks though, they either needed to be precise in saying that <u>only</u> hydrogen and carbon were involved or showing that the hydrogen and carbon are bonded in a molecule/compound.

(c) There was evidence here that candidates were familiar with the uses of the different fractions, however many of them were unable to put the correct fraction with the use. Very few candidates gained full marks here though many did gain some credit.

(d) Most candidates were able to draw the correct structure for ethane.

Question 9

(a) Candidates found it very difficult to define the term food web, with many simply saying it was a food chain. Very few candidates mentioned that a food web shows a flow of energy.

(b) Almost everyone scored the marks for producer and consumer. Some got the herbivore and carnivore mixed up and a few did not realise the sun should be the source.

(c) (i) To gain the mark here candidates needed to predict the effect AND explain it. A number of candidates made a correct prediction but did not explain it.

(ii) As in the previous question here, too, some candidates only said how or why it affects large fish and both answers were needed for the mark.

COMBINED SCIENCE

Paper 0653/23
Core Theory

Key messages

Candidates do well in this paper when they read the question carefully and take care to answer exactly the question that is being asked.

Care should be taken to use precise language when giving answers.

General comments

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

When a question asks candidates to 'explain' something, it is important that they do more than just 'describe' what happens. Examiners are looking for an answer that explains 'why' using their science knowledge.

A number of questions were not attempted. When candidates have finished the paper they should be encouraged to go back and make an attempt at any questions that have been left blank.

Comments on specific questions

Question 1

(a) (i) Answered well by many candidates. Some gave answers that were a type of force, e.g. pull, rather than the unit that was asked for.

(ii) This question was attempted by most candidates but only the most able were able to express the idea that the man was applying a force to move the arrow some distance.

(b) (i) In this question examiners were looking for precision in stating energy transfers, so 'elastic' energy was insufficiently precise for stored or potential energy. Most candidates were able to identify kinetic energy in the flying arrow.

(ii) Very few candidates correctly identified a suitable loss of energy in the transfer from bow/bowstring to arrow. Many gave answers that described energy lost from the arrow during its flight in the air.

(c) (i) Few candidates were able to complete the full calculation, with a good number managing the conversion from km to m while only a few correctly converted per hour to per second.

(ii) A good number of candidates correctly recalled and were able to use the required formula here and so scored full marks.

Question 2

(a) Candidates scored fairly well in this question. A common mistake was to identify electrons in the nucleus instead of neutrons.

(b) Both magnesium and magnesium oxide were often correctly placed. Some candidates filled in the remaining box with 'heat' instead of oxygen as the other reactant.

(c) Candidate had difficulty in identifying the gas which produces a squeaky pop as being hydrogen. Few realised which test-tube would produce a gas. Overall there were few correct responses to this question.

(d) (i) Stronger candidates were able to identify sodium chloride as the ionic compound here but only a few of these explained this in terms of sodium being metal and chlorine a non-metal with a number of candidates trying to answer by talking about electron transfer.

(ii) Candidates found this question difficult. Those that could identify a substance with covalent bonds often explained this in terms of sharing electrons which is a description rather than the explanation asked for in the question.

Question 3

(a) (i) The vast majority of candidates made an attempt at this question. Some confused the Vena cava with pulmonary vein, so failed to gain credit.

(ii) A number of candidates misidentified the valve as the ventricle. Only the strongest candidates were able to both name the structure and describe its function precisely.

(iii) A good number of candidates correctly noted an increase in oxygen but didn't then go on to say that there was a decrease in carbon dioxide in order to gain full credit.

(b) (i) A number of candidates did not attempt an answer to this and only the strongest candidates were able to complete the word equation correctly.

(ii) Many answers to this question repeated the example given in the question stem of heart muscle pumping blood around the body. Other candidates thought that the question was asking for types of energy rather than uses of the energy released.

(c) Almost all candidates were able to suggest an appropriate activity. The question asked for an explanation, and many candidates simply described the information in Table 3.1 rather than explaining that their chosen activity was more energetic than sitting and less energetic than running.

Question 4

(a) Candidates found this question very tricky. A few able candidates completed the whole electromagnetic spectrum, which was unfortunate as by doing this they failed to select the particular radiation being asked for in the question.

(b) Radiation was more often correctly identified than convection. A number of candidates gave types of energy (e.g. kinetic) rather than methods of energy transfer.

(c) A good number of candidates were able to suggest insulating the tank. Some candidates used the information from the next part of the question to suggest that being made of metal helped to stop the water cooling down.

(d) Stronger candidates correctly described expansion of the metal when heated. A few thought that it would melt, which was not a sensible suggestion for this situation.

(e) The information in the question stem led students to say water would freeze. However, to gain credit they needed to suggest why that would be a problem for the heating system so there needed to be some mention of frozen pipes (or damage to pipes such as cracks) or the water not able to flow through pipes for credit here.

(f) Many candidates were able to show the ray refracting as it entered the glass. A good number also showed correct refraction as the ray left the glass. Very few candidates gained the full credit as they were unable to mark the angles correctly.

Question 5

(a) Only the most able candidates were able to recall a correct reagent here and they were also able to give the positive result as well. Many candidates did not attempt the question at all.

(b) (i) Many candidates were able to place all the correct labels. The most frequent error was to get 'anode' and 'cathode' the wrong way round.

(ii) A good number of candidates correctly identified copper. Some confused the colour of copper with the colour of copper chloride.

(iii) Very few candidates correctly recalled the colour of chlorine gas. Some candidates mistakenly reported that litmus paper would be red, rather than bleached.

Question 6

(a) (i) More candidates were able to identify the stigma correctly with only the strongest candidates also identifying the sepal.

(ii) Very few candidates answered correctly here. Some didn't add any label to the diagram and gave the answer 'petal' suggesting, perhaps, that they had misunderstood the question.

(iii) The most popular answer here was to identify brightly coloured petals. A few candidates mentioned scent or nectar. Examiners were looking for a precise feature and so answers that simply stated 'petals' were too vague to gain credit.

(b) (i) Only the strongest candidates identified transpiration rate affecting the movement of the bubble but a lot of answers thought that the bubble was moving because of convection.

(ii) A number of candidates were able to pick an appropriate value for the reading but then found it difficult to explain that there is less transpiration in more humid conditions.

(c) (i) Many candidates were able to explain that the root hair cells in root 1 would cause it to take in water more quickly. Candidates did need to use precise language and not simply describe the 'tentacles' or use other vague language.

(ii) This was well answered by many candidates with the path shown right into the xylem. There were one or two candidates who drew the diagram again below the question and while they could still gain credit it probably did waste valuable time in the examination.

Question 7

(a) (i) Candidates found this question difficult. Although some correctly identified the wavelength there were a number of candidates who gave wavelengths of either 100 cm or 25 cm. Candidates who gave the correct measurement of wavelength from Fig. 7.1 were given credit.

(ii) A few candidates contradicted correct answers here by also marking a wavelength with no indication of which answer they were offering for this part.

(b) While many candidates were able to gain some credit here, full marks were rarely awarded. Common mistakes included placing a voltmeter, rather than ammeter in the circuit, drawing a fixed resistor rather than variable resistor and a few candidates drew a line rather than an arrow through their resistor which was not sufficiently precise to gain credit.

(c) (i) Very few answered this correctly. A number used the equation to calculate a value here, rather than name the property as the question asked. Quite a few candidates did not attempt a response here.

(ii) A number of candidates made no attempt at this question. This was surprising as candidates performed calculations better elsewhere on the paper and suggests that they did not understand what they were being asked to do.

Question 8

(a) Strong candidates gained both marks here and a number of others were able to gain one mark. 'Distillation' was a common error for process B and a number of candidates gave the answer 'heating' for process C, which was too vague.

