COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

Biology

General comments

The questions generally fell well within the scope of most candidates. Almost 70% of the questions were answered correctly by more than half the candidates taking the paper, though two of the questions proved to be sterner tests of ability.

Comments on individual questions

Question 1

A relatively straightforward question revealed that almost a quarter of the candidates, including several who otherwise performed well on the paper, thought that starch grains are a constituent of the cell sap in the vacuole of a plant cell. This reveals a misunderstanding both of the nature and importance of chloroplasts as well as of cell sap.

Question 2

Rather surprisingly, this question, still requiring a knowledge of cell structure, did not pose similar problems and was one of the easiest question in the biology section.

Question 3

At this level, the mention of enzymes will, perhaps, promote thoughts in the candidate‘s mind of what happens in a test-tube in the laboratory or in the gut of a mammal. Candidates need to appreciate that enzymes are manufactures within cells, rather than in, say, the gut of a mammal.

Question 9

This question proved to be the most challenging on the paper. Most candidates knew that insulin is secreted when blood glucose levels are high. Many of those candidates thought that insulin would decrease rather than increase the amount of glucose taken up by the liver.

Chemistry

General comments

Overall the examination performed well. The Chemistry questions seemed to have approximately the same difficulty as the Biology and Physics questions for candidates.

Comments on individual questions

Question 18 proved to be easiest, being answered correctly by over 80% of the candidates.

Questions 20, **21**, and **26** proved to be the most difficult being answered correctly by fewer than 40% of candidates

Question 19 Candidates that incorrectly chose option **C** perhaps did not understand the meaning of the word sterilise and chose what they recognised as a chemical process.

Question 20 The higher-scoring candidates were able to select the correct response here. Other candidates usually selected options **B** and **C**. Candidates need to be aware that a process can be both reduction and electrolysis.

Question 21 Incorrect options **B** and **C** were equally popular, indicating that candidates were perhaps guessing on the basis that there had to be some blue, somewhere. Copper will not react with either water or copper sulfate.

Question 27 Option **A** was the most commonly given incorrect response here. Candidates correctly rejected the two weaker distractors but some opted for the wrong remaining alternative. Candidates need to be made aware that petroleum (crude oil) is a mixture of compounds.

Physics

General comments

Candidates found item **31** particularly challenging. Other items with a lower facility were **30**, **32**, **33**, **34**, **37**, **38** and **40.**

Comments on individual questions

The measurement item **28** was answered well; option **C** was the most popular distractor, these candidates failing to divide the reading by the number of balls.

In item **29** all distractors worked well.

In item **30**, the candidates that chose option **A** were choosing the smallest mass rather than the lowest density.

Speed / time graphs were covered by item **31**. A large proportion of candidates incorrectly chose option **B**. This may be because these candidates believe that uniformly decreasing speed means decreasing acceleration. It must be emphasised to candidates that acceleration is the gradient of a speed / time graph and where there is a straight line graph (such as between X and Y), the acceleration is constant.

A significant proportion of candidates opted incorrectly for option **C** from item **32**, indicating a belief that kinetic energy is stored in a reservoir.

Performance was poor again in item **33**. Option **D** was a popular distractor.

In item **34** some incorrectly chose option **B**, adding the two resistances to get a value for current. Most candidates were able to correctly use Ohms law to reach the correct answer.

In item **35**, also on circuits, just over one in five thought that fuse C, connected in parallel with a bulb, had blown.

Heat transfer was the topic for item **36**, and a significant number chose options **A** and **B** which were distractors.

In item **37**, more than half of the candidates incorrectly opted for option **C**, despite the rays starting from a principal focus of the lens. Candidates need to be made aware of the difference of the behaviour of light rays when they start from the centre of curvature compared to when they start from the principal focus.

Similarly in item **38**, option **C**, a distractor, attracted over half of candidates, linking heating more strongly to ultraviolet rays than to infra-red.

Item **39**, the incorrect option **C** was popular, this being the exact opposite of the key. Candidates must be made aware of more than the simple idea that pitch and loudness are affected by the frequency and amplitude; they must know that frequency effects pitch and that amplitude effects loudness.

In the final item **40** candidates demonstrated some confusion over the nature of alpha-particles.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

Biology

General comments

The questions generally fell well within the scope of most candidates who generally performed well. Three of the questions proved to be sterner tests of ability.

Comments on individual questions

Question 2

This question, requiring a knowledge of cell structure, was competently answered by the majority of the candidates, and was the easiest question in the biology section.

Question 3

A relatively straightforward question revealed that many of the candidates, including several who otherwise performed well on the paper, thought that starch grains are a constituent of the cell sap in the vacuole of a plant cell. This reveals a misunderstanding both of the nature and importance of chloroplasts as well as of cell sap.

Question 4

At this level, the mention of enzymes will, perhaps, promote thoughts in the candidate's mind of what happens in a test-tube in the laboratory or in the gut of a mammal. Candidates need to appreciate the fact that enzymes are manufactured within cells rather than in, say, the gut of a mammal.

Question 8

It was perhaps surprising that this was the most difficult of the biology questions. The most common belief was that it is the pulmonary artery that carries oxygenated blood away from the heart. Candidates need to be familiar with heart structure and the concept of a double circulation.

Question 9

This question proved to be challenging even for the better candidates. Most candidates knew that insulin is secreted when blood glucose levels are high. Many of these thought that insulin would decrease rather than increase the amount of glucose taken up by the liver.

Chemistry

General comments

The Chemistry questions seemed to have approximately the same difficulty as the Biology and Physics questions for candidates.

Comments on individual questions

Question 27 proved to be easiest being answered correctly most of the candidates and **questions 20, 21,** and **24** proved to be the most difficult.

Question 20 The incorrect options **B** and **C** were equally popular indicating that candidates were perhaps guessing on the basis that there had to be some blue somewhere. Copper will not react with either water or copper sulfate.

Question 21 The higher-scoring candidates were able to select the correct response here. Other candidates usually selected options **B** and **C**. Candidates need to be aware that a process can be both reduction and electrolysis.

Question 23 Many candidates chose option **A** which was clearly a hydrocarbon. Other candidates misunderstood the word 'polymer'.

