COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

General comments: Biology

The biology questions provided a satisfactory test for the candidates at this level. No question proved either too difficult or too easy, and all questions distinguished well between candidates of differing abilities.

Comments on specific questions

Question 3

This question may have appeared a little confusing at first sight, and, as a result, there appeared to be a good deal of guesswork involved. However, it may be that an appreciable proportion of the candidates who answered the question incorrectly are aware that the process of transpiration involves the diffusion of water in the gaseous rather than liquid phase.

Question 4

This proved to be the easiest question in the biology section of the paper. Two facts were required to answer this question – that enzymes are catalysts and that they are protein in nature. A sizeable proportion of candidates were very comfortable with these facts.

Question 10

In reality, candidates were asked what the effect of adrenaline is on pulse rate and blood glucose concentration. Over 80 per cent appreciated that the heart rate would increase, but it was, perhaps, surprising that almost a third of those felt that it would decrease the concentration of glucose in the blood. There is the possibility that they linked raised pulse rate with exercise that would use up blood glucose.

Question 12

A detailed knowledge of the menstrual cycle was required for this question. It was necessary to appreciate that ovaries release ova alternately, that fertilisation is likely to occur around the time of ovulation and that menstruation occurs 14 days after ovulation – a good deal of information to use in one question. Almost half the candidates were successful and they are to be congratulated on that achievement.

General comments: Chemistry

The Chemistry questions provided a good test of candidate's ability. **Question 15** was the most straightforward for the candidates and **Question 25** proved to be the most difficult.

Comments on specific questions

Question 15

Candidates demonstrated a clear understanding of the formula representation of elements and compounds.

Question 17

This question on electrolysis produced a popular distractor, **B**, showing that many candidates did not understand how to derive the name of the electrodes from the diagram of the electrical cell.

Question 20

A significant proportion of candidates thought that the solid was zinc hydroxide rather than the correct answer, zinc.

Question 25 produced a popular, positive distractor, **B**. This suggests that many candidates, when using test-papers, link "pink" to "acid" without realising that cobalt chloride paper is used to test for the presence for water and that the positive result is a colour change (from blue) to pink.

General comments: Physics

No questions in the physics section of this paper were found to be particularly easy or difficult.

Comments on specific questions

Question 28

Candidates performed very well on this question, demonstrating an excellent understanding of speed-time graphs.

Question 29

Almost half of the candidates opted for **D** in this question on density, correctly dividing the mass by the density, but failing to calculate the length of one side of the cube from this value.

Question 30

This question asked about energy resources for which the Sun was the original source, and many less able candidates appeared to resort to guessing.

Question 31

The most popular distractor here was option **B**, candidates believing that evaporation causes a temperature increase in the remaining liquid.

Question 33

A very common mistake in this question was thinking that heating air increases its density.

Question 35

This question concerned refraction of light. While most candidates correctly predicted the light would bend towards the normal, a significant proportion did not know how to measure the angle of incidence or angle of refraction.

Question 39

The topic of this question was electrostatics, and option **C** was a relatively popular choice, incorrectly linking opposite charges to repulsion.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

General comments: Biology

The performance of candidates on the questions suggested that the ability of the candidates and the difficulty of the questions were well matched.

Comments on specific questions

Question 1

There is always the belief the breathing and respiration are different names for the same process, and there was evidence of this confusion in this question. However, it was a distinct minority that believed that breathing is a characteristic of living things.

Question 6

That phloem is a transporting tissue was generally well known, but the nature of the materials transported was not so. As this is a fundamental piece of knowledge at this level, candidates are ill advised to take a test without being sure of the relevant facts of this topic.

Question 7

This question tested simple knowledge of heart structure. The traditional problem with this topic is distinguishing left from right, but that was not required here. The problem here was, somewhat unusually, distinguishing atrium from ventricle which proved an obstacle for one fifth of the candidates.

Question 10

Candidates found this the easiest biology question on the paper. Perhaps the offer of only one option, that suggested phototropism is the response to light, contributed to the relatively undemanding nature of the question.

Question 11

Those who knew the difference between anther and stigma had no problems here, but to several of the less able, this posed a problem.

General comments: Chemistry

All of the Chemistry questions provided a good challenge for the candidates.

Comments on specific questions

Question 14

This question produced a popular incorrect answer, **C**, showing that some candidates believed that the beaker would only contain water.

Question 17

A significant number of candidates though that electrode **Y** was the anode.

Question 22

This question was the least challenging for the candidates. Candidates clearly understand that the most reactive metals lie in the group on the extreme left of the Periodic Table.

Question 24

Option **A** was a popular incorrect answer. However, the vast majority of candidates realised that calcium and sodium would both react with cold water so could not be the answer.

General comments: Physics

Question **28** was found the easiest in the physics section, with questions **35** and **36** causing the most problems.

Comments on specific questions

Question 29

Approximately two thirds of weaker candidates opted for **D** in this question on density, presumably dividing the mass by the length of one side of the cube, rather than by its volume.

Question 31

In this question on compressibility of different states of matter, the most common error was to believe that the volume of a liquid as well as a gas can be reduced by applying an external pressure.

Questions 33

It does not appear to be widely known by weaker candidates that radiation is the only process of energy transfer through a vacuum.

Question 35

Quite a large proportion of responses to this question on critical angle were incorrect. Distractors **A** and **C** were popular, these being the options in which total internal reflection would occur, so that no light would enter the air.

Question 36

This question concerned suitable safety precautions when using an X-ray machine. Many candidates either failed to notice that this was one of the few occasions in which a negative question was used, or they believed that safety glasses would provide more effective protection than lead blocks, leading them to opt for **C**.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

General comments: Biology

There were some questions in the biology section of the paper that candidates found difficult. It was usually insecurity over relatively basic facts that appeared to be the problem, and this led to a measure of guesswork. Nevertheless, no question failed to make a contribution to the overall assessment.

Comments on specific questions

Question 2

It may be worthy of note that this question proved to be the easiest in the biology section of the paper, though it tested an essentially mathematically orientated biological skill.

Question 4

Two features combined to make this a demanding question. First, candidates regularly find graph interpretation difficult, and second, they often confuse the shape of graphs that show the effect of temperature and pH on the rate of enzyme action. Even given an example of the shape of a graph showing the effect of temperature, they struggled to match it with the similarly-shaped graph that indicated the same effect but with a faster maximum rate.

Question 5

Confusion between the position and appearance of xylem and phloem proved the downfall of even some of the better candidates, who otherwise had no problem in identifying the cuticle of the leaf.

Question 6

This question tested simple knowledge of heart structure. The traditional problem with this topic is distinguishing left from right, but that was not required here. The problem here was, somewhat unusually, distinguishing atrium from ventricle which proved an obstacle for one fifth of the candidates.

Question 9

It was, perhaps, understandable that candidates felt that energy is required for temperature regulation, but they had overlooked the fact that, in plants, evaporation does not require energy liberated by the plant.

Question 10

It was, perhaps, surprising to note that even the better candidates believed that adrenalin, after having its effect, is breathed out rather than destroyed by the liver.

General comments: Chemistry

The Chemistry questions provided a good test of candidate's ability. **Question 17** was particularly challenging.

Comments on specific questions

Question 17

This question on electrolysis was very challenging for the candidates. Many candidates thought that electrode **Y** was the anode. Very few candidates realised that the electrolyte is in its molten state.

Question 18

Half the candidates mistakenly thought option **A** was the correct answer as candidates confused the terms *exothermic* and *endothermic*.

Question 20

The general equation for the reaction of acid with carbonate was not well known.

Question 21

The difference in the positive test results for iron(II) and iron (III) ions was not well known.

Question 23

The properties of transition metals were not clearly understood.

Question 24

The reactions of an acid with different metals were not well known.

Question 26

Some of the more able candidates confused the *thermal decomposition* of calcium carbonate with *combustion*.

General comments: Physics

No questions in the physics section of this paper were found to be particularly easy, but questions **36**, **40** and, particularly, **37** caused difficulty for many.

Comments on specific questions

Question 29

Perhaps unsurprisingly, the most common error in this question on average speed was to fail to consider the units, leading to the incorrect option A.

Question 29

Able candidates had little difficulty with calculating density, but almost half of weaker students opted for C; this value was obtained by dividing the mass of the full bottle by the volume of the oil.

Question 30

This question on power showed that many less able students linked increased power to increased potential energy (option **B**), rather than linking it to increased speed.

Question 33

A very common mistake in this question was believing that convection occurs in all three states of matter.

Question 35

Almost two thirds of candidates could not identify the focal length of the lens from the choice on the diagram.

Question 37

This question on echoes was too difficult for more than three quarters of candidates, with almost half making the classic mistake of failing to double the distance travelled by the sound to 264 m.

Question 39

The topic of this question was electrostatics, and option **C** was a relatively popular choice, incorrectly linking opposite charges to repulsion.

Question 40

There appeared to be widespread lack of knowledge that the current at all points in a series circuit is the same.

COMBINED SCIENCE

Paper 0653/21
Core Theory

Key messages

Candidates should use a ruler for diagrams where appropriate.

When answering questions on Chemistry, candidates should take note whether the question is asking for the name or the formula in the answer.

Candidates should carefully read the information provided before answering their questions.

General comments

Most candidates attempted the whole paper and appeared to have sufficient time to complete their scripts. The use of the available space for responses was appropriate, with fewer candidates running out of space. Most answers could be read without difficulty, but in some cases the illegibility of handwriting meant that key words for an answer could not be credited. It is recommended that this report is read alongside the question paper and the published mark scheme.

Comments on specific questions

Question 1

(a) Many candidates gained most of the available credit in this question. Candidates should be aware that dissolved sugar travels both upwards and downwards in the phloem. This enables non-photosynthesising parts of the plant in all areas to respire.

(b) (i) Many candidates correctly identified the cell parts. Other candidates should be aware that the cell membrane of a plant cell is found inside the cell wall. The labelling line on Fig. 1.1 does not reach that far.

(ii) The majority of candidates found this question challenging. Many candidates stated that starch grains are only found underground. Candidates should be familiar with the presence of starch in a leaf and therefore presence of starch grains could not be the correct answer. Statements referring to the absence of chloroplasts were credited.

(iii) This question was well answered by most candidates who were familiar with the practical test.

(c) Candidates across the range found this question challenging. Candidates were required to interpret the results in terms of the need for both light and chlorophyll, and many did not do this. Candidates are reminded of the need to be familiar with the practical work described in the syllabus.

Question 2

(a) (i) This question was well answered by a few candidates. For maximum credit a device for measuring the volume of gas produced had to be correctly connected to the flask by a delivery tube going through a bung. The apparatus had to be airtight. Many responses showed balloons to collect the gas. The absence of a method to measure the volume of gas in balloons meant that they were not considered to be appropriate for this response.

(ii) The limewater test for carbon dioxide was well known by most candidates.

(iii) Most candidates correctly answered that the rate of reaction slowed down as the acid concentration decreased.

(b) Candidates were familiar with writing a word equation. Most wrote the left side of the equation correctly using the information in the question. Knowledge of the products of the general reaction of a carbonate with an acid were less well known. Many candidates incorrectly wrote that hydrogen was the gas produced.

(c) Many candidates succeeded in deducing that the salt produced is sodium nitrate.