(b) Many candidates correctly identified that increasing the temperature would increase the rate of reaction. The strongest candidates gained full marks here. 'Shaking' was considered as being agitation, like stirring, and so was not given credit.

(c) (i) More candidates were able to identify the gas as carbon dioxide than the salt. 'Sulfur' was a common incorrect name for the salt.

(ii) There were a variety of acceptable ways of expressing the correct answer here, including references to neutralising and decreasing acidity.

(iii) A reasonable number of correct answers were seen but quite a few candidates made no attempt and a common wrong answer was 5.

Question 9

(a) A good number of candidates gained full marks here. The most common correct link was knowing that cows add methane to the air. Very few made no attempt at all.

(b) (i) Most candidates were able to identify an appropriate human activity. Use of vehicles (which burn fossil fuels) was the most common, with a number mentioning deforestation.

(ii) Answers here revealed a number of misunderstandings as many suggested not being able to breathe as a consequence of increased carbon dioxide in the atmosphere. Damage to the ozone layer was another common incorrect response.

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Key messages

Those candidates who scored well on this paper ensured that:

- they had read the questions carefully and used the number of marks available for each question as a guide to how much detail to include
- they included sufficient detail in their answers and did not leave out key information assuming that it would be so obvious that they did not need to include it; a typical example of this is seen in answers to **9(b)(i)**
- they used symbols accurately; this means for example, that in chemical equations they avoided mistakes such as $\mathbf{C_2O_2}$ instead of 2CO
- they answered questions involving comparison carefully; for example, stating that as the result of heating, molecules move *faster* rather than simply stating that they move *fast*, or that molecules *begin to move;*
- they had learned concise definitions that appear in the syllabus, for example, the roles of vitamins, protein and fibre in diet ; candidates who do this gain credit very efficiently
- their handwriting was reasonably legible and not too small.

General comments

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

Some questions tested the ability of candidates to apply their knowledge and understanding of Science to describe and explain contexts that may be unfamiliar. Some candidates found these questions challenging. Examination practice of this type of question is very useful.

Success in answering questions covering the three Science disciplines was well balanced, except possibly for organic chemistry which seemed to be rather unfamiliar to many candidates. There was no evidence that the time allowed for the paper was insufficient. Some copied lengthy sections of the question into their answers and in many cases they did not add any new information. Candidates need to be careful to avoid falling into this trap since no credit can be awarded for what is often a lot of effort.

Candidates should write their answers legibly to ensure that examiners award as many marks as possible. A number of scripts in this examination were very difficult to read either because letters were incorrectly formed or because candidates' handwriting was extremely small.

Comments on specific questions

Question 1

(a) (i) Only a minority of candidates identified *light* as the type of energy converted into electrical energy by the solar panels. The majority correctly identified *kinetic* as the other missing energy type.

(ii) This was very successfully answered by most candidates, who showed familiarity with the use of the relationship between speed, distance and time.

(b) (i) The majority of candidates correctly read the speed from the vertical axis. Although mistakes were rare, the most common one was to suggest 0.8 m/s rather than the correct value.

(ii) In order to obtain full credit, candidates had to recognise not only acceleration and deceleration, but also that acceleration was constant and deceleration was not. A frequent reason for loss of credit in this type of question is to suggest that *the motion increases or decreases* rather than discussing *speed*. Most candidates gained at least partial credit for recognising speed increasing and then decreasing.

(c) (i) The relationship work done = force × distance (represented here by mgh) was very familiar and large numbers of correct answers were seen. The most common mistake was to omit the value of the acceleration of gravity.

(ii) Candidates were generally familiar with the use of power = work done ÷ time and many correct answers were seen. Although candidates were allowed to carry forward an error from part **(c)(i)** many lost credit because they did not convert time to seconds.

Question 2

(a) Many candidates gave correct responses. The most common mistake was to suggest that the atom contained 23 neutrons.

(b) Most candidates were able to state the electron configuration of sodium.

(c) It was clear that the connection between group number and number of outer electrons was familiar to most candidates. A number of these candidates lost credit because their answers contained errors in wording. A typical example was *group number shows the number of valence atoms.*

(d) (i) Although candidates very often knew that sodium atoms ionise by electron loss they needed to be clear that one electron is lost from each atom.

(ii) A large number of candidates did not gain credit here, despite answering part **(b)** correctly. Many incorrect elements were suggested, the most common ones being potassium, lithium and magnesium.

(e) Candidates generally showed good estimation skills and many gained full credit. Some showed they had attempted to find a mathematical pattern in the melting points.

(f) Candidates struggled to gain credit in this question. The idea that sodium chloride is a compound and sodium chloride solution is essentially a mixture may have been so simple that candidates overlooked these as possible answers. Credit was given for any relevant correct scientific ideas including discussion of the difference in boiling point between water and sodium chloride for the second observation.

Question 3

(a) Geotropism was familiar to many. The most common mistake was to suggest phototropism. Candidates who were unfamiliar with these terms suggested answers such as *growth* and *germination*.

(b) Some excellent answers to this were seen from candidates who understood phototropism very clearly. Some candidates gained full credit from a combination of sentences and clear sketch diagrams. The question suggested that they could do this if they wished and it is often a very good idea to complete a diagram when offered the opportunity. Some candidates gave good descriptions of the advantages to the plant of the phototropic response, but regrettably these could not be credited.

(c) (i) Most candidates were able to interpret the data in the table correctly and gained at least partial credit. Full credit came from the use of data in the table to support their answer. This could have been something as simple as making the connection between pH and acidity, or as detailed as discussing the differing relative increases in germination between different pairs of pH values.

(ii) In order to gain credit candidates had to discuss the effect of pH on enzymes. The word *enzyme* was essential in this case, but the term *denatured* was not. Many candidates simply reworded ideas they had expressed in answer to **(c)(i)**.

(iii) Candidates who gained the credit here realised that they were being asked to predict the germination rate in another experiment that used a solution whose pH was somewhere between 4 and 5. Many candidates were distracted by all the data and made this essentially simple calculation into something that was complicated and incorrect. A typical example of this was the idea that the numbers germinating at both 4 and 5 should be expressed as a percentage of the total number germinating, i.e. $(6/37) \times 100$.

(d) (i) Questions testing simple ecology are common in this paper and yet candidates struggled to gain full credit. Relatively few identified the key pollutants, sulfur dioxide and nitrogen oxides. As is often the case, many answers showed confusion between acid rain, ozone depletion and global warming. Another common mistake was to discuss acidic effluent being passed into water courses which then caused acid to enter the water cycle.

(ii) Most candidates gained credit here for reference to crop damage. Vague statements such as *acid rain affects crops* did not gain credit, but these were relatively rarely seen.

Question 4

(a) (i) Some higher-scoring candidates had mastered the scientific principles behind this question and gained full credit for excellent answers. Full credit, however, was difficult to obtain, although partial credit for a reference to evaporation was frequently scored by candidates across the mark range. Many candidates discussed particles becoming *more energetic* when warmed by the sun, but in this question they needed to be more specific and refer to particles gaining *kinetic energy* or *moving faster*. The most difficult mark to obtain was for the idea that only those particles having sufficient energy to escape do so.

(ii) Only a small number of candidates suggested answers based on increasing the reflectivity of the trough. By far the most common suggestion was to provide shade and this was allowed as a reasonable alternative. Other suggestions gained credit if they were scientifically valid.

(b) (i) Candidates generally knew that the required answer was refraction. Reflection was the most common mistake.

(ii) Candidates were generally unfamiliar with this phenomenon and with the ray diagram that is used to explain it. A very small number gained full credit. Those showing some familiarity with ray diagrams showing refraction gained partial credit.