Question 24 Candidates knew that carbon dioxide was produced, but not that water was also produced, and so incorrectly chose option **C**.

Question 25 Candidates rejected the two weaker distractors but opted for the wrong alternative of option **A**. Candidates need to appreciate that petroleum (crude oil) is a mixture of compounds.

Physics

General comments

Physics items that were challenging were items **28**, **29**, **30**, **31**, **32**, **34**, **35**, **36**, **37**, **38**, **39** and **40.**

Comments on individual questions

Speed / time graphs were covered by item **28.** A large proportion of candidates incorrectly chose option **B**. This may be because these candidates believe that uniformly decreasing speed means decreasing acceleration. It must be emphasised to candidates that acceleration is the gradient of a speed / time graph and where there is a straight line graph (such as between X and Y) the acceleration is constant.

In item **29** option **A** was chosen by half the candidates, this option showing the smallest mass rather than the lowest density.

Item **30** showed that there is considerable confusion of the concepts of mass and weight.

The measurement item **31** was better answered; option **C** was a popular distractor.

In item **32** all distractors worked well, especially option **B**.

In item **33**, on circuits, just over under a quarter of candidates thought that fuse C, connected in parallel with a bulb, had blown.

The straightforward item **34** concerned the connection of an ammeter and voltmeter, and nearly half of candidates chose option **D**.

A significant proportion of candidates opted incorrectly for option **C** for item **35** indicating a belief that kinetic energy is stored in a reservoir.

Almost half of candidates chose the correct option in item **36** on heat transfer.

Item **37**, more than half the candidates opted for option **C**, a distractor, linking heating more strongly to ultraviolet rays than to infra-red.

Item **38** showed an improvement in understanding, although option **C** was popular, this being the exact opposite of the key.

In item **39** more than half of the candidates incorrectly opted for option **C**, despite the rays starting from a principal focus of the lens. Candidates need to be made aware of the difference in the behaviour of light rays when they start from the centre of curvature compared to when they start from the principal focus.

In the final item **40** there was widespread confusion over the nature of alpha-particles.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

Biology

General comments

The questions fell comfortably within the scope of almost all candidates who, generally, performed very well in the Biology section. Only one question was not successfully handled by around half or more of those taking the paper.

Comments on individual questions

Question 1

A relatively straightforward question revealed that almost half the candidates, including several who otherwise performed well on the paper, thought that starch grains are a constituent of the cell sap in the vacuole of a plant cell. This reveals a misunderstanding both of the nature and importance of chloroplasts as well as of cell sap.

Question 3

This question, also required a knowledge of cell structure, did not pose similar problems and was the easiest question in the biology section.

Question 4

At this level, the mention of enzymes will, perhaps, promote thoughts in the candidate's mind of what happens in a test-tube in the laboratory or in the gut of a mammal. Candidates need to appreciate that enzymes are manufactured within cells, rather than in, say, the gut of a mammal.

Question 12

Candidates need to be made aware that the term *embryo* has a botanical as well as a zoological application.

Chemistry

General comments

Overall the examination performed. The Chemistry questions seemed to have approximately the same difficulty as the Biology and Physics questions for candidates.

Comments on individual questions

Questions 13, **15**, **16**, **18**, **20**, and **23** proved to be easiest and **question 22** the most difficult.

Question 19 The higher-scoring candidates were able to select the correct response here. Other candidates usually selected options **B** and **C**. Candidates need to be aware that a process can be both reduction and electrolysis.

Question 22 The incorrect options **B** and **C** were equally popular, indicating that candidates were perhaps guessing on the basis that there had to be some blue, somewhere. Copper will not react with either water or copper sulfate.

Physics

General comments

Of the Physics items, **29** and **36** were found to be particularly easy by candidates, and items **32**, **38** and **39**, more challenging.

Comments on individual questions

The concepts of mass and weight seem very secure, as shown by large proportion of candidates choosing the correct response for item **28.**

The performance of the candidates on the measurement item **29** was also very good.

In item **30**, the few candidates that chose option **A** were choosing the smallest mass rather than the lowest density.

Those few candidates that incorrectly chose option **C** from item **31** were indicating a belief that kinetic energy is stored in a reservoir.

Speed / time graphs were covered by item **32**. A large proportion of candidates incorrectly chose option **B**. This may be because these candidates believe that uniformly decreasing speed means decreasing acceleration. It must be emphasised to candidates that acceleration is the gradient of a speed / time graph and where there is a straight line graph (such as between X and Y), the acceleration is constant.

Little difficulty was experienced with item **33** on heat transfer.

In item **34** more than one in ten candidates incorrectly chose distractor B, adding the two resistances to get a value for current. Most candidates were able to correctly use Ohms law to reach the correct answer.

Item **35** worked very well.

Few candidates were taxed by item **36** on fuses, or by item **37** on waves.

In item **38,** most candidates opted for option **C**, a distractor, linking heating more strongly to ultraviolet rays than to infra-red.

More than half of the candidates incorrectly opted for option **C** from item **39**, despite the rays starting from a principal focus of the lens. Candidates need to be made aware of the difference in the behaviour of light rays when they start from the centre of curvature compared to when they start from the principal focus.

COMBINED SCIENCE

Paper 0653/21

Core Theory

General comments

The majority of candidates were appropriately entered for this Paper. A very small minority were able to answer most questions very well, suggesting that they might have performed well enough on Paper 3 to have achieved a grade higher than Grade C, the maximum available on this Paper.

Most responses indicated that candidates were able to understand the questions. It is important that candidates realise that they must answer the question that is asked. For example, if a word equation is asked for, that is what they must give; similarly, if a name, symbol or formula is asked for, that is what is required.

Comments on specific questions

Question 1

(a) A minority of answers were correct. Carbon dioxide, water, glucose, starch and oxygen often appeared, but in an apparently random order. Quite frequently, the same substance appeared on both sides of the equation. 'Sunlight', 'chlorophyll' or 'energy' were often written inside the boxes. Some candidates used symbols, which was not what the question asked for.

(b) (i) The name of the green pigment was well known. Spelling was often incorrect, but this was not penalised as long as it was clear that 'chlorophyll', and not 'chloroplast', was intended.