Question 3

(a) (i) The shape of the graph was successfully drawn by many candidates who scored full credit. Some candidates did not complete the graph beyond the end of the race and others drew a completely vertical line after the horizontal section. Both of these responses lost credit. Candidates are reminded to use a ruler to draw graphs. Credit was lost in many cases because their horizontal line was not drawn accurately.

(ii) The majority of candidates correctly identified the horizontal section of their graph.

(iii) Those candidates who omitted the final section of their graph were able to gain full credit by showing acceleration in the first part of their graph. This question was generally well answered.

(b) The majority of candidates successfully applied the equation to gain full credit.

(c) (i) A few candidates successfully drew the correct diagram. It was clear that many candidates were not familiar with the ray diagram. Candidates are reminded that knowledge of the converging lens is a syllabus requirement for core candidates. The use of a ruler was essential for this response to show the light travelling in straight lines.

(ii) Some candidates responded successfully to this question even though they were unable to do the ray diagram. They realised that the image must focus on the light sensor. Some candidates lost credit by just measuring the distance from the lens to the light sensor as 4.5 cm, disregarding the fact that this represents a 15 cm distance on the diagram.

(d) Many candidates successfully identified the energy transfers.

Question 4

(a) (i) Some candidates could identify the arteries leading from the heart. Candidates should be aware that there are two arteries leaving the heart and two veins entering the heart.

(ii) Most candidates were unfamiliar with the chamber that receives the blood from the lungs.

(iii) Many candidates correctly described the function of the septum of the heart to keep the oxygenated and deoxygenated blood separate. Incorrect responses included the function of the septum as a valve or a pump for blood.

(b) This question was correctly answered by many of the higher-scoring candidates. Other candidates were not familiar with the differing structures of the artery and the vein. Responses which described the artery as being thicker were not acceptable. They needed to refer to the thicker wall in the artery.

(c) (i) Most candidates correctly deduced the method of this calculation from the table and gave the correct answer.

(ii) Changes in the pattern of breathing were the required answers here. Incorrect answers included descriptions of the release of adrenaline and further detail about heart rate which had been covered in **(c)(ii)**. Some candidates confused the term ‘respiration’ with ‘breathing’ and wrote sentences such as ‘The rate of respiration of their lungs increased’.

Question 5

(a) Many candidates across the range successfully matched the pairs in this question. A common error was the confusion of filtration and distillation as methods of separation. Candidates should focus on the collection of the required product of the separation in order to choose their best method.

(b) This question was correctly answered by the higher-scoring candidates. Candidates should be aware that the nucleon number is the sum of the protons and neutrons, so the number of neutrons can be found by a subtraction calculation.

(c) (i) The type of bonding required depended on whether the reactants were a metal and non-metal, which would produce ionic bonding, or two non-metals, which would result in covalent bonding. Many candidates successfully deduced the type of bonding. Other candidates either wrote the same type of bonding for both reactions, or confused ionic and covalent bonding.

(ii) Many candidates correctly identified the type of chemical reaction as exothermic. The main incorrect answer given was endothermic. Candidates should be aware that reactions giving out heat are exothermic and reactions taking in heat are endothermic.

(d) (i) The reaction of iron with oxygen is an oxidation reaction because oxygen combines chemically with the iron. Therefore, candidates' responses describing the oxygen mixing with iron were not acceptable.

(ii) Most candidates successfully responded that water is the other substance involved in the formation of rust.

(iii) To gain full credit candidates had to describe a method of rust prevention followed by how it is effective. Many candidates scored full credit by describing a suitable substance to provide a barrier and a suitable explanation of why it works. Responses describing keeping objects indoors were not acceptable.

Question 6

(a) Many candidates successfully completed the sentences. Others should be aware that the mass does not change during heating, but the volume and density do change.

(b) The fact that the liquid in the thermometer does not freeze at temperatures below 0 °C was the most important point in this question. Many candidates responded correctly. Incorrect answers included reference to the levels of liquid in the thermometers, and references to the boiling point of water.

(c) (i) Many candidates correctly identified convection as the method of heat transfer in liquids.

(ii) Candidates found this question challenging. The question was looking for answers relating to glass being a poor conductor of heat as the reason for heat not escaping at the top of the thermometer. Those responses which said that glass does not conduct heat were not acceptable because glass has to conduct heat into the bulb to reach the liquid.

(d) This question was answered correctly by the higher-scoring candidates. Correct responses required reference to the arrangement of the molecules and the degree of touching shown by them. Therefore, responses referring to the movement of molecules were not given credit. The process of elimination of diagrams 1 and 3 by describing their arrangements was also not acceptable because it did not describe anything about the liquid.

Question 7

(a) Candidates had to interpret the graph provided to state a simple description of the change in oxygen concentration. Most candidates responded to this successfully. The explanation required linking the action of bacteria to the change in oxygen concentration. Fewer candidates did this successfully.

(b) Most candidates made acceptable explanations for the disappearance of the fish in the polluted area.

(c) In this question, there were several acceptable answers, with the danger of disease being the focus of what was needed. Candidates who just referred to bacteria being present as a reason for drinking water to being unsafe did not gain credit, since not all bacteria are harmful. Acceptable answers included the danger of disease or poisoning.

Question 8

(a) Many candidates scored full credit in this question. Carbon monoxide was the most frequent incorrect response.

(b) (i) Many candidates successfully responded that coal, natural gas and petroleum are examples of fossil fuels.

(ii) Fewer candidates identified methane as the main constituent of natural gas. Nitrogen was frequently given as an incorrect response, written by candidates who may have been referring to the air.

(c) (i) Many of the higher-scoring candidates answered this question correctly. Partial credit was obtained by responses stating that the molecule contains hydrogen and carbon. The addition of the word 'only' to these responses enabled full credit to be awarded. Candidates should be aware that the hydrogen and carbon must be chemically combined in a hydrocarbon, so mixtures of hydrogen and carbon were not accepted.

(ii) Many higher-scoring candidates obtained full credit for this question. The main reasons for loss of credit were giving the formula for methane, and the omission of the double bond from those responses with the correct formulae.

Question 9

(a) (i) Some candidates correctly named the variable resistor. The majority stated that the component is a resistor, omitting the variable aspect of its function. These responses could not gain credit.

(ii) There were some excellent responses to this question with many candidates across the range gaining full credit. Candidates are reminded that the voltmeter is added to the circuit across the component being tested, so the placing of the voltmeter across any other component lost credit, though credit was awarded for the correct symbol. Candidates are also reminded that the symbol for the voltmeter does not have a line through the centre.

(b) Generally well answered by those candidates who took the reading of the current from the graph. This was essential due to the shape of the graph and it could not be done by proportion.

(c) Many candidates scored full credit by writing electrons for the charged particle.

(d) (i) Visible light and infrared were placed in the correct boxes by most candidates, showing a good knowledge of the electromagnetic spectrum.

(ii) Many candidates succeeded in identifying gamma radiation. The most frequent incorrect answer was radio waves with the lowest frequency, but the longest wavelength.

COMBINED SCIENCE

Paper 0653/22
Core Theory

Key messages

Candidates should indicate clearly if their response to a question is not in the allocated space.

When answering questions on Chemistry, candidates should take note whether the question is asking for the name or the formula in the answer.

Candidates should carefully read the information provided before answering their questions.

General comments

Most candidates attempted the whole paper and appeared to have sufficient time to complete their scripts. The use of the available space for responses was appropriate, with fewer candidates running out of space. Most answers could be read without difficulty, but in some cases the illegibility of handwriting meant that key words for an answer could not be credited. It is recommended that this report is read alongside the question paper and the published mark scheme.

Comments on specific questions

Question 1

(a) Many candidates found this question challenging, with few gaining full credit. Many candidates were unfamiliar with the term *ingestion*. More candidates could identify the areas of the digestive system for absorption and secretion of digestive enzymes.

(b) A few candidates gave the correct response that the plasma is the part of the blood for transferring dissolved nutrients. Many candidates incorrectly wrote red blood cells as their response.

(c) The movement of glucose from the plasma into the cells is an example of the process of diffusion. Only the higher-scoring candidates described this. The majority of candidates described the movement of glucose as shown by the arrow but omitted to mention the process of diffusion.

(d) (i) Many candidates correctly stated the optimum pH as 2.7. Many incorrect answers suggested the optimum pH was 4.6, the pH at which activity stops.

(ii) Several candidates successfully referred to the graph to conclude that there would be no activity at pH 8. Many candidates incorrectly stated that the activity would increase. Candidates should be aware that information provided in the question should be read carefully.

Question 2

(a) (i) Electrolysis was the single word answer required here, and many candidates gave this answer correctly. Spelling was important here because of incorrect words being similar, for example electrolyte.

(ii) Those candidates who were familiar with this experiment answered well. Incorrect responses included identifying lead as the product at the anode. Many candidates did not know the colour of bromine.

(b) The word equation was correctly given by many candidates. Credit was lost by those candidates who tried unsuccessfully to write the formulae for the equation. Other candidates did not score because they did not identify the metal as copper, just writing 'metal' as one of the products.

(c) (i) Many candidates successfully stated the upward trend of boiling points of elements going down Group VII.

(ii) Most candidates correctly identified the sub-atomic particles in the atom.

(iii) The nucleon number as being the sum of the protons and neutrons was known by many higher-scoring candidates. Incorrect answers using electrons instead of protons in the calculation are not acceptable in the definition because the number of electrons can vary during ionisation.

Question 3

(a) Many candidates gave weight or gravitational force as the correct response. Some lower-scoring candidates incorrectly gave responses in terms of potential energy.

(b) (i) Most candidates found this question challenging. The fact that on the level the cart's weight would be acting downwards (at 90° to the direction of motion) was an acceptable answer for not affecting the speed (in this case ignoring frictional forces). Alternatively, the candidates could respond that the speed of the cart decreased due to the effect of friction.

(ii) The majority of the candidates did this calculation successfully. They were familiar with the equation speed = distance / time. Candidates are reminded to bear in mind the number of significant figures in their responses.

(iii) Many candidates correctly interpreted the information provided to produce the correct graph. Careful reading of the question was required here because many candidates drew graphs including the downhill acceleration and so lost credit. Credit was also lost by those candidates who only drew the final deceleration.

(c) Many candidates correctly identified both types of energy. Other candidates found challenging the identification of the thermal energy transferred by the brakes as the cart stops.

Question 4

(a) Only the highest-scoring candidates gained full credit in this question. Many candidates were confused about the differing roles of the cell wall and the cell membrane. Also, the absorption of amino acids by the root hair cells was another misconception shown by many candidates.

(b) The majority of candidates found this question challenging. To answer it successfully required studying the diagram and predicting what would happen as the root grows downwards. Many candidates answered this question in terms of the plant needing more root hairs, rather than the damage that could occur to the existing ones.

(c) (i) This question was answered correctly by many candidates.

(ii) The conditions needed for photosynthesis were widely known and generally this question was answered well.

Question 5

(a) (i) The process of fractional distillation was identified by many candidates. Distillation on its own was not acceptable.

(ii) Many of the higher-scoring candidates answered this question correctly. Partial credit was obtained by responses stating that the molecule contains hydrogen and carbon. The addition of the word 'only' to these responses enabled full credit to be awarded. Candidates should be aware that the hydrogen and carbon must be chemically combined in a hydrocarbon, so mixtures of hydrogen and carbon were not accepted.