(c) It was evident from answers to this question that many candidates assume that radio waves are used in mobile phones. The straightforward answer that sound waves must be involved in this context was missed by a large number of candidates. Some candidates gained at least partial credit for answers describing the differences between sound waves and electromagnetic waves.

Question 5

(a) (i) Many candidates had learned the blast furnace equations and gained full credit. A common mistake was in the reduction of carbon dioxide where candidates suggested C_2O_2 instead of 2CO. Candidates generally unfamiliar with the blast furnace equations still usually gained credit for the oxidation of carbon.

(ii) Of those candidates who understood what was required here, most opted to discuss iron oxide. However, they lost credit if they stated that *iron*, rather than *iron oxide* was reduced. Credit was obtained by candidates who described reduction in terms of electron gain, but full credit was only given if these candidates specified that *iron ions* or *Fe^{3+}* or iron(III) was reduced.

(b) (i) Candidates needed to specify that aluminium is *more reactive than carbon* rather than simply suggesting that aluminium is *too reactive*.

(ii) Correct ideas about the need for ionic mobility in electrolysis were given by many candidates. It was not enough for candidates simply to state that ions need to separate.

(c) (i) Aircraft construction is a common context for aluminium use and it was clear that large numbers of candidates had been well-prepared to answer this question in terms of the lower density of aluminium alloys.

(ii) Those candidates who gained credit in part **(c)(i)** also tended to gain credit here. This question addresses the syllabus section that deals with reasons why alloys are used and improved strength is essentially the only reason that needs to be familiar to candidates studying this syllabus.

Question 6

(a) (i) A margin of ± 1 °C was allowed but candidates had to include the correct form of the units. The majority of candidates successfully read the temperature from the graph.

(ii) Large numbers of candidates discussed denaturation of enzymes. Answers like this did not gain credit because the question wanted candidates to describe evidence for enzyme activity from the graph shape. So they needed to refer specifically to the decrease in lactic acid production at higher temperature.

(b) (i) Candidates who had learned a concise definition of the role of protein in the body gained the credit and wasted no time in doing so. Candidates who wrote a list of roles of different nutrients did not gain credit even when the list contained the role of protein.

(ii) The required answer, *vitamins,* was the most common response and so most candidates gained at least partial credit. Full credit was less often gained but higher-scoring candidates correctly identified either the general role of vitamins or a correct function of a specific vitamin, invariably vitamin C or D. Wording was important which meant that the idea of vitamins *fighting disease* was not accepted. The most common incorrect suggestions were *iron* and *water*.

(c) Vague ideas such as *helping with going to the toilet* are not suitable for a biological question about the avoidance of constipation. However, answers such as *as an aid to peristalsis in the colon* are clearly credit-worthy without mentioning constipation. Serious misconceptions revealed by many answers involved confusion between digestion and egestion and also between excretion and egestion.

Question 7

(a) (i) The majority of candidates correctly added the potential differences and arrived at the correct answer.

(ii) Many of the candidates who had been successful in **(a)(i)** went on to use Ohm's Law to calculate the ratio 2.6/0.3 rather than the resistance of the lamp.

(iii) The use of the relationship power = p.d. × current was familiar to many of the higher-scoring candidates.

(b) Only a minority of candidates gained the available credit. Lower-scoring candidates did not understand the context and although they often wrote correct statements about parallel circuits these could not be credited.

Question 8

(a) (i) Candidates needed to state either crude oil or petroleum. The answer *oil* was too vague a term in this context. The term *petrol* was often suggested but candidates need to avoid the confusion with *petroleum*. The variety of incorrect responses suggested that many candidates were unfamiliar with industrial fractional distillation.

(ii) Most candidates familiar with the topic correctly stated boiling point. Acceptable alternative answers included references to molecular size. Melting point was not accepted.

(b) (i) Candidates towards the higher end of the mark range were able to work out the formula of propene. Large numbers of candidates found this question very difficult and many simply guessed the formula of a hydrocarbon.

(ii) Although ethene is one of the small number of hydrocarbons whose formulae should be learned by candidates, many incorrect responses were suggested. These included the first four alkanes and alkenes as well as guesses such as methene and carbon hydroxide.

(iii) Details of the bromine test for unsaturation were unfamiliar to large numbers of candidates from across the mark range. Incorrect suggestions included combustion, fractional distillation and cracking. Similarly to **(b)(ii)** this suggests that organic chemistry is one of the less familiar sections of the syllabus.

(c) Candidates towards the upper half of the mark range tended to gain the credit here. Many of the other candidates did not attempt the question.

Question 9

(a) This was answered very successfully by the majority of candidates with many gaining full or nearly full credit. The most common mistake was to suggest vein instead of artery.

(b) (i) This question addresses a very important issue and candidates are very familiar with the ways that HIV can be transmitted. Unfortunately this familiarity worked against some candidates who seemed to assume that important detail would be obvious and so there was no need to state it in their answers. Consequently answers unsuitable for a science examination were often seen and did not gain credit. Typical examples of this included short statements such as *by sex*, *by blood, by needles, by sharp objects, by mother to baby.* Candidates need to be aware of the risk of losing credit in this way.

(ii) Understanding of how HIV acts in the body was generally good and candidates from across the whole mark range gained at least partial credit. The idea that HIV leads to the weakening of the immune system was very frequently stated. A common mistake was to suggest that the virus *killed antibodies* rather than attacked white blood cells.

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Key messages

Those candidates who scored well on this paper ensured that:

- they had read the questions carefully and used the number of marks available for each question as a guide to how much detail to include
- they noticed when words or phrases had been emboldened and realised why this had been done, e.g. in **Question 5(c)**
- they used chemical symbols accurately; this means for example, they avoided mistakes such as C^8h^{18} instead of C_8H_{18}
- they had learned electrical circuit symbols, particularly how to draw a fuse and an a.c. supply
- when they described forces in equilibrium they used the term *balanced* or the term *equal and opposite* rather than simply suggesting that the forces were the *same*
- their handwriting was reasonably legible and not too small.

General comments

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

Some questions tested the ability of candidates to apply their knowledge and understanding of Science to describe and explain contexts that may be unfamiliar. Some candidates found these questions challenging. Examination practice of this type of question is very useful.

Success in answering questions covering the three Science disciplines was well balanced. There was no evidence that the time allowed for the paper was insufficient.

Candidates should write their answers legibly to ensure that examiners award as many marks as possible. A number of scripts in this examination were very difficult to read either because letters were incorrectly formed or because candidates' handwriting was extremely small.

Comments on specific questions

Question 1

(a) (i) The relationship between frequency and wavelength was familiar and many candidates answered the question correctly.

(ii) The electromagnetic spectrum had been learned by many candidates, and radio waves was usually located correctly. The most frequently seen mistake was to locate radio waves in the microwave position.

(b) (i) The constancy of the speed of electromagnetic radiation should be a very familiar idea. A number of candidates believed that the speed of e/m radiation varies with frequency.

(ii) The formula *speed* = *frequency* × *wavelength* and its use was familiar to large numbers of candidates from across the mark range. Many gained full credit. Some candidates stated the formula correctly and then rearranged it incorrectly. Others made arithmetic errors when attempting to deal with the exponents.

(c) (i) The majority of candidates from across the mark range correctly identified *kinetic* and *sound* and gained full credit.

(ii) Only higher-scoring candidates tended to answer this correctly. It is possible that large numbers of candidates assumed that a combination of **A** and **B** must be required.

(d) Many candidates successfully described the comparison of particle arrangement. It was common to read from lower-scoring candidates that particles in compression are *more compressed* or that particles in rarefaction are *random*. Many vague ideas such as particles being *free* were also seen.