(ii) This was also well answered, although numerous candidates labelled the nucleus, cytoplasm or – less frequently – the cell wall. Some did not draw a label line as asked, instead writing the letter P on the diagram. This was credited as long as it was absolutely clear which structure was being labelled.

(c) (i) Answers ranged from those who knew this well and gained all three marks, to those who simply chose letters at random.

(ii) Good answers included lines to delineate the two areas on the leaf, and labelled the covered area blue-black and the uncovered area orange-brown. By far the largest proportion of answers gave the colours the wrong way round, showing the area covered by the paper as blue-black, and the uncovered area as orange-brown. Some candidates drew lines on the leaf showing a light-coloured area all around the edge, suggesting that they were recalling a different experiment in which a variegated leaf was tested for starch.

Question 2

(a) Most candidates did not know the test for hydrogen. Some knew that a 'pop' sound would be made, but generally stated that a 'glowing' splint would be used, rather than a 'lighted' splint. Many candidates stated that you would look for bubbles, or that you would mix the gas with oxygen and see if it produced water.

(b)(i) Many candidates correctly identified metal Z as copper, and went on to say that copper does not react with hydrochloric acid, or that it is unreactive. Explanations such as 'because no gas was produced' were not credited.

(ii) The most frequently seen correct answers were to heat the reactants, or to increase the concentration of hydrochloric acid. References to increasing surface area were only credited if it was clear that the powdered metal would be made into an even finer powder. Some also correctly suggested stirring or shaking the mixture.

(c) (i) Very few candidates knew the formula for sulfuric acid (H_2SO_4). Some tried to write equations.

(ii) A small proportion of answers correctly stated that the sulfuric acid had all been used up.

Question 3

(a) (i) This was often answered correctly, most candidates recognising that the rock had potential energy.

(ii) Many answers gained one mark for stating that kinetic energy would change to another type of energy, and some candidates were also able to suggest what this other type of energy might be. Many, however, simply said that the energy would be lost, which did not gain any marks.

(b) (i) Most candidates correctly read the scale on the graph, and gave a correct answer.

(ii) The majority of candidates knew the meaning of the term 'accelerate' and were able to describe this correctly.

(c) (i) Very few answers were correct. By far the most common was a 'radioactivity meter'. A few candidates knew about Geiger-Müller tubes or photographic film.

(ii) Some candidates correctly explained that the radioactivity could damage cells, cause mutations or cancer, or burn skin. Many simply said that radioactivity was dangerous, which was not enough to gain a mark. Many did not relate their answer to radioactivity at all, suggesting that the rock would be very hot, or that it was moving so fast that it might hit the person and hurt them.

Question 4

(a) (i) The majority of answers indicated no understanding of the difference between an element and a compound. Those candidates who did appear to have some relevant knowledge often had difficulty in finding words to express their answer. Answers which described compounds as 'mixtures' of elements could not be credited. Very few candidates used the examples given; for those who did, there was a mark simply for stating that copper or oxygen are elements and that copper oxide is a compound.

(ii) Many answers gave a correct description of oxidation, often saying that the copper had gained oxygen. Incorrect answers often simply reiterated a definition of oxidation, including 'the removal of hydrogen'.

(iii) A minority of answers correctly gave ionic (occasionally electrovalent) bonding. Most suggested either covalent or metallic. Some candidates did not know the meaning of the term 'chemical bonding' and gave answers such as 'oxygen' or 'oxidation'.

(b) (i) Quite a few candidates were able to label the anode, although some labelled the wires or the + sign rather than the electrode itself. Fewer were able to label the electrolyte, often labelling the cathode or the power supply.

(ii) Only a very small number of candidates showed an understanding of the terms 'atom' and 'ion'. Good answers stated simply that an atom is uncharged whereas an ion has a charge, often explaining this in terms of the numbers of electrons in the outer shell, or the relative numbers of electrons and protons. Many incorrect answers explained the difference in terms of size, often stating that ions were bigger than atoms, or that ions had reacted whereas atoms had not.

(ii) A small proportion of answers included observations, such as bubbles appearing or a pink-orange layer forming. Generally, however, these answers gave the observations at the wrong positions, with the bubbles appearing at the negative electrode and copper at the positive. The majority of answers did not describe observations at all.

Question 5

(a) A small number of candidates correctly placed X-rays in the left hand space and microwaves at the right. Most answers did not include either of these waves. The most commonly seen incorrect answers were 'alpha', 'beta', 'sound' and – less frequently – 'bluetooth'.

(b) Some answers to all three sections were excellent, labelling the normal correctly, carefully drawing a reflected ray at an approximately correct angle, and stating that the angle of reflection would be 50º. Part **(i)** was often incorrect, with many answers labelling the incident ray, the mirror or the angle as being the normal, and many candidates making no attempt at labelling at all. The reflected ray was often drawn appropriately, but sometimes with an arrow pointing in the wrong direction. Quite a few answers showed the ray passing through the mirror. The most common wrong answers to **(iii)** were 40º or 45º.

(c) (i) Only a very small minority of candidates knew the meaning of the term 'frequency'.

(ii) The range of human hearing (20 Hz – 20 000 Hz) is not well known. Very few answers provided a range at all, often stating just one number.

(d) A small minority answered both of these questions correctly. Many gave the answers the wrong way round, stating that A had the lowest pitch and D the smallest amplitude. Part **(i)** was more often correct than part **(ii)**.

Question 6

(a) Some candidates wrote the correct terms in each of the three spaces. The most common incorrect choice for the first space was 'detectors', and 'brain' often appeared in the second space. 'Receptors' was the most common incorrect choice for the last space.

(b) (i) There were some good explanations of the term 'enzyme'. Many answers, however, described enzymes entirely in terms of digestion, which could sometimes get marks if there was also a statement that enzymes are catalysts, or that they are proteins.

(ii) Most candidates gave the correct answer, digestion.

(iii) A small minority of answers stated that digestion is necessary so that the small molecules can be absorbed through the wall of the gut, into the bloodstream. Often, despite having correctly answered **(i)**, candidates said that this was necessary so that food could be digested properly or more easily. There were many incorrect explanations in terms of food being easier to swallow, or so that it could pass through the digestive system.