(b) (i) Not many candidates identified methane as the main constituent of natural gas. Nitrogen was frequently given as an incorrect response, written by candidates who may have been referring to the air.

(ii) Many candidates correctly identified oxygen as the gas which reacts with natural gas when it burns.

(c) (i) Many candidates correctly completed the diagram to give the structure of ethanol. Although the formula was provided some candidates disregarded the total number of atoms and therefore lost credit.

(ii) Most candidates successfully stated water and carbon dioxide as their responses.

Question 6

(a) Only a few candidates correctly explained that the increase in sea level in this case is due to thermal expansion. Many candidates incorrectly gave explanations about the rise in sea level being due to melting ice caps. This explanation was given and the question was asking for something else. Candidates are reminded to read the question carefully. Candidates who gave particle explanations of the process of expansion should be aware that the particles themselves do not expand, but the distance between them.

(b) (i) Most candidates correctly stated evaporation as the correct answer.

(ii) Many candidates wrote correct answers for both parts 1 and 2, reflecting that they had understood the particle explanation for evaporation. Some candidates incorrectly wrote that the temperature of the sea water increases after the loss of the more energetic particles. The loss of these particles reduces the overall energy of the remaining water and therefore reduces the temperature.

(c) (i) Radiation as a method of energy transfer was the only acceptable answer here, with both conduction and convection requiring a medium. Many candidates incorrectly stated these responses.

(ii) This question was more challenging than previous questions of a similar type. The candidates had not only to identify the two types of radiation, but also place them in the correct boxes in the electromagnetic spectrum.

Question 7

(a) (i) Many candidates completed the boxes correctly and were awarded full credit.

(ii) The food chain was written correctly by many higher-scoring candidates. Common reasons for loss of credit were the writing of the arrows the wrong way around, and less frequently, attempts at a food web.

(b) (i) Large-scale activities producing methane were not widely known. Many candidates incorrectly referred to exhaust from vehicles and emission from factories.

(ii) Some candidates correctly described the role of methane as a greenhouse gas and its contribution to global warming. Incorrect responses included effects on the ozone layer and the production of acid rain. Candidates are advised to be clear about the different effects that humans have on their environment.

Question 8

(a) (i) This question was correctly answered by the higher-scoring candidates who could put the metals in order of reactivity.

(ii) Most candidates gained credit for stating that bubbles of gas would be seen during the reaction.

(b) The majority of candidates found this question challenging. The tests for identification of ions were not widely known.

(c) (i) Many candidates correctly identified the type of chemical reaction as exothermic. The main incorrect answer given was endothermic. Candidates should be aware that reactions giving out heat are exothermic, and reactions taking in heat are endothermic.

(ii) Most candidates correctly stated that the charge on a sodium atom is 1+.

(iii) Candidates generally found this question challenging. Many described a reaction during which sodium ions are formed, e.g. adding sodium to water. These answers did not gain credit because they did not describe the change in the structure of the sodium atoms.

Question 9

(a) (i) Some candidates correctly named the variable resistor. The majority stated that the component is a resistor, omitting the variable aspect of its function. These responses could not gain credit.

(ii) Some candidates who did not gain credit in part **(i)** were able to gain at least partial credit in this question, showing that they understood the purpose of the variable resistor. Other candidates found this part of the question challenging because they had identified the component incorrectly, for example, as a fuse or a switch.

(iii) There were many candidates who gained full marks in this question. Most of the circuit was provided in Fig. 9.1 and it had to be completed including an ammeter in Fig. 9.2. Candidates are reminded that the symbol for an ammeter does not have a line down the middle. Many candidates used spare space to do the diagram instead of completing Fig. 9.2 as required by the question with no indication by the candidates for the examiner to look elsewhere.

(b) Most candidates correctly used the information on the graph to calculate the resistance.

(c) Many candidates gave correct responses to this question showing that they knew the relationship between frequency and pitch, and between volume and amplitude.

COMBINED SCIENCE

Paper 0653/23
Core Theory

Key messages

Candidates should indicate clearly if their response to a question is not in the allocated space.

When answering questions on Chemistry, candidates should take note whether the question is asking for the name or the formula in the answer.

Candidates should carefully read the information provided before answering their questions.

General comments

Most candidates attempted the whole paper and appeared to have sufficient time to complete their scripts. The use of the available space for responses was appropriate, with fewer candidates running out of space. Most answers could be read without difficulty, but in some cases the illegibility of handwriting meant that key words for an answer could not be credited. It is recommended that this report is read alongside the question paper and the published mark scheme.

Comments on specific questions

Question 1

(a) Many candidates found this question challenging, with few gaining full credit. Many candidates were unfamiliar with the term *ingestion*. More candidates could identify the areas of the digestive system for absorption and secretion of digestive enzymes.

(b) A few candidates gave the correct response that the plasma is the part of the blood for transferring dissolved nutrients. Many candidates incorrectly wrote red blood cells as their response.

(c) The movement of glucose from the plasma into the cells is an example of the process of diffusion. Only the higher-scoring candidates described this. The majority of candidates described the movement of glucose as shown by the arrow but omitted to mention the process of diffusion.

(d) (i) Many candidates correctly stated the optimum pH as 2.7. Many incorrect answers suggested the optimum pH was 4.6, the pH at which activity stops.

(ii) Several candidates successfully referred to the graph to conclude that there would be no activity at pH 8. Many candidates incorrectly stated that the activity would increase. Candidates should be aware that information provided in the question should be read carefully.

Question 2

(a) (i) Electrolysis was the single word answer required here, and many candidates gave this answer correctly. Spelling was important here because of incorrect words being similar, for example electrolyte.

(ii) Those candidates who were familiar with this experiment answered well. Incorrect responses included identifying lead as the product at the anode. Many candidates did not know the colour of bromine.

(b) The word equation was correctly given by many candidates. Credit was lost by those candidates who tried unsuccessfully to write the formulae for the equation. Other candidates did not score because they did not identify the metal as copper, just writing 'metal' as one of the products.

(c) (i) Many candidates successfully stated the upward trend of boiling points of elements going down Group VII.

(ii) Most candidates correctly identified the sub-atomic particles in the atom.

(iii) The nucleon number as being the sum of the protons and neutrons was known by many higher-scoring candidates. Incorrect answers using electrons instead of protons in the calculation are not acceptable in the definition because the number of electrons can vary during ionisation.

Question 3

(a) Many candidates gave weight or gravitational force as the correct response. Some lower-scoring candidates incorrectly gave responses in terms of potential energy.

(b) (i) Most candidates found this question challenging. The fact that on the level the cart's weight would be acting downwards (at 90° to the direction of motion) was an acceptable answer for not affecting the speed (in this case ignoring frictional forces). Alternatively, the candidates could respond that the speed of the cart decreased due to the effect of friction.

(ii) The majority of the candidates did this calculation successfully. They were familiar with the equation speed = distance / time. Candidates are reminded to bear in mind the number of significant figures in their responses.

(iii) Many candidates correctly interpreted the information provided to produce the correct graph. Careful reading of the question was required here because many candidates drew graphs including the downhill acceleration and so lost credit. Credit was also lost by those candidates who only drew the final deceleration.

(c) Many candidates correctly identified both types of energy. Other candidates found challenging the identification of the thermal energy transferred by the brakes as the cart stops.

Question 4

(a) Only the highest-scoring candidates gained full credit in this question. Many candidates were confused about the differing roles of the cell wall and the cell membrane. Also, the absorption of amino acids by the root hair cells was another misconception shown by many candidates.

(b) The majority of candidates found this question challenging. To answer it successfully required studying the diagram and predicting what would happen as the root grows downwards. Many candidates answered this question in terms of the plant needing more root hairs, rather than the damage that could occur to the existing ones.

(c) (i) This question was answered correctly by many candidates.

(ii) The conditions needed for photosynthesis were widely known and generally this question was answered well.

Question 5

(a) (i) The process of fractional distillation was identified by many candidates. Distillation on its own was not acceptable.

(ii) Many of the higher-scoring candidates answered this question correctly. Partial credit was obtained by responses stating that the molecule contains hydrogen and carbon. The addition of the word 'only' to these responses enabled full credit to be awarded. Candidates should be aware that the hydrogen and carbon must be chemically combined in a hydrocarbon, so mixtures of hydrogen and carbon were not accepted.

(b) (i) Not many candidates identified methane as the main constituent of natural gas. Nitrogen was frequently given as an incorrect response, written by candidates who may have been referring to the air.

(ii) Many candidates correctly identified oxygen as the gas which reacts with natural gas when it burns.

(c) (i) Many candidates correctly completed the diagram to give the structure of ethanol. Although the formula was provided some candidates disregarded the total number of atoms and therefore lost credit.

(ii) Most candidates successfully stated water and carbon dioxide as their responses.

Question 6

(a) Only a few candidates correctly explained that the increase in sea level in this case is due to thermal expansion. Many candidates incorrectly gave explanations about the rise in sea level being due to melting ice caps. This explanation was given and the question was asking for something else. Candidates are reminded to read the question carefully. Candidates who gave particle explanations of the process of expansion should be aware that the particles themselves do not expand, but the distance between them.

(b) (i) Most candidates correctly stated evaporation as the correct answer.

(ii) Many candidates wrote correct answers for both parts 1 and 2, reflecting that they had understood the particle explanation for evaporation. Some candidates incorrectly wrote that the temperature of the sea water increases after the loss of the more energetic particles. The loss of these particles reduces the overall energy of the remaining water and therefore reduces the temperature.

(c) (i) Radiation as a method of energy transfer was the only acceptable answer here, with both conduction and convection requiring a medium. Many candidates incorrectly stated these responses.

(ii) This question was more challenging than previous questions of a similar type. The candidates had not only to identify the two types of radiation, but also place them in the correct boxes in the electromagnetic spectrum.

Question 7

(a) (i) Many candidates completed the boxes correctly and were awarded full credit.

(ii) The food chain was written correctly by many higher-scoring candidates. Common reasons for loss of credit were the writing of the arrows the wrong way around, and less frequently, attempts at a food web.

(b) (i) Large-scale activities producing methane were not widely known. Many candidates incorrectly referred to exhaust from vehicles and emission from factories.

(ii) Some candidates correctly described the role of methane as a greenhouse gas and its contribution to global warming. Incorrect responses included effects on the ozone layer and the production of acid rain. Candidates are advised to be clear about the different effects that humans have on their environment.

Question 8

(a) (i) This question was correctly answered by the higher-scoring candidates who could put the metals in order of reactivity.

(ii) Most candidates gained credit for stating that bubbles of gas would be seen during the reaction.

(b) The majority of candidates found this question challenging. The tests for identification of ions were not widely known.

(c) (i) Many candidates correctly identified the type of chemical reaction as exothermic. The main incorrect answer given was endothermic. Candidates should be aware that reactions giving out heat are exothermic, and reactions taking in heat are endothermic.

(ii) Most candidates correctly stated that the charge on a sodium atom is 1+.

(iii) Candidates generally found this question challenging. Many described a reaction during which sodium ions are formed, e.g. adding sodium to water. These answers did not gain credit because they did not describe the change in the structure of the sodium atoms.

Question 9

(a) (i) Some candidates correctly named the variable resistor. The majority stated that the component is a resistor, omitting the variable aspect of its function. These responses could not gain credit.