Question 2

(a) Most candidates knew that atomic/proton number was required here. Incorrect responses included *the number of valence electrons* and *relative atomic mass*.

(b) (i) Candidates were generally successful in matching the descriptors to the elements shown in the question, and many gained full credit. The most common mistake was to suggest **B C D** instead of **B E F**. There was also some evidence that the reactivity trend in Group 1 elements was more familiar than the reactivity trend in Group VII.

(ii) Those candidates recognising element **G** as a transition metal realised that typical transition metal properties were required here. One general metal property was also allowed.

(c) Most of the higher-scoring candidates gained full or partial credit. Credit was not gained for a simple answer in terms of aluminium ions being positive and oxide ions being negative.

(d) Higher-scoring candidates were familiar with balancing ionic charges to generate the correct formula. Other candidates tended to guess but often with a degree of logic, suggesting answers such as MgN^-.

Question 3

(a) Candidates had learned this part of the Biology syllabus very well and full credit was frequently gained. A common mistake was to draw a label line to a chloroplast rather than the cytoplasm. Candidates knew that they needed to label the cell membrane rather than the cell wall and successfully did so.

(b) (i) This question was well-answered and many candidates gained full credit. Credit for describing the trapping of light depended on candidates mentioning either chloroplasts or chloropyll.

(ii) The balanced equation for photosynthesis is frequently tested and large numbers of candidates from across the mark range gained full credit. Relatively few candidates made the mistake of stating the equation for respiration.

Question 4

(a) (i) Most candidates identified length. Those not gaining credit suggested a very wide variety of incorrect answers. Many of these such as *material* and *width* were identified in the question as being the same in both wires suggesting that some candidates needed to take more time to read and understand the question.

(ii) Some good circuit diagrams were seen although only a very small minority of candidates gained full credit. The least familiar circuit symbol was the a.c. supply and most candidates drew a cell or battery. The symbol for a fuse was often drawn incorrectly and quite often the switch was drawn in the closed position. Credit for the general structure of the circuit was available even if most of the circuit symbols were incorrect.

(b) There was evidence that the context of this question was very unfamiliar to candidates. Even though the question prompted candidates to think about the effect of thermal energy on the distances between particles, many did not choose to do this. Only the highest-scoring candidates gained full credit, realising that steam created inside the iron would be pressurised and so forced out of the iron. Credit was given for the general idea that the increasing separation of water molecules could only occur by the steam leaving the confined space of the iron.

(c) Many candidates, unfamiliar with the context, answered the question from the point of view of safe operation of the iron. Of those who referred to the expansion of material when heated only a small number understood that the bimetallic strip bends because of differential expansion. Full credit was gained by the small number of candidates who stated clearly that when the strip bends the circuit is broken.

Question 5

(a) Many candidates gave the correct answer. Frequently seen alternative suggestions included *gas syringe* and *measuring cylinder.*

(b) (i) The reason for the loss of mass in this context was not generally understood. Those who did know that it involved gas production needed also to make clear that the gas was lost from the apparatus. Many suggested that the mass loss was the result of evaporation. The main question stem specified that dilute hydrochloric acid was in excess and so candidates needed to realise that the mass became constant when all of the calcium carbonate had reacted.

(ii) Many candidates were well-prepared for this question and gained full credit. Candidates needed to take care that the line they drew started at the same point as the given line.

(iii) Collision theory of reaction rate is frequently tested and candidates generally answered this question very well. Candidates lost credit if they suggested that a higher collision frequency was the result of increased kinetic energy.

(c) The majority of candidates missed filtration as the first step in this process. It was hoped that the emboldening of **excess** calcium carbonate would prompt candidates to realise that unreacted calcium carbonate would first need to be removed.

(d) Many candidates from across the mark range gained at least partial credit here. The most common mistake other than reversing the electrodes was to suggest chloride rather than chlorine.

Question 6

(a) (i) Candidates had to be very careful to show CO_2 passing into the alveolus from the plasma and not from a red blood cell.

(ii) This was generally well-answered and many candidates gained full credit. Candidates who gained credit were careful to refer to the wall of the alveolus being thin or one cell thick. Answers such as *it is thin* are not sufficiently detailed. Candidates also needed to describe the alveolus and not the capillary and so description of thin capillary walls could not gain credit.

(b) (i) Only a very small number of candidates noticed that the vertical axis did not begin at a value of zero and so most candidates lost the credit by suggesting the answer 2.6 dm^3.

(ii) The most frequently seen mistake was made by candidates who did not refer back to the diagram which showed only three breaths being taken in ten seconds. These candidates invariably multiplied their answer to **(b)(i)** by ten.

(c)(i) Most candidates gained at least partial credit and understood how to interpret the diagram. Credit was often lost for vague statements like *the volume of air increases* or *breaths are shorter*. Some candidates suggested answers not connected directly to breathing, for example they discussed pulse rate.

(ii) This part of the syllabus is often tested and some candidates were very well prepared to apply their knowledge to this question. Candidates generally avoided confusing the terms *breathing* and *respiration* although some still made this mistake. Some candidates suggested little more than the simple idea that the student *needs more energy*. This statement alone did not gain credit. They needed to describe the need for more oxygen (not air) to provide (not make) energy by the process of respiration.

Question 7

(a) Correct use of the terms *mass* and *weight* were essential for credit in this question. Of those candidates who realised that the small stretching force was caused by the ball, only a minority gained full credit. Many stated that the stretching force was being caused by the ball's mass without any reference to gravity. Many attempted to answer without any reference to the ball.

(b) (i) The great majority of candidates simply stated that the forces in the elastic cords would increase and this was credited.

(ii) Large numbers of candidates gained partial credit for correctly stating that the upward force was 100 N. Candidates suggesting 100.55 N also gained the credit. Although some candidates realised that forces in equilibrium were somehow involved they needed to be very clear that forces were balanced or they needed to state that forces were equal and opposite. Many just suggested that the forces were equal.

(c)(i) The form and use of the relationship $KE = \frac{1}{2} mv^2$ was very well understood and large numbers of correct answers were seen. Having stated the formula correctly, some candidates lost credit for mistakes which included not squaring the velocity term in their calculation, converting the mass to weight or squaring the mass rather than the velocity.

(ii) Many higher-scoring candidates were familiar with this type of calculation and gained full credit. Large numbers of candidates, however, found this question too difficult and many made no attempt to answer. Partial credit was allowed for stating that the potential energy gained by the ball would be given by PE = mgh. Many attempts to combine this relationship with the value of KE obtained in **(c)(i)** were seen, but the correct way to do this eluded most lower-scoring candidates.

Question 8

(a) Most candidates correctly stated *wood*. The most common distractor was *natural gas*.

(b) (i) Those candidates who realised that this question was testing the mechanism of fractional distillation usually gained credit for reference to molecular size. Some did not gain credit because they reversed fractions **A** and **B** by suggesting that, for example, **B** would have smaller molecules. A minority of higher-scoring candidates also discussed molecular attractive forces. Many candidates attempted to answer this question by describing the reasons why fractional distillation is carried out.

(ii) This chemical formula was marked strictly. Some candidates lost credit because they suggested incorrect forms such as C^8H^{18} or C_8h_{18}. The majority of candidates stated the formula correctly.

(iii) Cracking was not familiar to many candidates, and a large number did not attempt to answer or made incorrect suggestions including *fractional distillation, condensation* and *heating*.

(iv) Details of the bromine test for unsaturation were unfamiliar to many candidates from the lower end of the mark range. Many made no attempt to answer or made incorrect suggestions some of which were not related to organic chemistry.