Question 7

(a) The symbol for an ammeter was well known, although some failed to include the circle around the letter A. The symbol for a fixed resistor was much less often correct. There were many circles around the letter R, and voltmeters or switches were frequently seen. Some drew the symbol for a variable resistor.

(b) Relatively few answers were entirely correct. The second row was the most likely to be wrong.

(c) (i) There were some good answers to this question, often with simple statements that the circuit was no longer complete. It was not enough to say 'because the lamps are connected in series'.

(ii) It was quite rare to see a correct formula (such as total resistance = $R_1 + R_2$). Many gave the formula R = V/I, but some of these then went on to correctly add 5 + 5 and obtain a correct answer of 10 ohms. Many used the formula for adding resistors in parallel, which is not part of the Core syllabus and therefore is not tested on this Paper.

(d) (i) Some candidates could name the device as a transformer. Many did not attempt to answer this question.

(ii) Most were able to calculate the output voltage correctly, though some had difficulty in rearranging the formula and a significant number of candidates made no attempt to answer.

Question 8

(a) (i) A small minority of candidates correctly counted the number of carbon and hydrogen atoms, and wrote the formula as C_8H_{18}. Some tried to do the right thing but miscounted. Most did not know how to use the information to write a formula, or did not know what a 'formula' is, giving answers such as 'Oc'.

(ii) A very few answers were entirely correct. Some candidates correctly wrote 'oxygen' in the first space, and a few wrote 'carbon dioxide' as one of the products. It was very rare to see 'water', and 'hydrogen' appeared much more frequently. Most answers did not include any of these substances, with 'air', 'nitrogen', 'waste gases' and 'hydrocarbon' appearing very frequently as alternative products.

(iii) A number of answers correctly stated that nitrogen is present in air, implying that that was the source of the nitrogen in the waste gases. Only a very few also stated that nitrogen is unreactive or that it did not burn along with the octane.

(iv) A small minority of candidates correctly stated that the combustion of the fuel is an exothermic reaction, or that it produces heat. Most answers stated simply that metals conduct heat, but this was not credited unless the source of the heat was mentioned.

(b) (i) Most candidates correctly wrote '6' in one of the spaces, but it was rare for this number to appear twice. The number 12 was commonly written at least once.

(ii) There were many correct responses, in which candidates selected an element from the same group as carbon, and wrote its symbol correctly. Some answers were almost correct, but wrote the symbol using two capital letters, such as PB instead of Pb. Some candidates did not answer the question that had been asked, and gave the name rather than the symbol. Some wrongly chose an element from the same period, rather than from the same group.

Question 9

(a) (i) This was generally well answered, most candidates showing that they know how to draw a food web. Less than half of those webs drawn, however, showed the arrows pointing in the correct direction. There were some food chains, and some webs showing herbivores eating each other.

(ii) A minority of candidates correctly stated that the arrows showed 'energy flow'. The most common incorrect answer was 'eaten by'. It is important that candidates recognise that they need to move on from what they have learnt about food chains and webs at a lower level, in order to gain marks at IGCSE. Those who knew that the arrows represented energy flow generally drew the arrows in the correct direction in **(i)**.

(iii) Most answers correctly stated that the plants were the producers.

(b) (i) It was very rare to see a correct answer to this question. Most candidates did not understand the meaning of the term 'chemical', and gave answers such as 'blood' or 'lungs'. The most commonly seen correct responses were 'proteins' or 'carbohydrates'. 'Carbon dioxide' was also accepted.

(ii) Very few candidates understood how decomposers return carbon to the air as carbon dioxide, through respiration. There was no credit simply for mentioning decomposers, as this information was already given in the question. Some tried to describe 'carbon' diffusing out of the dead wolf, or it breathing out carbon dioxide as it died.

(c) This question was often answered well, with many candidates able to use the information to deduce that fur colour is determined by genes, while fur length is affected by the environment.

COMBINED SCIENCE

Paper 0653/22

Core Theory

General comments

There were some excellent performances on these Papers, indicating that some candidates have a very good knowledge and understanding of most areas of the Core syllabus. These candidates were also able to answer numerical questions well and express their ideas clearly. Many candidates, however, obtained fewer than half the marks and showed a poor understanding of many basic scientific concepts including chemical changes, electrical current and the reproductive systems of humans and plants.

Comments on specific questions

Question 1

(a) Good answers stated that the bear's fur acts as an insulator, but it was rare that this was explained in terms of air trapped in the fur. Many answers simply reworded the question while some attempted to use reflection or radiation to explain how the bear kept cool.

(b) (i) The increased risk of skin cancer, eye damage or sunburn due to exposure to ultraviolet was sometimes suggested. Many candidates confused ultraviolet with infrared radiation and described the effects of global warming on the ice cap or other climatic effects.

(ii) X-rays and their use in medicine was the most common correct example given. Many candidates had difficulty in naming another part of the electromagnetic spectrum.

Question 2

(a) (i) Some candidates were able to write the equation. Many struggled with the concept of relating the reactants to the products they form. The same elements did not always appear on each side of the equation.

(ii) A compound was sometimes correctly named, but relatively few candidates could explain why it is a compound. Good answers stated that a compound contains more than one element, the elements being chemically bonded together.

(b) (i) The majority of candidates knew that a power supply was required in the circuit. The most common incorrect response was 'a switch'.

(ii) Very few candidates were able to identify chlorine as the gaseous product and of these only a small minority explained that negatively charged chloride ions migrate to the positively charged anode.

Question 3

(a) (i) Some candidates knew that plants lose water vapour by transpiration. Various wrong answers were seen, including condensation, photosynthesis and respiration. 'Evaporation' was not sufficient, because this is the process by which liquid water turns to water vapour, and the question asked about the loss of water vapour. 'Evapotranspiration' was occasionally seen, and this is an acceptable term. 'Diffusion' was also accepted, as this is the process by which the water vapour moves out of the leaf.

(ii) A minority of answers correctly named stomata.