(ii) Some candidates who did not gain credit in part **(i)** were able to gain at least partial credit in this question, showing that they understood the purpose of the variable resistor. Other candidates found this part of the question challenging because they had identified the component incorrectly, for example, as a fuse or a switch.

(iii) There were many candidates who gained full marks in this question. Most of the circuit was provided in Fig. 9.1 and it had to be completed including an ammeter in Fig. 9.2. Candidates are reminded that the symbol for an ammeter does not have a line down the middle. Many candidates used spare space to do the diagram instead of completing Fig. 9.2 as required by the question with no indication by the candidates for the examiner to look elsewhere.

(b) Most candidates correctly used the information on the graph to calculate the resistance.

(c) Many candidates gave correct responses to this question showing that they knew the relationship between frequency and pitch, and between volume and amplitude.

COMBINED SCIENCE

Paper 0653/31
Extended Theory

Key messages

Those candidates who scored well on this paper

- read the questions carefully and used the number of marks for each question as a guide to the detail required in their answers
- added clear label lines to diagrams when required
- understood that instructions to *Use data* require candidates to quote figures from a given graph or table to support their answers
- ensured that their handwriting was legible enough to allow the examiner to award as many marks as possible.

General comments

At the upper end of the range of marks, many candidates completed excellent scripts that showed mastery of all sections of the syllabus and good examination technique. Candidates whose scores were towards the lower end of the range may have been more suited to entry for Paper 2. Candidates generally showed familiarity with all of the Science disciplines. As in previous years, large numbers of candidates were very well prepared for the types of calculation that appear in these papers, and usually showed working which was often well-organised and clear. Colleagues should continue to advise candidates that the number of marks and the space allocated for answers are guides to the length and detail required. Only a very small number of candidates left questions at the end of the paper unanswered which confirms that most were able to complete the paper in the available time.

Comments on specific questions

Question 1

(a) Candidates generally showed good knowledge of these aspects of plant biology and at least partial credit was gained by almost all of them. Large numbers gained full credit. The mistake most frequently made was to miss the third point for which candidates either suggested *upwards* or *downwards.*

(b) (i) Unfortunately many candidates did not notice the instruction to draw label lines from the names of structures **1** and **2** to the corresponding parts on the diagram. This resulted in those candidates losing credit even though they had correctly named cell wall and vacuole. Those who did label the cell wall needed to be very careful that their label line did not touch the cell membrane. Credit was also lost if candidates stated that the cell wall and/or vacuole provides support or structure for the plant rather than this individual cell. Almost all candidates understood that structures had to be found only in plant cells, which led many to suggest that (unlabelled) starch grains or the nucleus were chloroplasts or even chlorophyll.

(ii) By far the most common way that candidates lost credit was to discuss the presence of starch grains which was accompanied by a variety of incorrect reasoning. However, many candidates did pick up on the absence of chloroplasts although the second point referring to the impossibility of photosynthesis was not seen so frequently. Candidates needed to refer to photosynthesis and had to say more than statements such as *there is no light getting through.*

Question 2

(a) (i) Some candidates who were clearly very familiar with this experiment also showed excellent drafting skills, producing almost text-book diagrams of a gas syringe properly connected. This degree of competence was not essential for full credit. Candidates needed to have made a reasonable attempt to show apparatus in which evolved gas was directed into a device that could measure its volume over time. This meant that the container into which gas was passed had to show graduations of some kind. Most candidates gained at least partial credit.

(ii) It was not easy for candidates to gain full credit in this question. Some had not read the question carefully and gave answers that related to the effect on rate of reaction due to temperature change. Candidates towards the high end of the mark range did gain credit for discussing or implying that the concentration of reacting particles decreases. Answers referring to the decrease in surface area of calcium carbonate were also accepted. Full credit was awarded to candidates who avoided the vague statement *there are less collisions* and specified that *decreasing collision frequency* was the key factor. The best candidates went further and discussed *decreasing collision frequency between the reacting particles*.

(b) Only a minority of candidates were familiar enough with this balanced equation to gain full credit. A smaller number gained partial credit for an unbalanced equation but with correct formulae. In questions like this, attention to fine detail is essential and slips such as $CaCO_2$ are penalised. For the majority, however, this question was beyond their experience.

(c) The great majority of candidates were familiar with the limewater test.

(d) A quarter of candidates performed well to gain full credit on what proved to be a difficult question.

Question 3

(a) (i) The great majority of candidates gained the credit here.

(ii) The relationship linking acceleration, change in speed and time was familiar to the majority of candidates across the mark range and most could successfully apply it in this context.

(iii) The process of calculating the area under a speed/time graph to find distance travelled was familiar to the majority of candidates and most gained at least partial credit and many gained full credit. Partial credit was awarded to candidates who did not produce the correct numerical result but who showed, in their working, that they knew that the area under the graph had to be calculated.

(b) To gain the credit here, candidates had to make a reasonable attempt to show a device that would cause refraction and label it using the word *lens*. A degree of flexibility was allowed regarding the actual shape of the lens but an obviously diverging lens was penalised.

(c) (i) The relationship KE = $\frac{1}{2}$ m v^2 was familiar to the majority of candidates across the mark range and most could successfully apply it in this context. The most common mistake was to omit squaring the velocity term. In some cases this omission was made by candidates who had correctly stated the KE formula.

(ii) Many candidates gained partial credit for knowing that some of the chemical energy would end up as heat or sound, but only a minority could support this by a clear explanation that energy does not disappear. Many answers suggested that some candidates were probably familiar with this general aspect of Physics but found it difficult to express their understanding clearly enough.

Question 4

(a) (i) Either candidates had learned their heart diagrams or they had not. Approximately half the candidates gained the credit. The most common incorrect suggestion was, predictably, **A** and **D** although all combinations of the labels were seen.

(ii) Unsurprisingly, performance on this question was similar to part **(a)(i)** with candidates scoring well in **(i)** also tending to gain the credit here. The full range of blood vessels associated with the heart was seen from those not gaining credit.

(iii) Candidates generally did much better on this question than in parts **(i)** and **(ii)** with the majority gaining the credit.

(b) Candidates in the upper half of the mark range tended to be the ones more familiar with the structure and function of arteries. The most common correct answers referred to the thick arterial wall, although some described this as a thick ring of muscle and others placed incorrect emphasis on the apparently narrow lumen. It was common for candidates to miss out on full credit by stating that blood pressure in arteries was high rather than by referring to the necessity of arteries to withstand the high pressure without damage. The elasticity of arterial walls was rarely mentioned.

(c) (i) The function of the coronary artery is often tested and candidates repeatedly do not gain credit because their choice of words is not sufficiently precise. Large numbers stated *to supply the heart with blood* which is not accepted as an answer to this question. The safest answer is to specify heart muscle as in the mark scheme. Other acceptable ways to answer this include *to supply oxygen/glucose/blood to the heart itself* or *to supply the heart with blood so that it can function*.

(ii) Most candidates were familiar with terms for the substance blocking the artery. Several candidates suggested *fatty acids* which was not accepted.

(iii) Candidates needed to read the question carefully which fortunately most did and so gained at least partial credit. A minority described lifestyle choices that should be made rather than those that should be avoided and so lost credit. Knowledge in this area is generally important and so it is encouraging to see that most candidates are aware of the dangers of smoking or excessive fat in diet. Vague answers such as *avoid junk food* or *don't have a poor diet* did not gain credit, neither did *don't be overweight* or *avoid carbohydrates*.

Question 5

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

(b) (i) The majority of candidates were very familiar with this aspect of organic Chemistry.

(ii) The majority of candidates were very familiar with this aspect of organic Chemistry.

(iii) The majority of candidates gained the credit here. They needed to state clearly either that hydrocarbons are compounds or that they are not elements. The answer *because they are hydrocarbons* does not add enough key information.

(c) It did not matter if candidates drew the inner electrons in the carbon atom, and any unambiguous method of representing four shared electron pairs gained the credit. Although about half of the candidates gained the credit this was less than expected, especially as methane is a common example of a dot and cross diagram, and a full framework had been given.

(d) (i) The key word in the question was *increased*, and so rather than simply giving the one word answer *deforestation* candidates needed at least to discuss *increasing amounts of deforestation*. The same criticism applied to discussion of combustion of fossil fuels or the use of vehicles.

(ii) Candidates are generally aware of the suspected harmful effects of increasing carbon dioxide levels and many gained the credit. One of the alternative points in the mark scheme refers to any negative consequence (of global warming) and it was important that candidates stressed negative impacts. It was not sufficient simply to state *the ice caps melt* or *the climate is changing.*

Question 6

(a) The majority of candidates gained the credit here.

(b) It is very likely that the great majority of candidates understood the context and knew why the liquid inside the thermometer could not be water. The main reason for loss of credit was that candidates did not refer directly to the numbers shown on the scale. A minority referred to the lower temperature on the scale as 20 °C rather than −20 °C which unfortunately meant that they could not be credited.

(c) (i) Full credit was gained only by a minority of candidates. Many completed all of the spaces in the figure correctly but did not specify which type of radiation is associated with thermal energy. Answers like this gained partial credit.

(ii) The fundamental concept that all electromagnetic radiation travels at the same speed had been learned by some candidates but many others suggested a wide range of incorrect ideas in answer to this question. One recurring misconception was that the speed of radiation is related to its position in the electromagnetic spectrum.

(iii) A minority of candidates transferred their understanding of this aspect of Physics successfully to this context. A degree of flexibility in accepted wording of answers was adopted. This allowed credit for answers such as *stand the thermometer on a dark surface*. Some thoughtful suggestions were made such as *make the bore of the capillary tube narrower* but with minimum credit available these could not be rewarded. There was a whole range of less thoughtful suggestions such as *hold the thermometer nearer the sun*.

Question 7

(a) The majority of candidates had difficulty in answering this question. Many wrote fairly lengthy answers that were simply descriptions of the figure and repetition of the information in the question. For example they stated that *more energy is lost along the food chain in **B**.* Another common problem was the use of the term *consumers* instead of *trophic level.* The statement that food chain **B** *contains more consumers* is not an alternative to the correct statement that food chain **B** *contains more trophic levels.* This question needed to be answered in general terms but many candidates discussed what happens to energy when the man eats the whole cow or all of the corn.

(b) Candidates were a little more successful in this question than in **(a)**. Very often, partial credit was gained when they described a life process requiring energy. Candidates nearer the upper end of the mark range tended to be the only ones gaining full credit.

(c) (i) Fewer candidates than expected gained the credit here. Many simply wrote the single word *rain* which was not enough. They needed to discuss or imply some mechanism which would carry fertiliser into the lake. Thus *water run-off, underground water flow, flooding* even *excessive irrigation* gained credit.

(ii) Candidates in the upper half of the mark range answered this question very well and large numbers of them gained full credit for their knowledge of processes related to eutrophication. However, some candidates showed a degree of confusion and suggested that loss of oxygen from the lake water would cause respiration failure in plants. Another common cause of lost credit was the idea that excess fertiliser would poison plants both near the surface and in the lake.

Question 8

(a) (i) Writing the electronic structure of sodium was familiar to candidates from across the whole mark range and the majority gained full credit.