Question 9

(a) Candidates across the mark range answered this question very successfully. By far the most common mistake was *algae* instead of *sun* in the first space.

(b) Most candidates gained credit for correctly writing at least one relevant food chain extracted from the given web. Only a minority of candidates used the food chains they had suggested to show how small fish were occupying different trophic levels.

(c) Many detailed and largely correct descriptions of eutrophication were seen and many candidates gained full credit. The most common incorrect suggestions, mainly from candidates towards the lower-scoring end of the mark range were that it would be fertiliser that blocked light from penetrating the lake, or that the fertiliser would be toxic.

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Key messages

Read the stem of the question carefully, especially those questions set in an unfamiliar context.

Use the mark allocation for each question as a guide to how much detail is required in responses.

Include sufficient explanation in responses. **Questions 6(b)** and **8(c)** needed to have explanations in order to obtain the mark.

General comments

There were some excellent scripts from candidates who had prepared well, and who could apply their knowledge of the syllabus across all of the three Science disciplines in both familiar and unfamiliar situations. There were fewer candidates with very low marks, indicating that the standard of candidates entered for this paper was more appropriate than in recent years.

Candidates used the available space wisely, and there were fewer candidates who repeated the question in their responses. There was no evidence of unanswered questions towards the end of the paper, implying that candidates had enough time to complete their papers. Most candidates wrote clearly, but there were some responses where key words were illegible. Care should be taken by candidates to make all responses easy to read.

It is recommended that this report is read alongside the question paper and the published mark scheme.

Comments on specific questions

Question 1

(a) (i) Most candidates successfully identified both the formula and the unit in this question. Candidates should be aware that the calculation required changing the distance to metres before multiplying it by the force in order to obtain the result in joules. As a result, many candidates gave 12 000 J instead of 120 J.

(ii) The idea that the amount of work done became the amount of energy stored was appreciated by many candidates who gained credit.

(b) (i) Many candidates used the formula correctly to calculate the amount of kinetic energy in the arrow. Errors in applying the formula included a failure to square the velocity, thereby obtaining a small amount of energy to carry on to **(b)(ii)**.

(ii) The answers obtained by candidates in **(a)(ii)** and **(b)(i)** were carried forward for this calculation, with many candidates scoring full credit. Common errors included inverting the formula resulting in efficiencies of over 100%.

(iii) There were many candidates who identified a force which would reduce the speed of the arrow. Some responses focussed on the fact that the arrow had lost energy but did not explain how this happened.

Question 2

(a) (i) The majority of candidates identified a stopwatch or other suitable timing device.

(ii) Almost all candidates correctly identified calcium as the metal taking the least time to react, therefore reacting fastest.

(b) There were many excellent responses to this question. Many candidates were well prepared in collision theory, remembering that the crucial idea is there are more collisions in a set time, not just more collisions. Candidates should be aware that the particles responsible for affecting the rate of reaction are the hydrogen ions in solution, not hydrogen molecules.

(c) The majority of candidates successfully combined the information in the two tables to give a correct order of reactivity of the metals.

(d) There were many correct interpretations of Fig. 2.2 to explain the results of the displacement reactions. Common errors included comparing the reactivity of the metal with the salt solution, not the metal within it, also stating that the reaction in **A** was slow, and that the brown layer on the surface of the lead was rust. Candidates should remember to compare the reactivity of the metal in the salt with the metal added to the solution. Any responses referring to the reactivity of the salt were not acceptable.

Question 3

(a) (i) Most candidates could answer this question well, therefore gaining full credit. Candidates had to say that the blood goes through the heart in each circuit of the body to score the mark. Just saying 'the blood goes through the heart twice' without qualification did not contain enough detail.

(ii) A knowledge of the difference in pressure of blood coming out of the heart was needed for this answer. Many candidates correctly identified the blood vessel as the aorta and related the high pressure to the need to send blood to all parts of the body. Candidates should take care when stating that the aorta pumps blood. Arteries do have a recoil after blood has passed through which helps to propel the blood forwards, but no candidates indicated that this was what was intended in their answers.

(iii) The function of valves in veins to prevent backflow of blood was well known by the majority of candidates. Also, most candidates appreciated the function of the wide lumen to allow maximum blood flow with a low resistance to that flow. A minority of candidates referred to blood pumping through the veins. These candidates are reminded that by the time the blood has passed through the capillaries it is travelling slowly without a pulse when it enters the veins.

(b) (i) Crucial to this answer is the fact that the rate of respiration increases in the muscles of the student's legs to release more energy. Most candidates correctly explained that the extra blood supplied more oxygen for the increased rate of respiration.

(ii) Most candidates correctly identified a suitable activity with the majority giving walking as their answer. To gain full credit the explanation had to include some indication of the energy/oxygen requirements of this activity, or the degree of exertion needed. Answers purely in terms of number of heart beats was not considered sufficient.

Question 4

(a) (i) Candidates had to do two things in this question. They had to identify infra-red as the correct form of radiation, and they had to place it in the correct box. Some candidates gave too much information and filled all of the missing boxes. This meant that their intended answer could not be identified. Candidates should read the stem of the question carefully, and only give the information requested.

(ii) Many candidates correctly responded with the idea that all electromagnetic waves travel at the same speed (in vacuo).

(b) (i) The vast majority of candidates gave black as the best colour for absorption. Candidates should be aware that absorption (of infra-red) is the correct term for the explanation, and attracts, conducts, or transmits are not acceptable.

(ii) Many candidates correctly gave conduction as their response to part 1. The most common incorrect answer was radiation, which was how the thermal energy reached the tubes, but conduction was the method of thermal energy transfer across the wall of the copper tubes. In part 2 most candidates gave convection as their response and gained full credit.

(iii) Candidates generally found this question challenging, with few gaining full credit. An explanation of convection was what was needed to gain full credit, including the fact that the water expands and becomes less dense. Explanations about the particles becoming further apart when heated were acceptable, but any explanations describing the particles becoming less dense were not correct, so did not score.

By far the greatest misconception was the description that the flow of water from the mains was the driving force for the upward movement of water, instead of convection. Answers of this type did not gain credit.

Question 5

(a) (i) The answer to this question, methane, was given by a minority of candidates. Incorrect answers included all the gases found in the air, the elements making up the molecules and descriptions of how natural gas was formed. Candidates should be aware that natural gas is composed of methane, along with small amounts of other hydrocarbons.

(ii) This question was generally well answered. <u>Fractional distillation</u> was necessary for candidates to gain full credit in the second answer.

(b) Many candidates successfully deduced both formulae needed to produce the balanced equation. Candidates are reminded to use the uppercase **H** for the hydrogen symbol, rather than the lowercase **h**.

(c) (i) The most important point to include in this response is that a hydrocarbon contains only hydrogen and carbon. A few candidates confused the word hydrocarbon with carbohydrate and included oxygen which was not acceptable.

(ii) There were many correct responses to this question with candidates knowing the general formula of an alkene. Lower-scoring candidates found this question challenging.

(iii) The test with bromine water and the expected results were widely known by most candidates. When describing the results candidates are reminded that the acceptable answer of bromine water with alkenes is ‘colourless’ and not ‘clear’.

Question 6

(a) Many candidates could describe suitable structural differences in the stamen and stigma in wind-pollinated flowers compared with insect-pollinated ones. Common errors included descriptions of adaptations of insect-pollinated flowers, and the confusion of the stamen and stigma.

(b) The majority of candidates correctly identified slide 1 as the pollen from the wind-pollinated flower and gave a correct adaptation of its structure. Credit was not awarded to candidates who wrote about the greater quantity produced enabling a greater chance of pollination taking place. It was an adaptation of the pollen that was required, and since the pollen on slide 2 was bigger, fewer grains could be seen on the slide of the same magnification.