(iii) Some candidates mentioned condensation, or that water vapour had changed to liquid, and some related this to the fall in temperature. However, many candidates wrote incorrectly about respiration or photosynthesis.

(b) (i) This was well answered, most candidates labelling two of the cell wall, chloroplast or vacuole.

(ii) Many candidates knew that this cell was from the palisade layer. Some incorrectly suggested 'epidermis', and a significant number suggested areas other than the leaf, such as the stem.

(iii) Only a minority of answers were correct. 'Carbon dioxide', 'water', 'glucose', 'starch' and 'oxygen' often appeared, but in an apparently random order. Glucose (or any other carbohydrate) was often missing. Quite frequently, the same substance appeared on both sides of the equation. 'Sunlight', 'chlorophyll' or 'energy' were often written inside the boxes.

Question 4

(a) Many answers correctly stated that the train took 28 s to stop. Other common answers were 82 (no subtraction having been done) or 6 (reading from the wrong axis).

(b) (i) Quite a large number of candidates had difficulty in approaching a question where they had been given an answer for them to verify. Good answers gave the formula 'distance = speed x time', and then substituted into it to arrive at a final answer of 5400. Many felt they should include the answer in their calculation, presumably to work back to compare the speed or time taken with the data provided. Others carried out unsupported mathematical processes in the hope of arriving at the answer.

(ii) Most candidates did not know the formula 'work done = force x distance'. However, even those who were not able to give the correct formula sometimes calculated the answer correctly.

Question 5

(a) Most answers conveyed the idea of restoring the full number of chromosomes in the zygote.

(b) Ovary was the more likely to be given correctly, but many candidates did not know where fertilisation takes place.

(c) The protective function of the amnion was usually known, and some also knew that it produces or contains amniotic fluid. There was quite often confusion with the roles of the placenta, such as the provision of nutrients or the prevention of mixing between the blood of the mother and fetus.

(d) Most candidates knew that calcium is required by the fetus for bone development. The role of iron in producing haemoglobin was seldom mentioned, although its importance for the production of blood was sometimes suggested. Candidates could also have suggested that the mother's body needs to make substances for both herself and the fetus.

Question 6

(a) Some candidates correctly explained that water conducts electricity. The majority restated the question, and described electrocution.

(b) The great majority of candidates made at least a fair attempt at drawing the circuit diagram, and many obtained full marks. A significant minority did not know any circuit symbols and copied Fig. 6.1. Most knew the correct circuit symbols, although some drew squares instead of circles for the ammeter and voltmeter symbols. A few candidates did not attempt this question.

(c) Some candidates understood the logic of this switching circuit.

(d) Many correct answers were given, using a 12 ohm and 8 ohm resistor. Some candidates did not notice that only two resistors should have been used.

(e) This was quite well answered, with many candidates able to place the stages of electricity production in order.

Question 7

(a) (i) Many knew that the elements with the symbols O and S are in the same group.

(ii) The atomic structure of oxygen was well known. Phosphorus was often correctly identified from its structure, but some wrote its symbol instead of the name, as required in the instructions for filling in the table.

(b) (i) A small number of candidates correctly suggested that a compound such as copper oxide or copper carbonate could be used to produce copper chloride from hydrochloric acid. Some did recognise that a substance containing copper would be required, but incorrectly suggested copper sulfate or copper. Many candidates did not realise that a copper compound would be needed, and made suggestions involving elements such as carbon or sulfur or compounds containing those elements.

(ii) Some candidates correctly suggested magnesium or aluminium as elements that would safely displace hydrogen from hydrochloric acid. However, there were many suggestions that were neither safe nor from the third period.

(c) (i) Wrong answers given in answer to this question were 'boil', 'photosynthesis', 'diffusion' or 'calcium hydroxide'. The correct answers were combustion or oxidation and polymerisation

(ii) Candidates needed to demonstrate a knowledge of polymerisation to gain marks on this question.

Question 8

(a) (i) The yield of 2000 kg per hectare at pH 5.5 was usually read correctly from the graph.

(ii) Most candidates selected a sensible pH range for best growth.

(iii) Only a very small number of candidates identified calcium carbonate as a base, and a few described it, inaccurately, as an alkali. A minority could explain that it would neutralise the acid or raise the pH. Candidates needed to demonstrate that they understood the idea of pH change during neutralisation.

(b) Many candidates could make at least one practical suggestion for reducing the risk of erosion of soil in a steep field.

(c) (i) Many answers correctly stated that the coloured flowers would be pollinated by insects, but there were also suggestions of wind pollination.

(ii) A large number of candidates confused the growth of soya beans on the plant with the germination of the bean seed. This meant that the need for fertilisation was seldom included in the answer.

(iii) The biuret test for protein was correctly described by some candidates, but the iodine test for starch was sometimes offered instead. Some candidates suggesting burning or tasting the seeds.

Question 9

(a) Many candidates could place the ionising ability of beta radiation between that of alpha and gamma. Some could assign the correct charge to beta and gamma. Very few could describe the structure of an alpha particle.

(b) A small minority of candidates knew that smoke detectors are safe because of the low penetration of alpha radiation in air. Some candidates mentioned absorption by skin or clothes. Incorrect answers discussed the dangers of house fires, smoke or smoking.

Question 10

(a) This was well answered. Correct choices of water treatments were usually made and most candidates could explain why they are used.

(b) (i) Few answers explained that sulfur dioxide dissolves in rain water and forms acid rain. Many ascribed pollution to the effects of inhalation of the gas.

(ii) There were a few good responses describing methods of removal of sulfur dioxide from waste gases, but many candidates answered as if sulfur dioxide was the fuel.

(c) Answers suggested that some candidates found it challenging to relate a molecular model to a chemical formula.

COMBINED SCIENCE

Paper 0653/23

Core Theory

General comments

There were some excellent performances on these Papers, indicating that some candidates have a very good knowledge and understanding of most areas of the Core syllabus. These candidates were also able to answer numerical questions well and express their ideas clearly. Many candidates, however, obtained fewer than half the marks and showed a poor understanding of many basic scientific concepts including chemical changes, electrical current and the reproductive systems of humans and plants.