(ii) Candidates towards the higher end of the mark range tended to be the ones gaining full credit although partial credit for suggesting *oil* was awarded to candidates across the full range. A surprising number of candidates thought the liquid could be water or even acid. Credit was only given for a practical suggestion and so answers such as liquid helium or crude oil were not accepted. The explanation needed to focus on the prevention of reaction between rubidium and water (vapour) or oxygen. In this extension paper preventing reaction with *air* was not accepted. It was not sufficient for candidates simply to state that *rubidium is very reactive*.

(iii) Approximately half of the candidates gained the available credit and these were found across the whole mark range. Predictably the most common mistake was to suggest chloride instead of chlorine.

(b) (i) Most candidates knew that the temperature increased during an exothermic reaction. *Release of thermal energy* was also accepted, but *the release of energy* was not precise enough.

(ii) This was well answered by many candidates, many gaining full or nearly full credit. One frequently seen reason for loss of credit was the suggestion that a lithium *ion* loses its outer electron and/or an oxide *ion* gains electrons. Some explanations for the ionic charges that did not gain credit included statements such as *because they react* and *because they form an ionic bond.*

Question 9

(a) (i) The symbol for a variable resistor was recognised by large numbers of candidates. The term *resistor* was not accepted and the other most common mistake was *fuse*.

(ii) Full credit was very rarely gained even by candidates who had very high overall scores. The answer to this question was essentially a brief rationale of the experiment and so candidates needed to refer to control of the potential difference across the lamp by adjusting the overall resistance in the circuit. When candidates did mention potential difference it was often in vague terms rather than specifying the potential difference across the lamp. Credit could also have been obtained by discussing the control of the current flowing in the circuit. Credit was often lost because candidates used phrases such as *to measure the resistance* or *to measure p.d.* Some candidates suggested the variable resistor was present as a safety measure and thought it would act like a fuse.

(b) Candidates in the upper part of the mark range answered this question very successfully. Some unfortunately forgot to include the switch in an otherwise correct circuit and so gained only partial credit. Some candidates moved the voltmeter into its correct position but left a short circuiting connection where the voltmeter had been in Fig. 9.1.

(c) (i) Ohm's Law and its application had been very well learned and large numbers of candidates across the mark range gained full credit

(ii) Many candidates gained credit for stating that resistance increases with filament p.d. Full credit was not very often gained and then only by candidates with high total scores. Those who did gain full credit used data from the graph to calculate the resistance at a potential difference higher than that in part **(c)(i)** and showed that it was greater than 2 Ω.

COMBINED SCIENCE

Paper 0653/32
Extended Theory

Key messages

Those candidates who scored well on this paper:
- read the questions carefully and used the number of marks for each question as a guide to the detail required in their answers
- avoided suggesting unsafe procedures in Chemical testing
- ensured that their handwriting was legible enough to allow the examiner to award as many marks as possible.

General comments

Many candidates completed excellent scripts that showed mastery of all sections of the syllabus and good examination technique. Candidates whose scores were towards the lower end of the mark range may have been more suited to entry for Paper 2. Candidates generally showed familiarity with all of the Science disciplines, and although many had some knowledge of ecology, only those nearer the upper end of the mark range were able to express their ideas clearly and without confusion. For example, they could explain in detail how industry could contribute to acid rain formation. As in previous years, large numbers of candidates were very well prepared for the types of calculation that appear in these papers, and usually showed working which was often well-organised and clear. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. Only a very small number of candidates left questions at the end of the paper unanswered which confirms that most were able to complete the paper in the available time.

Comments on specific questions

Question 1

(a) Large numbers of candidates gained full or nearly full credit for their responses. The most common mistake was the suggestion that the liver secreted digestive enzymes. A minority of candidates appeared to confuse the terms *ingestion* and *egestion*.

(b) The majority of candidates gained at least partial credit. The safest way to gain credit was to describe the **walls** of the capillary, rather than just the capillary, as being thin. For full credit candidates needed to include the term **diffusion** in their answers. Many candidates had some relevant knowledge, although credit was sometimes lost by suggesting that red blood cells needed to move through the capillary walls. Another common reason why some well-prepared candidates lost credit was that their answers contained no reference to capillary structure. This emphasises how important it is for candidates to pause and make sure that they have grasped what it is that the question is asking.

(c) (i) Most candidates were able to read the optimum pH from the graph.

(ii) The concept of denaturation of enzymes was familiar to many candidates, and it is good to see far fewer candidates suggesting that enzymes are *killed* as a result of the pH change. Some candidates essentially repeated the question. An example typical of many that were seen is *The enzyme works well when it is acidic but stops working in the duodenum.* For the second marking point candidates needed to refer directly to the graph. Full credit was gained by many of the higher scoring candidates who had detailed knowledge of the meaning of the term *denatured*.

(iii) Most candidates gained at least partial credit for reasonably accurate sketches of the pH curve. The question directed candidates to draw their sketches on Fig. 1.3. Some drew their own axes in the blank space below the figure and unless these had been done with great care and with sufficient detail it was difficult to award full credit. A minority of candidates had their curves falling to zero at pH 8 rather than having their maximum at this pH.

Question 2

(a) (i) Most candidates recognised electrolysis and very few lost credit through misspelling.

(ii) Candidates unfamiliar with the electronic charge of the lead(II) ion could have deduced it from the formula $PbBr_2$ and the knowledge that the charge on bromide is –1. Many candidates towards the higher end of the mark range gained full credit which was available only if both ions were correctly stated.

(iii) Most candidates gained at least partial credit for stating bromine. Bromide, Br and Br^- were penalised. The responses *red* and *yellow* were not accepted as correct colours. If candidates suggested that the element produced was lead then an error carried forward for stating a suitable colour was allowed.

(b) (i) This question proved very challenging for all candidates except those in the highest quarter of the mark range. Credit for a correct set of state symbols was not dependent on the chemical formulae being completely accurate.

(ii) Familiarity with the usual test for chlorine was not quite as high as expected. A wide range of incorrect suggestions were made, some of which were very unsafe. Candidates should be advised that answers involving obviously unsafe procedures will never gain credit.

(c) (i) The majority of candidates gained the credit here.

(ii) Stating electronic structure was a skill familiar to large numbers of candidates. Common incorrect responses included giving the correct structure of an element other than fluorine, stating the total number of electrons and stating only the outer shell electrons.

(iii) This was very familiar to the great majority of candidates**.**

Question 3

(a) Inclusion of the phrase *due to the effect of gravity* in the question should have deterred candidates from suggesting the answer *gravitational force* and giving instead the required answer *weight*. A more serious mistake was to suggest *gravitational energy*.

(b) (i) The great majority of candidates gained the credit here. The common mistakes were to place **P** at times of 0 and 4 seconds.

(ii) These calculations were completed successfully by large numbers of candidates who were familiar with calculating the area under a speed/time graph. Candidates were allowed an error carried forward from misplaced **P** in **(b)(i)**. One mistake that was seen several times was the calculation of the entire area under the graph even when **P** had been correctly located in **(b)(i)**.

(c) (i) The most common errors here were *potential, frictional and gravitational.*

(ii) The great majority of candidates were very familiar with the relationship PE = m g h and could apply it. Many candidates from across the mark range gained full credit here.

(iii) This question proved to be too challenging for all except candidates positioned in the highest quarter of the mark range and even many of these were unfamiliar with this type of calculation. The step of equating the PE lost to KE gained was beyond the experience of most candidates and those who made an attempt at this calculation could not see what to do other than try to apply distance = speed ÷ time. Many did not attempt to answer.

Question 4

(a) Candidates from across the mark range did well with this question and many gained full credit. The most problematic of the three terms was the first one, *cell membrane*. Candidates often suggested *nucleus* and may have been distracted by the term *controls*.

(b) (i) This balanced equation and its counterpart for photosynthesis are frequently tested and those candidates who had prepared thoroughly gained credit. Although candidates in the upper half of the mark range tended to be the ones gaining full credit, many candidates in the lower half had learned this equation and stated it correctly. Candidates generally paid attention to detail and wrote subscripts and balancing numbers clearly and correctly. No credit was given for a word equation even if correct.

(ii) Candidates should be advised to learn a proper statement of the role of chlorophyll. Many gained partial credit for the idea that chlorophyll traps light energy but the second point about conversion to chemical energy is not well understood. No credit was given for references to chlorophyll acting as a catalyst nor for the suggestion that chlorophyll *helps to produce glucose/starch*. Chlorophyll is obviously important for photosynthesis but answers that simply suggested this did not gain credit. The terms *the sun* or *sunshine* are not accepted as alternatives for light energy.

Question 5

(a) Candidates from across the mark range gained full credit here and the question was generally answered successfully by the majority.

(b) (i) Candidates in the upper half of the mark range tended to recognise cracking. The most common error was fractional distillation.

(ii) Candidates generally were able to recognise the alkene and to identify the presence of the double bond as the key feature. Some stated that the molecule (**B**) fitted the general formula C_nH_{2n} which was credited.

(iii) Candidates in the highest quarter of the mark range were familiar with the bromine test and its results but full credit was rarely given for candidates lower in the range. It was surprising that after doing so well with part **(b)(ii)** many candidates seemed completely unfamiliar with the bromine test. This is frequently tested and candidates would do well to prepare this part of the syllabus thoroughly.

Question 6

(a) (i) This proved challenging for the majority. Although the question specifies a reason other than ice melting, this was the answer given by many candidates. A range of other incorrect suggestions were seen, many of which revealed misconceptions. One example of such an answer that was seen several times was that increased temperatures caused more of the seawater to evaporate and so would enhance the water cycle causing more rain to fall on the sea.

(b) (i) Candidates generally were able to locate infra-red in its correct position.

(ii) The range of incorrect answers revealed several misconceptions about the electromagnetic spectrum and radiation from the sun. Only candidates in the highest quarter of the mark range tended to be familiar with the concept being tested here. Some claimed that the sun does not emit infra-red, others stated that the speed of the components of the electromagnetic spectrum varied with wavelength/frequency. Since only limited credit was available, candidates more or less had to state categorically that the speed would be identical. Some wrote statements that were not technically incorrect but which could not be credited, for example *infra-red is part of sunlight,* which does not state the key concept clearly.

(c) This was challenging for candidates across the mark range, and full credit was rarely awarded. When partial credit was gained it was usually for recognising that some molecules would have greater energy and that it would be these that could break free from the surface. The second marking point which dealt with why the remaining water would be cooler was not understood by the majority. The idea that the average kinetic energy of remaining molecules would be reduced was

very rarely stated. One recurring suggestion was that when the faster molecules left the surface this would actively slow down the remaining molecules.

(d) The reasons for land heating more quickly than the sea are many and varied and a range of alternative answers was accepted. These included reference to the lower heat capacity of land compared to the sea, which was quite often seen from the minority who gained credit, and the idea that currents other than convection would mix the seawater. It was also decided to accept the idea that evaporation would have a cooling effect on the sea.

Question 7

(a) (i) The great majority of candidates extracted the correct data from the figure and calculated the efficiency. A minority lost credit by stating the final answer to be 4.75%.

(ii) This calculation was successfully completed by most candidates.

(iii) The consequences of energy losses through trophic levels is often tested and candidates continue to face challenges in expressing their knowledge clearly enough for credit. Many technically correct or plausible ideas were seen that regrettably did not refer to the key concepts required. Examples are *there are never more than four or five levels in a food chain* or *since this is an island there aren't enough species to support many levels.* Even answers that did contain the word energy needed to convey the key ideas and many did not, for example *most of the energy is not used efficiently* which is too vague to gain credit.