(c) (i) This question was challenging to candidates across the ability range. The type of apparatus used to investigate transpiration is widely known, but many candidates were unfamiliar with it. Those candidates who knew how the equipment worked made the connection between the evaporation from the shoot and the uptake of water causing the bubble of air to move upwards. Explanations in terms of increased evaporation due to the additional kinetic energy given to the water molecules were only seen in a few cases. Many candidates did not link the movement of the bubble to the shoot in any way, and incorrectly described the upward movement of the bubble in terms of convection currents. Candidates are reminded to read the stem of the question carefully.

(ii) Many candidates gave a possible correct reading and explanation in this question. There was a good general understanding of the decreased concentration gradient of water vapour molecules slowing down the rate of transpiration. A few candidates incorrectly stated that the rate of transpiration was reduced due to the leaf being able to take in water from the air. Credit was not awarded for this since the air inside the leaf is saturated with water molecules and no concentration gradient into the leaf is possible.

(d) Almost all of the candidates correctly identified root **X** as the root which takes in water more quickly due to its larger surface area. Some candidates did not mention the root hairs which make this possible, maybe due to the unfamiliar diagram showing them.

(e) Many candidates correctly described the role of chlorophyll in photosynthesis. Incorrect answers included the confusion of the chloroplast with chlorophyll.

Question 7

(a) (i) Many candidates could identify the wavelength as 50 cm. Many candidates gave 25 cm as their answer. Candidates are reminded that the wavelength is measured from one point on one wave to the same point on the next wave. This is done most accurately along the undisturbed line of the string.

(ii) A description of the term amplitude was correctly given by the higher-scoring candidates. Incorrect answers included the height of the wave from the peak to the trough, and references to the volume of sound.

(b) A correct circuit diagram was drawn by some candidates who drew the series circuit correctly with correct symbols. Common errors leading to loss of credit were drawing the ammeter symbol with a line going through, placing the ammeter in a parallel branch in the circuit, and giving the incorrect symbol for the variable resistor. Candidates should be familiar with the electrical symbols stated in the syllabus, and the way they are positioned in the circuit.

(c) (i) This calculation was correctly done by most candidates. The most frequently seen errors resulted from an incorrect formula, e.g. (R =) V×I or I/V.

(ii) This calculation was correctly done by most candidates. As in **(i)**, some candidates lost credit due to an incorrect application of the formula, or including the resistance they had worked out in **(i)** to use an incorrect formula.

Question 8

(a) Some candidates correctly stated that the aluminium oxide is a solid at room temperature, and heating it above its melting point makes the ions mobile and fee to move to the electrodes. Incorrect responses included describing aluminium instead of aluminium oxide, omitting to say that aluminium is a solid at room temperature, and explanations using collision theory.

(b) Most candidates correctly stated that the negative oxide ions would be attracted to the anode. The better candidates continued their explanations to include the loss of electrons at the anode to give oxygen gas. Other candidates incorrectly stated that the oxide ions gained electrons. Candidates are reminded that the oxide ions result from the oxygen atom gaining electrons and these must be lost to enable oxygen gas to form.

(c) The correct answer was given by most candidates. Candidates should be aware that when the command words are both 'State and explain', one word answers are not enough. In this question candidates who wrote 'reduced' without explanation did not gain the mark.

(d) The correct electronic structure was given by most candidates. Incorrect answers included adding five electrons to make the full shell, rather than the correct answer of losing three electrons.

(e) Many candidates predicted that the bonding would be ionic because a metal and a non-metal were involved. Candidates are reminded that ionic bonding occurs due to the transfer of electrons, so any reference to sharing electrons was not credited.

Question 9

(a) Most candidates scored full credit in this question.

(b) (i) 'Burning fossil fuels' and 'deforestation' were the most popular correct answers. Some candidates wrote 'respiration' as their answer. This was not accepted because the question was focussed on human activities, not their natural functions that would make very little difference, if any, to the carbon dioxide concentration of the atmosphere.

(ii) This question was well answered by most candidates reflecting good knowledge of the causes of global warming and its effects. Some candidates incorrectly stated that increased carbon dioxide concentration in the atmosphere affects the ozone layer.

COMBINED SCIENCE

Paper 0653/51
Practical Test

General comments

Colours should be stated when asked for in a question rather than just other descriptions of the mixture.

Comments on specific questions

Question 1

A relatively small number of candidates confused cation and anion in **(a)** despite the tests being stated in the Notes for Qualitative Analysis on the last page of the examination paper. It was pleasing that more candidates were specifically observing precipitates than in previous sessions. A number of candidates recorded a positive test for a chloride. **J** was a sulfate so may have given a slight white precipitate with silver nitrate solution but not the heavy white precipitate produced by a chloride.

In **(b)(i)** an acceptable description of the gas observed was usually seen, often as 'bubbling'. Few candidates recorded the appearance of the resulting solution although many candidates identified the gas as hydrogen along with the appropriate test. Some glowing splints relighting were recorded. This was not accepted.

In **(b)(ii)** care was needed when adding sodium hydroxide solution to the solution of zinc ions. Consequently some candidates did not observe the white precipitate although most realised that the cation was zinc.

Question 2

A variety of acceptable headings for columns two and three in Table 1.1 were seen. The heading for column one was often omitted. When time was given for column one it was rare to see incorrect units.

In **(b)** most candidates were able to carry out this experiment in full and produce suitable observations. 'Transparent' was accepted as an observation in this context however it is generally better to qualify the word with 'colourless' or a stated colour.

Part **(c)** produced a full range of marks because 'diffusion' was stated rarely and candidates assumed why the blue-black colour appeared instead of explaining it.

In **(d)** a relatively small number of candidates realised that the iodine would change to brown in the bag because they had not appreciated that the amylase was added after the experiment.

Question 3

This was a relatively easy practical to carry out. It is important for candidates to read the instructions carefully to establish the level of accuracy for the recording of results.
Good results were often seen in **(a)** and an accuracy mark was incorporated.

Dividing by twenty in **(b)** was carried out successfully in most cases. The squaring and rounding to one decimal place caused problems for many.

The standard of plotting of the graph in **(c)** was generally good. Many candidates did not indicate on their graph the values chosen to calculate the gradient. The wording of the question for a gradient has been kept the same to help candidates. A significant number of candidates calculated the gradient incorrectly as x/y.
Part **(d)** was another accuracy mark so if a mistake was made in **(c)**, this was corrected before marking this part.

COMBINED SCIENCE

Paper 0653/52
Practical Test

General comments

When suggesting the values for a variable in a plan, it is important to provide a suitable number of values (usually five) over a realistic and acceptable range.

Comments on specific questions

Question 1

This was a slightly challenging exercise but the majority of candidates carried it out well and generated useful results with evidence that the reaction was slowing at the end. Generally tables were completed well. Some candidates did not record all of their results to the same accuracy.

The plotting of points for the graph in **(b)** was generally done well. A number of candidates did not make best use of the grid; at least half of the grid should be used on both axes. There were many well drawn curves or straight lines. There were some curves which essentially joined all the points and this was unlikely to be correct.

Part **(c)(i)** was well answered however it was rare to see an adequate number and range of temperatures for **(c)(ii)**.

Question 2

Generally candidates carried out this thermochemistry exercise well producing meaningful results. The practical skill needed for making up solutions of different concentrations is probably rarely practised. Consequently some odd results were seen.
The changes in temperature were generally calculated correctly. Candidates found it hard to express in words how their data supported or did not support the statement. Very few candidates used calculations in their answers.
A significant number of candidates suggested the plotting of the appropriate graph for **(b)(iii)**.
A range of acceptable responses was seen in **(c)**. A digital thermometer is not necessarily more accurate so needs to be accompanied by more detail, such as ‘a digital thermometer accurate to 0.1 °C.