Comments on specific questions

Question 1

(a) Good answers stated that the bear's fur acts as an insulator, but it was rare that this was explained in terms of air trapped in the fur. Many answers simply reworded the question while some attempted to use reflection or radiation to explain how the bear kept cool.

(b) (i) The increased risk of skin cancer, eye damage or sunburn due to exposure to ultraviolet was sometimes suggested. Many candidates confused ultraviolet with infrared radiation and described the effects of global warming on the ice cap or other climatic effects.

(ii) X-rays and their use in medicine was the most common correct example given. Many candidates had difficulty in naming another part of the electromagnetic spectrum.

Question 2

(a) (i) Some candidates were able to write the equation. Many struggled with the concept of relating the reactants to the products they form. The same elements did not always appear on each side of the equation.

(ii) A compound was sometimes correctly named, but relatively few candidates could explain why it is a compound. Good answers stated that a compound contains more than one element, the elements being chemically bonded together.

(b) (i) The majority of candidates knew that a power supply was required in the circuit. The most common incorrect response was 'a switch'.

(ii) Very few candidates were able to identify chlorine as the gaseous product and of these only a small minority explained that negatively charged chloride ions migrate to the positively charged anode.

Question 3

(a) (i) Some candidates knew that plants lose water vapour by transpiration. Various wrong answers were seen, including condensation, photosynthesis and respiration. 'Evaporation' was not sufficient, because this is the process by which liquid water turns to water vapour, and the question asked about the loss of water vapour. 'Evapotranspiration' was occasionally seen, and this is an acceptable term. 'Diffusion' was also accepted, as this is the process by which the water vapour moves out of the leaf.

(ii) A minority of answers correctly named stomata.

(iii) Some candidates mentioned condensation, or that water vapour had changed to liquid, and some related this to the fall in temperature. However, many candidates wrote incorrectly about respiration or photosynthesis.

(b) (i) This was well answered, most candidates labelling two of the cell wall, chloroplast or vacuole.

(ii) Many candidates knew that this cell was from the palisade layer. Some incorrectly suggested 'epidermis', and a significant number suggested areas other than the leaf, such as the stem.

(iii) Only a minority of answers were correct. 'Carbon dioxide', 'water', 'glucose', 'starch' and 'oxygen' often appeared, but in an apparently random order. Glucose (or any other carbohydrate) was often missing. Quite frequently, the same substance appeared on both sides of the equation. 'Sunlight', 'chlorophyll' or 'energy' were often written inside the boxes.

Question 4

(a) Many answers correctly stated that the train took 28 s to stop. Other common answers were 82 (no subtraction having been done) or 6 (reading from the wrong axis).

(b) (i) Quite a large number of candidates had difficulty in approaching a question where they had been given an answer for them to verify. Good answers gave the formula 'distance = speed x time', and then substituted into it to arrive at a final answer of 5400. Many felt they should include the answer in their calculation, presumably to work back to compare the speed or time taken with the data provided. Others carried out unsupported mathematical processes in the hope of arriving at the answer.

(ii) Most candidates did not know the formula 'work done = force x distance'. However, even those who were not able to give the correct formula sometimes calculated the answer correctly.

Question 5

(a) Most answers conveyed the idea of restoring the full number of chromosomes in the zygote.

(b) Ovary was the more likely to be given correctly, but many candidates did not know where fertilisation takes place.

(c) The protective function of the amnion was usually known, and some also knew that it produces or contains amniotic fluid. There was quite often confusion with the roles of the placenta, such as the provision of nutrients or the prevention of mixing between the blood of the mother and fetus.

(d) Most candidates knew that calcium is required by the fetus for bone development. The role of iron in producing haemoglobin was seldom mentioned, although its importance for the production of blood was sometimes suggested. Candidates could also have suggested that the mother's body needs to make substances for both herself and the fetus.

Question 6

(a) Some candidates correctly explained that water conducts electricity. The majority restated the question, and described electrocution.

(b) The great majority of candidates made at least a fair attempt at drawing the circuit diagram, and many obtained full marks. A significant minority did not know any circuit symbols and copied Fig. 6.1. Most knew the correct circuit symbols, although some drew squares instead of circles for the ammeter and voltmeter symbols. A few candidates did not attempt this question.

(c) Some candidates understood the logic of this switching circuit.

(d) Many correct answers were given, using a 12 ohm and 8 ohm resistor. Some candidates did not notice that only two resistors should have been used.

(e) This was quite well answered, with many candidates able to place the stages of electricity production in order.

Question 7

(a) (i) Many knew that the elements with the symbols O and S are in the same group.

(ii) The atomic structure of oxygen was well known. Phosphorus was often correctly identified from its structure, but some wrote its symbol instead of the name, as required in the instructions for filling in the table.

(b) (i) A small number of candidates correctly suggested that a compound such as copper oxide or copper carbonate could be used to produce copper chloride from hydrochloric acid. Some did recognise that a substance containing copper would be required, but incorrectly suggested copper sulfate or copper. Many candidates did not realise that a copper compound would be needed, and made suggestions involving elements such as carbon or sulfur or compounds containing those elements.

(ii) Some candidates correctly suggested magnesium or aluminium as elements that would safely displace hydrogen from hydrochloric acid. However, there were many suggestions that were neither safe nor from the third period.

(c) (i) Wrong answers given in answer to this question were 'boil', 'photosynthesis', 'diffusion' or 'calcium hydroxide'. The correct answers were combustion or oxidation and polymerisation

(ii) Candidates needed to demonstrate a knowledge of polymerisation to gain marks on this question.

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(a) (i) The yield of 2000 kg per hectare at pH 5.5 was usually read correctly from the graph.

(ii) Most candidates selected a sensible pH range for best growth.

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(b) Many candidates could make at least one practical suggestion for reducing the risk of erosion of soil in a steep field.

(c) (i) Many answers correctly stated that the coloured flowers would be pollinated by insects, but there were also suggestions of wind pollination.

(ii) A large number of candidates confused the growth of soya beans on the plant with the germination of the bean seed. This meant that the need for fertilisation was seldom included in the answer.

(iii) The biuret test for protein was correctly described by some candidates, but the iodine test for starch was sometimes offered instead. Some candidates suggesting burning or tasting the seeds.