(iv) The main uses of energy from respiration were not as familiar to candidates as expected. Many suggested that energy from respiration would be utilised in photosynthesis and some even suggested that the energy would be used for movement.

(b) (i) Candidates in the upper half of the mark range were able to describe the sequence of events that lead to acid rain formation. Candidates who suggested that release of carbon dioxide was responsible did not gain full credit, neither did candidates who suggested release of sulfur rather than sulfur dioxide. A mistake sometimes seen was the suggestion that industry created sulfuric acid and released that into the atmosphere. Many vague answers that referred to *factories creating air pollution* could not gain credit.

(ii) Many candidates did well with this question and were able to describe the consequences of reducing food/energy working through a typical food chain. Answers needed to refer specifically to food/energy reduction leading to decreases in dependent populations. This meant that answers such as *there will be less herbivores so obviously less carnivores* could not gain any credit.

Question 8

(a) Most gained at least partial credit and very large numbers gained full credit. As might be expected a common mistake was to confuse endothermic and exothermic.

(b) Candidates generally gained partial credit for stating that the rate would decrease and those who could explain this using carefully chosen phrases referring to the frequency of particle collisions went on to gain full credit. Although the concept of activation energy is not part of this syllabus, correct references to it obviously gained credit. Candidates towards the lower half of the mark range tended to lose credit because their explanations were a little too vague although they did reveal some familiarity with the theory, examples being *there is less energy in the particles* and *if the temperature is reduced less particles will collide.*

(c) (i) This proved to be a very difficult question in which to gain any credit and only those near the top of the mark range successfully did so. Those who gained credit realised that this question was about the relative reactivities of copper and hydrogen and not copper and calcium. Credit was not given for suggesting that the reaction rate would be reduced. Candidates had to say that reaction rate would be zero.

(ii) Although this requires little more than recall of a syllabus statement this proved to be a surprisingly low-scoring question. The question refers to **the** method and only limited credit is available, so only the method shown on the mark scheme was accepted.

Question 9

(a) (i) Many candidates recognised the symbol for a variable resistor. The term *resistor* was not accepted. The other frequently-seen incorrect answer was *fuse*.

(ii) Full credit was very rarely gained even by candidates who had very high overall scores. The answer to this question was essentially a brief rationale of the experiment and so candidates needed to refer to control of the potential difference **across the buzzer** by adjusting the overall resistance in the circuit. When candidates did mention potential difference it was often in vague terms rather than specifying the potential difference across the buzzer. Credit could also have been obtained by discussing the control of the current flowing in the circuit. Credit was often lost because candidates used phrases such as *to measure the resistance* or *to measure p.d.* Some candidates suggested the variable resistor was present as a safety measure and thought it would act like a fuse. Candidates who had mistakenly identified the component as a fuse in **(a)(i)** were allowed an error carried forward if they described the function of a fuse correctly.

(iii) This proved to be an easy question in which to gain full credit and large numbers of candidates did so. If the ammeter had the connecting wire drawn through it then this was penalised. The ammeter could be located at any point that was in series with the buzzer.

(b) Full credit was very frequently awarded here. Most candidates had no difficulty in extracting the required current from the graph and then proceeding to calculate the resistance correctly.

(c) This pair of calculations was successfully completed by the majority of candidates and full credit was frequently awarded. The use of the relationship speed = frequency × wavelength was very familiar and most candidates went on to use the calculated value of speed in the second equation time = distance ÷ speed. One common mistake was to invert the speed and distance terms in the second equation.

COMBINED SCIENCE

Paper 0653/33
Extended Theory

Key messages

Those candidates who scored well on this paper:
- had prepared thoroughly for the examination
- read the questions carefully and used the number of marks for each question as a guide to the detail required in their answers
- understood that instructions to *Use data* require candidates to quote figures from a given graph or table to support their answers
- ensured that their handwriting was legible enough to allow the examiner to award as many marks as possible.

General comments

The number of candidates entered for this examination was clear that the majority were challenged by many of the questions.

Some candidates showed mastery of all sections of the syllabus, and good examination technique ensured that they achieved high marks. In some cases low scores were likely the result of unfamiliarity with the syllabus rather than any lack of ability. The main evidence for this comes from the observation that full credit for answers to several of the more advanced questions were seen from candidates right across the final mark range. Candidates' responses to the three Science disciplines were broadly balanced with neither Biology, Chemistry nor Physics standing out as any more problematic. However, it is worth highlighting that organic Chemistry and the structure of an alloy emerged as the least familiar parts of the syllabus. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. Only a very small number of candidates left questions at the end of the paper unanswered which confirms that most were able to complete the paper in the available time.

Comments on specific questions

Question 1

(a) (i) All candidates had a clear idea of what a mixture is. Those who gained credit made good attempts to express their answers in scientific terms, avoiding simplistic phrases such as *a mixture is when things are just mixed*. Candidates will lose credit if they make statements such as *mixtures contain no chemical bonding*. Some candidates stated that mixtures can be separated but credit can only be gained for answers like this if they are qualified in some way, for example *separated using physical methods*. It is useful for candidates if they have learned scientifically accurate definitions of terms like mixture, so that time in examinations can be saved while being assured of credit.

(ii) For full credit candidates needed to identify all three compounds that were contained in the mixture **Y**, although partial credit could be gained for a sensible description of matching the spots on the chromatogram. This question was answered successfully by many candidates.

(b) Only a small number of candidates had learned how to represent the structure of ethanol. Common incorrect suggestions included methane, ethane and propane, although many candidates did not seem to be familiar with the general form of structural formulae.

(c) (i) Most candidates were familiar with the general form of chemical word equations and gained credit.

(ii) Many candidates showed that they had experience of dot and cross diagrams, and sometimes correct structures for incorrect molecules such as ethane or methane were suggested. Only a minority of candidates gained credit for their answers.

(iii) Details of the bromine test for unsaturation are frequently examined and so it was unusual that so few candidates gained any credit.

Question 2

(a) This was answered correctly by most candidates.

(b) (i) Many candidates from across the mark range had learned Ohm's Law and were able to apply it. When stating a mathematical relationship such as Ohm's Law, candidates should avoid using inappropriate symbols, although words are acceptable. In this case electric current is represented by I and not by i or A. Candidates should also be encouraged to show full working because credit may be available even if an arithmetic mistake has led to an incorrect numerical answer.

(ii) The relationship linking potential difference, current and power was less familiar than Ohm's law, although full credit was gained by candidates from across the mark range. Incorrect suggestions for the relationship were many and varied with no noticeable commonly occurring misconception. Many candidates were guessing the way the electrical quantities had to be processed to obtain power.

(iii) The underlying theory being tested in this question was unfamiliar to most candidates. A very common misconception was that lamp **Y** came 'before' lamp **X** and so had 'used up' some of the available energy. When candidates had understood that the resistance of **Y** was greater, some of them used vague language such as *it has a greater resistance*. When the wording of the question makes it obvious to what the word *it* refers then this is accepted. In this case *it* is too ambiguous.

(c) Most candidates gained credit for the idea that the lights could be switched independently. Full credit was gained by a minority who also stated that failure of one light would not cause failure of all lights.

Question 3

(a) It was important in this answer to relate the rate of photosynthesis rather than just the rate of bubbling with light intensity. Many more candidates would have gained at least partial credit had they done so. Only a minority of candidates realised that the instruction *Use data from the graph* required them to quote figures from the graph in support of their answers. For example they may have described how the increase in rate of photosynthesis is lower at intensity values greater than 0.06. Alternatively they may simply have stated that the rate of photosynthesis increases with light intensity and then gone on to quote pairs of co-ordinates to support this statement.

(b) (i) Candidates generally gained credit for drawing a similar line that was below the given line. Credit was lost if the lines crossed, but there was no requirement for a quantitative answer.

(ii) Partial credit was for the fact that the rate of bubbling or photosynthesis (both were accepted in this question) would be reduced. A minority of candidates gained full credit for at least one scientific reason why the rate of photosynthesis would be lower. A simplistic answer such as *because there is less plant* was sometimes suggested but did not gain credit.

(c) (i) Almost every candidates was able to answer this question correctly.

(ii) Candidates generally had learned why energy transfer through trophic levels is inefficient and many scored partial credit for at least one relevant process by which energy is diverted from the consumer's body. A significant number of candidates lost credit by discussing energy loss from the tadpole's life processes. Full credit was not available for just any two life processes. One needed to be related to inefficient digestion/waste formation and the other could be selected from other processes mainly linked to respiration.

(d) Most candidates successfully constructed a fully correct food web, although it must be said that it was not necessary to spend time adding detailed drawings of the organisms. Partial credit was awarded if the arrows in the web were missing or inverted.

Question 4

(a) Either candidates were familiar with the concept of electron shell structure or they were not. Of those who did not give the correct response the most common suggestion was 11.

(b) (i) Very few candidates gained full credit. Many gained partial credit and this was invariably for balancing the equation rather than assigning the state symbols. Many candidates seemed unfamiliar with the correct form of state symbols, suggesting for example (G) for gas. Another common mistake was to assign the state symbol (*l*) to NaOH.

(ii) Candidates are asked to predict observations that are expected for this reaction. It is important therefore that they discuss, for example, the appearance of bubbles/effervescence/gas and not the appearance of hydrogen. A minority of candidates became diverted into a discussion of the relative reactivities of sodium and rubidium.

(iii) Candidates had to use the term *chemical* in the first box in order to gain the credit. In questions concerning energy transfers in chemical reactions, the term *potential* alone is not credited although *chemical potential* is obviously accepted. Due to the nature of the rubidium – water reaction *sound* was also accepted as an alternative answer in the second box.

(c) Candidates who had not gained credit in part **(a)** were always going to be challenged by this question. Those familiar with the electronic shell structure in atoms also tended to be familiar with the significance of the complete outer shell in noble gases, and so found it straightforward to gain at least partial credit. A number of these candidates attempted to account for the reactivity of Group 1 elements by suggesting that they needed to gain seven electrons rather than (easily) lose the outer electron. Other candidates understood that Group 1 elements would have only a single outer electron but could not go on to explain why this should confer high reactivity.

(d) (i) Candidates nearer the higher end of the mark range were familiar with the idea that increased atmospheric carbon dioxide prevents radiant heat escaping from the Earth. Many vague or incorrect answers were seen, for example, *it increases the greenhouse effect* and *carbon dioxide insulates* and *carbon dioxide increases the radiation from the sun*. As is so often the case, some candidates wrote answers which confused global warming, ozone depletion and acid rain.

(ii) The question specifically asks candidates to identify negative effects of global warming. Consequently candidates needed to say more than, for example, *polar ice melts* or *sea levels rise* or *climate change,* and go on to discuss consequences.

Question 5

(a) The majority of candidates correctly identified (gravitational) potential energy. In this context the term *potential* alone is accepted. The most common incorrect answers were *kinetic* and *heat*.

(b) Most candidates had learned and could apply the relationship linking speed, distance and time. Many gained full credit by realising that the time delay in hearing an echo is double the distance to the reflecting object. Many others gained partial credit for an answer that was half of the correct value.

(c) (i) The majority of candidates found it too difficult to describe a difference between longitudinal and transverse waves. A wide variety of incorrect or vague suggestions were seen.