Question 3

a and *b* in **(a)** were measured well although not always recorded to 0.1 cm as requested. Most candidates knew how to ensure that the centre of the modelling clay was directly above the 15.0 cm mark. Not all candidates were able to communicate this effectively even with the help of a diagram.
Mass *M* in part **(b)** was not always recorded to the nearest gram. This did not affect the ability to score subsequent marks.

Mass *m* was usually calculated correctly. Sometimes too many significant figures were used.
Most candidates scored the marks in parts **(d)** and **(f)**.
Many candidates were able to suggest one reason in part **(e)**. Two reasons were seen rarely.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper to be able to describe experimental procedures. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, stopwatches, rulers, thermometers etc. and record the values to the requested number of significant figures. Candidates need to be able to plan experiments and discuss the presentation of results.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of a very high standard, although sometimes not to the accuracy requested. Describing experimental detail proved to be very difficult for many candidates. The standard of graph drawing was generally high but chosen scales need to cover at least half of the grid and where a straight line is appropriate, it should be drawn with a ruler and be one single line of constant gradient. Designing an experiment proved to be very difficult for many candidates.

Comments on specific questions

Question 1 – Movement of molecules through a membrane

(a) Candidates found this quite difficult. The first column unit was often given as m or secs or 2 mins and the second column was frequently given as results which is too vague to be creditworthy.

(b) More able candidates gained some credit, usually for the reaction of starch and iodine. Many candidates thought that starch moved out of the membrane or that the starch was breaking down into sugar which then moved out of the membrane.

(c) (i) Few candidates gave a correct colour; the most common responses were colourless and blue-black.

(ii) The majority of candidates repeated the question that the starch breaks down into sugar without appreciating that all of the starch would be broken down.

(iii) Benedict’s reagent and its associated colour changes were quite well known although heating was frequently omitted. Common incorrect responses included iodine, biuret, blue and brown.

Question 2 – Identification of ions

(a) (i) The test was quite well known. Common incorrect responses included nitric acid, barium nitrate and electrolysis. Of those that gave the correct reagent, the colour was often correct although brown was quite common but precipitate was often omitted.

(ii) The test was not very well known. Common incorrect responses included sodium hydroxide, silver nitrate and electrolysis. Of those that gave barium nitrate, few also added nitric acid and a significant number thought only nitric acid was the reagent.

(b) (i) Most candidates gained credit. A few thought the gas produced was oxygen.

(ii) The test for zinc was not well known. The most common incorrect response was bubbles. Of those that gave the white precipitate, few had it redissolving in excess.

(c) (i) The most common incorrect response was dissolving but others included: reaction with sodium hydroxide, destruction of the cation and zinc being used up.

(ii) Thermal and combustion were quite common incorrect responses.

Question 3 – Period of a pendulum

(a) (i) The majority of candidates measured the length correctly. Common errors: recording the length in mm, 7 and 0.65.

(ii) Common incorrect responses included giving the same answer as **(a)(i)** or dividing by 10.

(iii) Candidates found this difficult with many repeating the question, 'measure from the clamp to the centre of the bob', or, 'measure accurately'.

(b) Many candidates rounded the reading correctly but omitted the .0 when recording it.

(c) Many candidates calculated the two values correctly but then didn't record the values commensurate with the significant figures of the values already printed in the table.

(d) A significant number of candidates did not use more than half of the printed grid. Many candidates plotted the last four points correctly but plotted the first point at 60. Some drew a line between the four points clearly in a straight line and then joined this line to the anomalous point.

(e) Able candidates gained credit but many stated only that the line was a straight line which was not creditworthy as the question asked for a straight line to be drawn.

Question 4 – Effect of acid on seedling growth

(a) (i) Most candidates measured the lengths correctly.

(ii) The vast majority of candidates calculated the averages correctly.

(b) (i) Many candidates labelled the bars on the x-axis but didn't give a unit for the height on the y-axis and also many did not use at least half of the grid. The plotting of the points was usually correct but a few plotted the average results.

(ii) Common non-creditworthy responses included: for accuracy, to compare and reliability.

(c) Many candidates gained partial credit for the stunted growth but only the most able appreciated the quantitative link between the variables. A small number thought that the acid either killed or increased the growth of the seedlings.

(d) A significant number of candidates incorrectly gave the answer as water.

Question 5 – Investigating five gases

(a) The majority of candidates gained credit but a few thought hydrogen or carbon dioxide.

(b) (i) The names of suitable indicators were well known by most candidates but many didn't give any observations or only gave one. There was also some confusion between the colours of litmus and the colours of Universal Indicator. A few candidates only discussed pH numbers with no reference to an indicator or a meter.

(ii) Many thought that either red litmus staying red or blue litmus staying blue was an indication of neutrality and a significant number gave litmus going green. Quite a few candidates gave Universal Indicator with no result or gave cobalt chloride paper going pink.

(c) Candidates found this very difficult. Many poured water from the bowl into the tubes or poured the tubes into the bowl containing water.

(d) Few correct responses with even fewer gaining full credit. The most common responses were hydrogen and oxygen with some nitrogen.

(e) Many candidates gained credit although a few described the test for hydrogen or oxygen.

Question 6 – Resistance

(a) A common error was to reverse the meters.

(b) Many candidates read the current correctly although 0.7 and 0.70 were quite common responses. The voltage proved to be more difficult. Common responses included 1.2, 1.25, 1.3, 1.4, 1.6 and 1.8.

(c) V/A was a common response for the unit and a significant number of candidates rounded the value for wire M incorrectly.

(d) Candidates often failed to gain any credit. Many repeated the experiment in the question but only for one more length of wire. Few chose a control variable and most presented the results in a table.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates should have performed identification tests on the range of substances detailed in the syllabus.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. The standard of graph drawing was generally high although candidates need to remember to include units on the axes and to draw smooth curves with a single line. Knowledge of identification tests for ions was limited.

Comments on specific questions

Question 1 – Enzyme catalysed reaction

(a) Most candidates read the rulers correctly. 3.0 and 3.2 were common incorrect responses for the height at 2 minutes.

(b) For some candidates the units were missing and the curve was often feathery with multiple lines.

(c) (i) Many discussed the results of the experiment rather than the shape of the curve.

(ii) Many discussed the height of the foam and many thought the rate increased during the experiment.

(d) Common incorrect responses included: lighted split either relighting or burning brighter, lighted or glowing splint popping, limewater going cloudy and the celery causing the oxygen bubbles in the foam.

Question 2 – Effect of concentration on temperature change in a reaction

(a) (i) The most common incorrect response was Fe(III).

(ii) Most candidates read the thermometer scales correctly but a significant number recorded T_i as 23 rather than 23.0.

(b) (i) Almost all candidates subtracted the values correctly.

(ii) Many candidates chose an appropriate linear scale and plotted the points correctly. Quite a few found drawing the line more difficult. Many joined the points rather than drawing a straight continuous line with a ruler and a significant number did not put the line through the origin.

(iii) Many candidates stated that the line was a straight line which was not creditworthy as the question asked for a straight line to be drawn.

(c) (i) Common incorrect responses included combustion and endothermic.

(ii) Non-creditworthy responses included same initial temperature and stirring.

Question 3 – Determining mass by moments

(a) Candidates should be encouraged to gain more experience of answering this type of question. Many repeated the question answering with ‘put the centre of the cube on the 15 cm mark’.

(b) (i) Most candidates read the scales correctly. A small number recorded 30.6.

(ii) The majority of candidates subtracted correctly.

(iii) The majority of candidates subtracted correctly.