Question 9

(a) Many candidates could place the ionising ability of beta radiation between that of alpha and gamma. Some could assign the correct charge to beta and gamma. Very few could describe the structure of an alpha particle.

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Question 10

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(b) (i) Few answers explained that sulfur dioxide dissolves in rain water and forms acid rain. Many ascribed pollution to the effects of inhalation of the gas.

(ii) There were a few good responses describing methods of removal of sulfur dioxide from waste gases, but many candidates answered as if sulfur dioxide was the fuel.

(c) Answers suggested that some candidates found it challenging to relate a molecular model to a chemical formula.

COMBINED SCIENCE

Paper 0653/31

Extended Theory

General comments

Many candidates showed that they had learned and understood most of the subject matter and also that they had prepared very well for the examination. Almost a quarter of the candidates scored a fifth or less of the available marks, and these candidates may have been more suited for entry to the Core Paper 2. In general, candidates completed the paper in the available time. When given the choice of including diagrams to help explain their answers, many candidates very wisely chose to do so, and many extra marks were gained by doing this. Many candidates showed that they had a satisfactory grasp of the subject matter, loosing marks through inattention to detail. In particular, it is most important that candidates:

- include physical units where appropriate in numerical answers,
- take care in writing chemical symbols and formulae properly,
- write labels on diagrams when requested to do so,
- avoid general, unscientific answers in favour of answers which demonstrate that they have learned the science which is relevant to the question.

Compared to some previous examinations, there was less evidence of candidates wasting time by re-writing sections of the questions. Colleagues should continue to advise candidates to look carefully at the mark allocation for each question and to adjust the quantity of writing accordingly. Written answers should easily fit onto the answer lines provided for each question.

Comments on specific questions

Question 1

(a) This question was answered accurately by a majority of candidates. If candidates choose to state the formula used using symbols rather than words then it is important that they use recognised symbols. Thus the ideal answer would be 'force = mass x acceleration'; 'f = m x a' would also be accepted. Similarly, 'weight = mass x gravity' and 'W = m x g' were acceptable answers. Candidates who suggested formulae which contained units, for example, kg to represent mass, did not score the mark for the formula. The required answer was **40 N**.

(b) Candidates generally found this question to be more difficult than **(a)**. The most common incorrect answer was 160 m obtained by multiplication of speed and time. The required answer was **80 m**.

(c) The majority of candidates were familiar with displacement methods and were able to describe the procedure very well. A maximum of three marks was awarded if candidates did not explain how density should be calculated. Many candidates described the displacement method to find the volume of the rock very clearly. They would have scored the remaining marks if they had gone on to describe how to find the mass of the rock and how the density would be calculated.

(d) (i) Any device which would detect radioactivity was accepted, including the Geiger counter, G-M tube and photographic film. Some candidates incorrectly suggested radiometers and weaker candidates gave the vague response, 'radiation detector'.

(ii) Candidates giving non-specific answers such as 'it harms the body' or 'it damages internal organs' did not score this mark. The response 'it ionises cells' was also not accepted as an answer to questions about the hazards of radioactivity. Specific harmful effects such as radiation sickness, radiation burns, killing cells, damage to DNA, or references to mutation and tumours were accepted.

Question 2

(a) (i) Candidates' knowledge of food webs was generally very good and many scored full marks. A common mistake was to draw the arrows in the reverse direction.

(ii) This question is often asked when feeding relationships are tested, and many gave the correct response, referring to energy flow. Some suggested 'energy losses' which was not accepted. The most common incorrect responses were ambiguous statements such as 'it shows what eats what'.

(iii) This question proved to be more difficult than **(ii)**, and even those candidates who correctly referred to energy in **(ii)** did not mention energy losses here. Many candidates attempted to answer this question in terms of populations, and it was also not uncommon to see answers that related more to part **(b)**.

(b) In general, candidates did very well in this question, and used the information given in the question sensibly. Some candidates organised their answers very clearly, dividing the space into two columns for the arguments in favour of and against conservation of the grey wolf. This is an excellent way to answer questions of this type. The key arguments in favour of conservation included references to maintaining biodiversity, maintenance of a balanced ecosystem and any reasonable reference to ethical or moral arguments. The main argument against conservation was the danger to livestock.

Question 3

(a) (i) Candidates all too often suggested transition metal properties which were not represented in the table. Many also gave single word answers such as 'colour', which were too vague to score the mark.

(ii) This was a challenging question and only the better candidates scored two marks. Candidates needed to be familiar with the charge balance in ionic compounds and, for many, the unfamiliar context of a copper (I) compound proved to be too challenging. Many had learned the more familiar Cu^{2+} and tried hard to make this answer work in the context of the question. Some candidates made logical attempts to justify Cu^{+} in terms of a dot and cross diagram, and were credited with both marks.

(b) (i) Candidates' labelling lines had to be drawn carefully. Many knew that the anode was on the positive side of the cell but labelled the connecting wire or the + sign, rather than the body of the anode.

(ii) Most candidates were able to describe some of the processes occurring during electrolysis in terms of ions, atoms and electrons as requested. Candidates were better at discussing the migration of ions under the influence of attraction between opposing electrical charges than they were at explaining how ions were discharged to atoms at the electrodes. Many candidates suggested processes which were the reverse of accepted theory, but credit was given for relevant concepts. Thus, if a candidate referred to attraction between positive chloride and negative anode, they could still score a mark for the idea of opposite charge attraction.

Question 4

(a) (i) Most candidates scored the mark for drawing the reflected ray. Candidates need to remember to include the arrow when drawing lines representing light rays. A minority of candidates drew the ray as if it had been refracted, and quite a number did not label the reflected ray as requested.

(ii) Most candidates were able to draw the normal, although quite a number did not label it.

(iii) The angle of incidence was labelled correctly less frequently than the reflected ray or normal asked for in parts **(i)** and **(ii)**. The most common mistake was to label the angle between the incident ray and the mirror.

(b) (i) This was generally well answered. Details of wave form and amplitude were not important, but with only one mark available it was critical that candidates ensured that two, and only two, complete waves fitted onto the grid.