(ii) Only some candidates had learned the two frequency limits but these candidates came from all parts of the mark range.

(d) (i) In defining melting point, candidates needed to use alternatives to the terms, *melting* and *point*. Most were able to do this.

(ii) Candidates needed to restrict their descriptions to features of the liquid arrangement shown in the diagram. Answers such as *the particles can move around* did not gain credit. Full credit was only rarely awarded for answers to this question, the point most often missed was that most particles in a liquid are actually in contact.

(e) The fundamental concept that all electromagnetic radiation travels at the same speed had been learned by some candidates but many others suggested a wide range of incorrect ideas in answer to this question. One recurring misconception was that the speed of radiation is related to its position in the electromagnetic spectrum.

Question 6

(a) Most candidates gained at least partial credit for their knowledge of the characteristics of these types of blood vessels. The most common correct answers referred to the thick artery wall and the function of valves in veins. It was common for candidates to miss out on full credit by stating that blood pressure in arteries was high rather than by referring to the necessity of arteries to withstand the high pressure without damage. The elasticity of arterial walls was rarely mentioned and some candidates were unfamiliar with the term *valves* in the context of veins.

(b) This question produced the full range of possible marks with the great majority of candidates gaining at least partial credit. There was no obvious pattern in the incorrect suggestions.

Question 7

(a) The most likely incorrect answers are magnesium and chloride and both were suggested by many candidates. However, many others did gain the credit and only a very small minority suggested substances that had nothing to do with magnesium chloride.

(b) (i) This was one of the least familiar parts of the syllabus and only a few candidates had learned how to represent a typical alloy. Credit was dependent on at least two differing atomic sizes being represented and so no credit was available for what was essentially the representation of a pure metal. Many did not attempt this question.

(ii) Difficulties experienced in part **(b)(i)** inevitably meant that the answer to this question was also outside the experience of the majority of candidates**.**

Question 8

(a) The calculation of acceleration using data from the graph was successfully completed by candidates from across the mark range. At this level no distinction is made between positive and negative values of acceleration; both were accepted.

(b) The procedure of calculating the area under a speed/time graph to find distance travelled was very familiar to many candidates, and at least partial credit was frequently gained. In order to gain full credit candidates needed to make a specific statement that the total area could be found as the sum of a rectangle and a triangle or they could have used data taken from the graph to calculate the actual value of distance.

(c) Both of the forces had to be correctly identified to gain the available credit. The great majority of candidates identified at least one force correctly but then gave the opposing force of the second, the most common occurrence of this being to suggest that **P** represented the weight of the truck.

(d) The majority of candidates were familiar with the total internal reflection of a light ray inside an optical fibre. Since they had been given the angle of incidence of the incoming ray and the normal, they needed to make a very good attempt to make the angle of reflection approximately correct. This should then lead to a relatively small number of internal reflections before the ray emerges. Some diagrams included very large numbers of reflections with no attempt being made to draw reasonably similar angles of incidence and reflection. Careless constructions like this could not gain full credit.

(e) (i) It was not essential for candidates to use the term *endoscope*. Any answer that meant obtaining images from inside the body was accepted. Answers such as *for surgery* were not specific enough. Common incorrect suggestions included use for intravenous drips or use in X-ray work.

(ii) Credit for answers here depended on a correct response to **(e)(i)**. The idea of minimising patient trauma was correctly suggested by many candidates from across the mark range. Other suggestions that gained credit included the idea of greater precision in surgical procedures.

Question 9

(a) The balanced chemical equation representing the overall process of respiration is often learned by heart. It was unfamiliar to most of the candidates and those gaining any credit tended to be in the upper half of the mark range.

(b) (i) This part of the syllabus was clearly unfamiliar to many candidates. Partial credit was more likely to be gained for a correct function of mucus rather than cilia. One common mistake was to suggest that cilia act as a filter for unwanted particles. One other reason for loss of credit was a lack of detail in describing the things that were trapped out by the mucus, for example, *mucus traps unwanted particles*.

(ii) Many candidates made guesses such as *the cilia stop working* or *the cilia are killed*. This question requires a more precise answer which was beyond the experience of most candidates. A minority of candidates gained partial credit for statements which implied that cilia stop moving.

(c) Many candidates showed that they were very unfamiliar with this aspect of human reproduction. The mark scheme was extended to include a reference to the role of the umbilical cord which allowed many more candidates to gain at least partial credit. Some candidates made no distinction between gaseous oxygen inhaled by the mother and oxygen travelling in the mother's blood. Some candidates seemed to believe that the fetus breathed gaseous oxygen which passed directly from the mother's lungs.

(d) (i) A reasonable number of candidates recognised amniotic fluid. The most common incorrect response was, understandably, water.

(ii) Many candidates were familiar with the role of amniotic fluid even if they had not gained credit in **(d)(i)**. Answers lacking detail did not gain credit, for example, *without it the fetus is not protected.* A common misconception was that the amniotic fluid provides the fetus with nutrition.

COMBINED SCIENCE

Paper 0653/04
Coursework

General comments

All Centres that entered candidates for this Paper have been doing so for several years. Without exception, they used suitable tasks and mark schemes, and assessed their candidates appropriately.

It is very apparent that asking students to do individual work in planning and carrying out experiments, collecting and analysing data, and evaluating their methods and their data, helps many students to raise their standards considerably. There were numerous excellent examples of good understanding and communication of scientific method and procedures. Even those who found some areas difficult – which tended to be particularly in the high-level skills of analysing and evaluating – managed to achieve something very worthwhile.

It is hoped that Centres will continue to provide their candidates with similar opportunities in the future, when this Paper is no longer available.

COMBINED SCIENCE

Paper 0653/51
Practical Test

General comments

Plans should include an equipment list, values for the variable, which variables are to be kept constant, the dependant variable to be measured and how the results will be used.

Comments on specific questions

Question 1

A number of candidates mixed up the units in the headings of the table. Despite the instructions stating time units in minutes, seconds often appeared in the table. The units for volume were often stated incorrectly as cm or cm^2 or ml^3.

A sizeable minority of candidates had less volume of juice collected with the added enzyme than with the water control.

Most candidates were able to produce two sets of results that could be plotted and analysed. Scales were too small in some cases or unnecessarily complicated. Candidates should take care not to draw points and lines with too thick a pencil. Although a straight line was not specified many candidates drew a straight line, missing the more obvious curve. Candidates need to be more careful when drawing best-fit lines. If their line does not go through all points then they should aim for an even spread of points either side of the best-fit line.

Part **(d)** was well answered.

Question 2

Most candidates obtained useful results with the least concentrated acid taking more than 180 seconds.

Candidates are not confident when proposing plans for similar experiments and they would be well advised to have a check list to choose from when constructing relevant answers. Such a check list should include an equipment list, values for the variable, which variables are to be kept constant, the dependant variable to be measured, what measurements should be taken and how the results will be used. Universal indicator was allowed for a titration but not simply to test the pH of the acids as the pH values would be –0.3, 0 and +0.3, giving the same colours.

Question 3

This experiment caused few problems and results allowed best-fit straight lines to be drawn with confidence. Occasionally candidates had balanced the ruler with it orientated in the opposite direction to that given in the diagram, and so produced a range of values of *p* which were decreasing.

Once again if there is no straight line which will go through all points then it is important to aim for an even spread of points either side of the best-fit line. There are still a number of candidates choosing awkward scales such as 10 small squares representing 0.3. These should be avoided as candidates invariably use them wrongly and the scale mark may not be credited. Very large diameter plotted points as well as carelessly drawn and thick lines of best fit were frequently seen.

Only a minority of candidates chose a gradient triangle of appropriate size. Many ignored the instruction to indicate on their graph the values chosen. Gradients should be taken over at least half of the line and either the triangle drawn on the graph or the coordinates used marked on the graph. It is important not to use coordinates of points not on the best-fit line.

Part **(c)** was usually well done.
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COMBINED SCIENCE

Paper 0653/52
Practical Test

General comments

Benedict's test is for reducing sugars in general rather than specifically for glucose. It does not test for all types of sugars.

Comments on specific questions

Question 1

There were some unexpected results in this experiment however allowances were made if the Supervisor's results differed from the mark scheme. A positive iodine test for starch is best described as blue-black in colour. Most candidates knew which food group was tested for by each reagent and consequently sensible conclusions were made in many cases. The most common error was stating sugar rather than reducing sugar or perhaps glucose for the Benedict's test.

In part **(a)(iv)** many candidates simply referred to surface area with fewer referring to the releasing of the food or the breaking open of the cells.

Question 2

The reaction in part **(a)** did not cause any problems and nearly every candidate described at least one of the expected observations allowing them to correctly conclude the presence of the copper ion. Greater care needs to be taken when describing shades of blue in such tests.

The question requiring apparatus to be drawn and labelled produced a large variety of responses. Common errors were the bung in the wrong tube and the delivery tube not going in to the limewater. In most cases 'milky' was recorded for the change in the limewater in part **(b)(ii)**. The colour change of the solid was seen less often.

Part **(c)** was more difficult than usual for barium chloride and silver nitrate tests because of the blue colour of the solution. Under such circumstances it can be helpful to pour some of the precipitate out or filter the mixture for viewing of the colour of the precipitate.

Question 3

This experiment gave results that were consistent and could be easily processed. Occasionally unexpected results were seen and this was allowed for if reported by the Supervisor. An error here was to insert room temperature as the value for the temperature of the hot water at t =0. It was rare to see that a candidate had converted the times to minutes but this was accepted, although this practice should be discouraged. The units of temperature, °C, were frequently seen as incorrect C or C°.

Candidates were proficient at calculating the overall temperature rise. They were less good at using this information to justify their choice of the better insulator.

Surprisingly part **(f)** was not answered well with few candidates suggesting more insulation and even fewer suggesting insulation below the beaker. Many candidates suggested using different insulation without really specifying the type or thickness and some suggested using a lid despite the wording of the question.

In part **(g)** ‘same room temperature’ was a common correct response and ‘same water temperature’ was a common inadequate response because ‘initial temperature’ needed to be specified to avoid ambiguity. Candidates rarely chose the beaker material or thickness.

CO-ORDINATED SCIENCES

Paper 0653/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, stopwatches, rulers, thermometers etc. Candidates should have performed identification tests on the range of substances detailed in the specification. Candidates need to be able to plan experiments and also evaluate experimental procedures.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard, although sometimes not given to the accuracy requested. The drawing of chemical apparatus proved challenging for many candidates. The standard of graph drawing was generally high but chosen scales need to cover at least half of the grid and gradients should be calculated over more than half of the line. Designing an experiment proved to be very difficult for many candidates. Knowledge of identification tests for ions was limited. Circuit diagrams were drawn carefully with few gaps in them.

Comments on specific questions

Question 1

(a) A number of candidates found this challenging. Table headings needed to include the quantity being measured and the unit.

(b) Reading of measuring cylinder scales was very good.

(c) Many candidates did not include units on the axes or chose a scale which did not cover more than half of the paper. Many candidates plotted the points correctly but then drew a straight line rather than a curve. A small number reversed the axes.

(d) While many candidates appreciated that more juice would be created, few appreciated that this would also be in a shorter time frame. Many candidates discussed the general role of an enzyme, such as how enzymes speed up chemical reactions, but did not refer to the process of the juice extraction.