(c) (i) Common incorrect responses included: 84.43, 84.40 and 84.

(ii) Many candidates calculated correctly but then gave their answer to too many significant figures. A small number inverted the division.

(d) Candidates found this very difficult. Incorrect responses included clay contains air, clay contains water, the density of the clay will change and the distances are inaccurate.

(e) Many candidates had both distances either increasing or decreasing.

Question 4 – Movement of water molecules through a membrane

(a) (i) The majority of candidates read the ruler to the level of the water in the beaker (1.7 cm) rather than the level of the water in the glass tube. The reading was often given in mm.

(ii) The two most common errors were 1.8 cm or 18 mm and 35 mm.

(b) (i) Most candidates subtracted correctly.

(ii) Many candidates calculated the speed correctly. Common errors included dividing by 2 and dividing by 5.

(iii) Many candidates gave generic answers rather than explanations specific to this experiment such as water moves from a high concentration to a lower one, without specifying the direction of travel or which concentrations they were discussing.

(c) The sample to be tested was often omitted. Benedict's reagent was well known but a significant number used iodine or cobalt chloride paper. Heating was often omitted but the expected negative result was quite well known. A significant number of candidates suggested physical methods such as evaporating and there would be no residue or checking the boiling point.

(d) Many candidates had the starch moving or nothing moving.

Question 5 – Identification of solutions

(a) (i) The majority of candidates gained credit. Nitric acid was seen quite often.

(ii) More able candidates gained credit. Some gave either white or precipitate but not both and some just said that it reacted.

(iii) The chloride test was not well known. The majority of candidates used litmus or another indicator or sodium hydroxide or limewater.

(iv) The test was well known but a significant number of candidates thought the precipitate would redissolve. A significant number thought the precipitate was white.

(b) (i) Many candidates chose an appropriate piece of apparatus. Beaker was the most common incorrect response.

(ii) Indicator names were well known but many confused the colours of litmus and Universal Indicator. A significant number gave a named indicator paper rather than a solution.

(iii) Most able candidates gained credit. The majority thought that the volume of solution was already known and so the indicator was not needed or that it was there as a control.

(iv) Filter and crystallise were the two most popular non-creditworthy responses.

Question 6 – Conduction of heat

(a) Most candidates read the scales correctly.

(b) Many candidates chose scales which covered more than half of the grid and gained credit for the points and the curves but many did not include units on the axes. Some of the curves were feathery with more than one line.

(c) (i) Of those candidates who chose **G,** many repeated the question rather than explaining their choice in terms of temperature. Many candidates chose **F**.

(ii) Many candidates gained credit as error carried forward from **(c)(i)**. A significant number chose two metals or two non-metals.

(d) Common incorrect responses included 0°C, 10°C and 60°C.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key messages

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

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of instruments was of a high standard, although sometimes not given to the accuracy requested. The standard of graph drawing was generally good but chosen scales need to cover at least half of the grid and drawing a curve with a single line proved challenging for some candidates. Designing an experiment proved to be very difficult for many candidates as did completing apparatus diagrams.

Comments on Specific Questions

Question 1 – Food tests

(a) Reagents were well known but Benedict's and biuret were often reversed. Many candidates did not know which test required heat, often giving heat needed for both Benedict's and biuret.

(b) Common incorrect responses included; incorrect colours for the negative tests and the colours for Benedict's and biuret reversed.

(c) Many candidates knew the colour for a positive Benedict's test but the colour of iodine was less well known with purple, brown and yellow being common.

(d) Candidates found this very difficult with the result for the different concentrations of sugar often being the only creditworthy point. A common response detailed timing the solution to go red or timing to the deepest colour.

Question 2 – Effect of concentration on rate of reaction

(a) Most candidates recorded the times correctly. 30.22 was the main error for t_1 and 31.8 or 31 for t_2.

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

(ii) Some candidates did not record the values to the required three decimal places.

(c) (i) Many candidates gained credit for the axes but some gave non-linear parts to the *y-axis* close to the origin or didn't use at least half of the grid. Most plotted the points correctly. The curve proved to be a little more difficult with several candidates drawing feathery curves with multiple lines or not passing their curve through the origin.

(ii) A significant number drew a curve but described the relationship as directly proportional.

(d) More able candidates gained credit. Many candidates chose one of the other two values because they did not fit onto their drawn line on the graph.

(e) Incorrect responses included: contaminated chips, all gas already released, all energy released and the most popular not a fair test. A significant number omitted this part.

Question 3 – Electrical resistance

(a) (i) Many candidates gave the correct symbol for the voltmeter but then connected it in series or connected it in parallel between incorrect points on the circuit.

(ii) Almost all candidates read the meter correctly.

(iii) The most common incorrect value was 0.22.

(iv) Most candidates calculated the value correctly but some didn't round their answer correctly. The unit was well known.

(b) The vast majority calculated the value correctly.
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(c) Some candidates did not refer to the data and a significant number argued for the three resistors being 3 × 5 = 15.

(d) Many thought the circuit would overheat, that the student was less likely to be electrocuted, to save energy or that the current would increase.

(e) Commonly, candidates discussed how the resistance would change rather than the reading on the ammeter.

Question 4 – Gas exchange in plants and animals

(a) Almost all candidates gained credit.

(b) (i) The most common non-creditworthy response was plants take in carbon dioxide with no reference to the process.

(ii) Common errors included either animals giving out or breathing out carbon dioxide with no reference to the process.

(iii) Whilst many candidates appreciated that the carbon dioxide produced by animals was taken in by plants far fewer appreciated that these would be in balance.

(c) The idea of control was well known with 'to compare' being the most common non-creditworthy response.

(d) (i) Many found this difficult. Few gave a method and opted for putting them in the same room. Many gave room temperature rather than a value and those that gave a value often did not put units on the number.

(ii) Almost all gained at least partial credit with many gaining full credit. A significant number did not qualify their factor for example 'tadpoles' without amount or size.

Question 5 – Properties of oxides

(a) (i) Many candidates included a bulb and an ammeter or a switch with no power supply.

(ii) A wide variety of oxides were given but the most common were iron(III) oxide, magnesium oxide and carbon oxide.

(b) (i) Candidates found this very difficult. Most did not put the thermometer into a stopper but put it into the liquid in the flask and resting on the bottom of the flask and some put it into the beaker. Of those that put the thermometer in a stopper most put the thermometer into the liquid or into the space just above the level of the liquid.

(ii) Almost all candidates read the thermometer correctly. The most common incorrect response was 99°C.

(iii) Many thought this was the start of the boiling process or that it was near enough to round to 100 or that an impurity lowered the boiling point of a substance. Many also used pH paper, cobalt chloride paper or copper sulfate powder.

(c) Common incorrect responses included calcium oxide and carbon oxide.

(d) Electrolysis was a common incorrect response.

Question 6 – Density of liquids

(a) (i) Most candidates read the measuring cylinders correctly but many didn't record them to the correct accuracy and so didn't gain full credit. Common incorrect readings included 20.9 for **R** and 40.1 for **S**.

(ii) More able candidates gained credit.

(b) Most candidates calculated the values correctly.

(c) (i) Beaker and glass were the most common incorrect responses. Many candidates chose apparatus that would not usually be found in a laboratory.

(ii) The most common non-creditworthy responses included: rounding to 60 would not involve much error and that it was the mass of liquid that was required not the mass of the liquid and measuring cylinder.

(iii) Most candidates gained credit. Some thought that the weighings should be more accurate.

(d) (i) Many candidates chose **S** but often didn't gain credit as low density was given as the reason. A significant number of candidates chose **R** because it had a high density.

(ii) Many candidates put the liquids into three layers or one layer.