(e) The vast majority of candidates described a control without specifying why beaker **B** acts as a control.

Question 2

(a) (i) Most candidates recorded the time correctly. A small number gave the reading in minutes and seconds or gave >124.

(ii) Stronger candidates gained credit on this question.

(b) Candidates often found this plan very difficult. Many copied the experiment described in **(a)**. Many candidates used UI incorrectly, describing how the greater concentration would lead to a red colour

rather than orange or yellow. A significant number of candidates thought that sodium hydroxide or limewater would produce a gas when added to the acid.

(c) Stronger candidates gained credit here. Common incorrect answers given were barium nitrate and magnesium.

(d) Most candidates gave “no reaction”, “very little reaction” or “too little reaction to measure” and so did not gain credit.

Question 3

(a) Most candidates read the rule correctly.

(b) The majority of candidates gained full credit on this question.

(c) (i) Many candidates did not choose a scale which would use half or more than half of the grid. Plotting and best-fit line gained more credit.

(ii) Many candidates calculated the gradient correctly but often omitted to indicate on the graph. Those who showed the triangle on the graph often did not use more than half of the line.

(d) The calculation was done well but many candidates gave their answer to more than three significant figures.

(e) Many candidates found this question challenging. Common incorrect responses included poor line of best-fit gradient, human error and inaccurate measurements.

Question 4

(a) More able candidates gained partial credit but often omitted a time scale. Boiling in ethanol was a common incorrect response.

(b) (i) More able candidates put a solid alkali into the flask. Common incorrect responses included acids, water and iodine.

(ii) Most candidates gained credit with water being the most common acceptable response. Incorrect responses included iodine, sodium carbonate and sodium hydroxide.

(c) (i) Most candidates gained partial credit for iodine but many did not include all or many of the other stages required. Very few answers included a safety precaution.

(ii) Only the strongest candidates gained credit, with most discussing the presence or absence of starch.

Question 5

(a) (i) Many candidates gained full credit.

(ii) More able candidates gained credit. Many candidates omitted this question or drew distillation apparatus. Of those who drew filtration apparatus, several drew the filter paper with a dotted or dashed line which could not be credited.

(iii) Many candidates gained some credit here but few responses gained full credit. Many answers only discussed colours with no reference to precipitate or solution. Common incorrect responses included white precipitate, green precipitate or colourless. The table asked for observations and so “no change” was not creditworthy. A significant number omitted this question.

(b) Most able candidates gained credit. Iron and zinc compounds were seen commonly. A significant number of candidates omitted this question.

(c) Most candidates gained credit. The most common incorrect response was silver chloride.

Question 6

(a) (i) A large number of candidates read the measuring cylinder to the nearest cm^3 but many read it to one decimal place.

(ii) Symbols of the components were very well known as was the connection of the ammeter in series but a large number of candidates connected the voltmeter in series. Quite a large number of candidates did not connect the heater into the circuit they drew.

(iii) The majority of candidates read the thermometers correctly but a significant number recorded them in reverse positions.

(iv) Many candidates performed the calculation correctly. Some candidates used 1 g.

(b) Many candidates gained partial credit with the more able gaining full credit. Common incorrect responses included heater, lamp, kinetic, light and chemical.

CO-ORDINATED SCIENCES

Paper 0653/62
Alternative to Practical

Key messages

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

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 be reminded to plot all points of data, but drawing of curves proved challenging for some candidates. Designing an experiment proved to be difficult for many candidates. Knowledge of identification tests for ions was limited. Aspects of safety specific to the experiment being described were not well known.

Comments on specific questions

Question 1

(a) Food groups were well known. The most common incorrect response given was “sugar” instead of “reducing sugar”.

(b) The strongest candidates gained credit here. The most common incorrect response was “increase the surface area”.

(c) Few candidates gained full credit on this question. Common incorrect responses included red for Benedict’s and sweetcorn and blue for iodine test. Many candidates did not know the reagent colours of Benedict’s and biuret solutions.

(d) Most candidates gained partial credit. The use of distilled water was frequently omitted and so the result of the test could not gain credit. Few candidates discussed safety measures when using flammable ethanol.

Question 2

(a) Most candidates identified the reagent but very few appreciated that the cation must be aqueous before the reagent is added. Many candidates discussed identification from the colours produced but often did not appreciate that the coloured product is a precipitate.

(b) (i) Most candidates found this diagram challenging. The majority had either both or neither container sealed and many did not have the delivery tube dipping into the limewater.

(ii) Stronger candidates gained credit for this question.

(c) More able candidates gained full credit here. Common incorrect responses included chlorine, the correct ions reversed, incorrect formulae or incorrect charges on the ions.

(d) This was generally well known.

Question 3

(a) Many candidates read the thermometer correctly but a significantly large number recorded the value as 77.

(b) Units were generally well known but some candidates gave C° or just C for temperature.

(c) (i) Many candidates calculated T_P correctly but many used 75.

(ii) The majority of candidates calculated R_p correctly from their T_p.

(d) (i) Many candidates calculated T_Q correctly but a significant number used 78.5.

(ii) The majority of candidates calculated R_Q correctly from their T_Q.

(e) Many candidates chose the more effective method of reducing energy loss but most discussed loss of temperature with no reference to time or rate and so did not gain credit.

(f) More able candidates gained partial credit here, usually for adding more layers of insulation but few candidates gained full credit. Common incorrect responses were the use of a lid or adding a vacuum layer.

(g) This was well answered by the majority of candidates. However, some candidates discussed temperature without specifying which temperature.

Question 4

(a) Many candidates gained credit although “growing towards gravity” and “gravitational” were common incorrect responses.

(b) (i) While most candidates gained credit, some had the root growing but did not specify how.

(ii) The most able candidates gained credit here. Many candidates described an effect of no gravity or gravity changing direction and so did not gain credit. Some candidates thought that the cork was giving energy or nutrients to the seedling.

(c) Most candidates gained credit. A small number of candidates drew the growth upwards or horizontally.

(d) Many candidates gained credit.

(e) More able candidates answered this question correctly. Common incorrect responses included “towards the light” and “downwards”.

(f) There was some confusion between germination and fertilisation. Those candidates who discussed germination often did not consider temperature or thought light was needed. Many candidates discussed moving pollen from one seedling to another.

Question 5

(a) (i) This was well known by most candidates. Common incorrect responses included beaker and flask.

(ii) More able candidates gained credit but many candidates discussed increasing the rate of reaction or making the substances react.

(iii) A significant number of candidates gained credit. However many candidates thought the addition of a cool reagent caused the temperature drop or thought it was because it gave out energy.

(b) (i) Most candidates answered this question correctly.

(ii) The points were usually plotted correctly although a large number of candidates did not plot 0, 0. Candidates found the curve more difficult often using rulers for the ascending temperatures and not drawing a cooling curve for the descending temperatures. A significant number drew a curve which did not reach the highest point plotted.

(iii) Many candidates did not gain credit here as they did not draw the vertical line from the maximum to axis.

(iv) Many candidates preformed the calculation correctly however some used 1 as the numerator.

(c) Only the strongest candidates answered this question correctly. Some candidates discussed more readings but did not specify which readings.

Question 6

(a) (i) Most candidates read the thermometer scales correctly.

(ii) Many candidates appreciated that the scale started at 20 °C rather than 0 °C, although some did not label the 20 °C. A significant number started the scale at 0 °C.

(iii) Most candidates plotted the points correctly for their chosen scale and drew suitable curves. However a few candidates used a ruler or attempted to draw straight lines. A number omitted to label the three curves.

(b) Many candidates appreciated the factors which needed to be considered but then omitted to specify that these variables needed to be kept constant.

CO-ORDINATED SCIENCES

Paper 0653/63
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from measuring cylinders, rulers, thermometers etc. Candidates should have performed identification tests on the range of substances detailed in the specification. Candidates need to be able to plan experiments and also evaluate experimental procedures.

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent 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 anomalous points should not be included in lines. Designing an experiment proved to be very difficult for many candidates. Knowledge of identification tests for ions and gases were limited. Data and calculations in tables should be recorded to the same number of decimal places as the rest of the data in the table and needs to be correctly rounded. When planning experiments the prompts in the question will help ensure that all aspects of the plan are considered.

Comments on specific questions

Question 1

(a) Many candidates gained partial credit, usually for molar. Incisor was not well known.

(b) (i) The use of an indicator was well known but a significant number of candidates used litmus and very few appreciated that water needed to be added.

(ii) A significant number gained credit but many alkaline pH's were given.

(iii) There were very few correct responses to this question. Most candidates thought that the bacteria were acidic.

(c) Many candidates found the planning challenging but most gained partial credit with a few of the stronger candidates gaining full credit. The candidates who used the prompts in the question usually gave more successful answers.

Question 2

(a) (i) Many candidates answered this question correctly.

(ii) These terms were well known.

(b) (i) Only the stronger candidates answered this question well. A significant number of candidates gave "reacts" or "does not react" or omitted this question.

(ii) This question proved challenging with the most common incorrect response seen being sodium chloride**.**

(c) (i) This test was not well known.

(ii) This was only answered well by stronger candidates. Weaker candidates often gave “goes coloured” or “gives a precipitate” as their answer.

(iii) This question was challenging for many candidates with zinc chloride seen as a common response.

Question 3

(a) Many candidates read the voltmeter correctly.

(b) Some candidates gained full credit but incorrect rounding or giving the value of R to a number of decimal places inconsistent with the rest of the data in the table were common.

(c) Many candidates did not include units on the axes or did not choose a scale which would use half or more than half of the grid. Plotting gained more credit but lines were often “dot-to-dot”.

(d) Few candidates described or justified the relationship correctly.

(e) Candidates found this challenging. Common incorrect responses included “insulate the wire” or “perform in a very cold room”.

Question 4

(a) The cell was drawn well by the majority of candidates.

(b) (i) Many candidates measured correctly although a significant number had the line too long.

(ii) Most candidates measured their line correctly.

(iii) Magnification was calculated correctly by the majority of candidates although a few inverted calculations were seen.

(c) (i) More able candidates gained full credit.

(ii) Cell components were well known.

Question 5

(a) (i) Rounding of the values was well executed although weaker candidates gave 71.9.

(ii) The calculations were completed correctly by many candidates although some used the values from stopwatches rather than the values from the table.

(iii) More able candidates completed the calculation correctly, 7.7 was a common incorrect response.

(iv) Stronger candidates answered this question well. However many candidates discussed the purity of the reagents or the loss of the mixture on heating.

(b) Few candidates appreciated the safety point of using a fume cupboard. Many candidates thought it was to stop any gas or mixture being lost.

(c) Few candidates knew the identification test for iron(lll) ions.

Question 6

(a) (i) Most candidates read the measuring cylinder correctly.

(ii) Most candidates read the thermometer correctly.

(iii) Most candidates started the vertical axis at 0 and so did not use half or more than half of the grid. Plotting of the points was done accurately by the majority but many candidates then included the anomalous point in the line for Y. Lines were usually labelled well.

(iv) A significant number gained partial credit, usually for the similarities between the lines.

(b) Stronger candidates answered this question correctly. A significant number discussed the insulation on Y rather than considering the results.

(c) This was addressed well by some of the stronger candidates. The most common incorrect response was the need for repetition of the experiment.