(ii) This was generally well answered. Details of the wave form and frequency were not important but candidates needed to draw their waves very carefully to correctly show the amplitude asked for.

(iii) This was generally well answered with most candidates correctly identifying traces **B** and **C**.

Question 5

(a) (i) Most candidates gave the correct formula. $H_{18}C_8$ was accepted as an alternative on this occasion.

(ii) This question proved to be more difficult than expected, possibly because octane was an unfamiliar context for testing complete hydrocarbon combustion. Many candidates wrote air instead of oxygen on the reactant side and a wide variety of incorrect products was suggested.

(b) (i) Most candidates gave the correct response to this question. The most common incorrect answer was 7.

(ii) Many candidates had learned the form of the dot and cross diagram of the triple bond in N_2 and many also correctly showed the lone pairs on each atom. The most common mistake was to suggest 7 as the answer to **(i)** and then go on to draw a single bonded molecule in **(ii)**.

(c) Just as in **Question 3(a)(i)** many candidates did no more than re-write information contained in the table. In order to score the marks, candidates needed to suggest why the properties of strength and low density are important in the context of aircraft manufacture. Thus candidates should have discussed safety, resistance to high forces in flight, reduced aircraft weight or improved fuel economy

Question 6

(a) Some fully correct answers were seen and most candidates scored at least one mark. The relay neurone was the least well-known.

(b) Candidates needed to specify a muscle as the effector and then any suitable reaction. In general, the mark for the reaction was scored but the mark for the effector was rarely awarded.

(c) (i) The action of amylase in breaking down starch to maltose was described by many candidates. Many others discussed processes related to chewing and swallowing. Reference to (simple) sugars was accepted as an alternative to maltose, but the general term ‘carbohydrates’ was not accepted as an alternative for starch.

(ii) Candidates needed to discuss the breaking down of large *molecules* into smaller ones, and not the breaking of food into smaller pieces. Further marks were available for referring to the process of absorption, the idea that absorption occurred either through the wall of the gut or into the blood and also that nutrients then became available for use in cells.

(iii) The graph needed to rise to a maximum between 30°C and 40°C and then fall. Most candidates were familiar with this graph and scored both marks. Some candidates drew a line from the maximum on their graph to the temperature axis to show that they knew the maximum needed to lie between 30 and 40°C. This often made it clearer that the mark for correct positioning of the maximum should be awarded.

Question 7

(a) Candidates generally did well with this question and many scored all three marks. The middle condition caused the most difficulty with many candidates suggesting ‘on, on, off’.

(b) (i) The majority of candidates recognised that the diagram represented a transformer. Generator and motor were the most common mistakes.

(ii) Candidates were not always able to give an accurate version of the formula relating primary and secondary turns and voltages. Some gave a formula of the correct general form but used non-standard symbols. In some cases, the working did not lead to the numerical answer which the candidates wrote on the answer line. This sometimes denied candidates marks even if their numerical answer happened to coincide with the expected answer, **230 V**.

(c) It was clear that nearly every candidate found this question to be the most challenging one on the paper. Many candidates were distracted into describing the working of a motor; many gave answers which contained points relevant to both motors and generators and, of those who limited their suggestions to the working of a generator, most were not able to describe the principles clearly. In order to answer this question successfully, candidates needed to explain first that, when the arms of the coil cut magnetic field lines, a voltage/current is induced in the coil. They then needed to account for the alternating nature of the induced current by describing how the relative direction of the arms of the coil with respect to the magnetic field reverses every half turn. Finally they needed to state that the slip rings allow alternating current to be collected.

Question 8

(a) Many candidates correctly stated that light was the energy source needed in photosynthesis. A second mark was available for candidates who stated that this energy allowed carbon dioxide to combine with water. Some stated that the light was used to produce glucose and oxygen, but this was not accepted as an alternative.

(b) One mark was available here for showing that the leaf would have a band across it which corresponded to the position of the black paper mask. The second mark was for correct labelling of the exposed (blue/black) and masked (brown) sections. The colours of the iodine test for starch were often ignored and the sections of leaf were labelled white and green.

(c) Answers to this question revealed that the majority of candidates did not appreciate that plant respiration is going on all the time. Most of those attempting the question seemed to think that plants do not respire during daylight because that is when they are photosynthesising. Candidates needed to realise that the net gas exchange results from the dominance of photosynthesis in daylight. Marks were available, however, for descriptions of the gaseous exchanges which occur during photosynthesis and respiration, and this was the main way that marks were scored.

Question 9

(a) (i) Most candidates correctly gave hydrogen, although a significant minority suggested carbon dioxide.

(ii) Although many candidates correctly gave H^+, a variety of other suggestions were seen. Common incorrect ideas were H^-, OH^- and H_2^+.

(b) (i) It is stated in the question that the same apparatus was used in all of the experiments. Thus if candidates suggested, for example, that the test-tube must be kept the same, they did not score the mark. Candidates needed to refer clearly to the acid concentration, and answers such as 'amount of water' or the 'amount of acid' were not accepted. Many candidates correctly stated 'temperature' but 'heat of the acid' could not be accepted.

(ii) A key phrase in the question is 'Explain how the results show...'. Candidates needed to explain that the time taken for gas to fill the test-tube was the greatest for metal **X**. General answers such as 'the reaction for **X** took the longest time' did not score the mark.

(iii) Many excellent answers to this question were seen, and large numbers of candidates had learned very well the relationship between surface area, degree of solid division and the affect on reaction rate. The best answers also correctly referred specifically to the increased frequency of successful collisions.

(c) Many fully correct balanced equations were seen, and also many examples where the only mistake was to write 2H instead of H_2. In this case, one mark was allowed. Even though some of the formulae were given in the question, several candidates changed them in an attempt to balance the equation. Candidates should realise that any formulae given in questions like this will be correct and should not be changed.

COMBINED SCIENCE

Paper 0653/32

Extended Theory

General comments

The majority of candidates showed that they had learned and understood most of the subject matter and also that they had prepared very well for the examination. Only a relatively small proportion of the candidates scored a fifth or less of the available marks. These candidates may have been more suited for entry to the Core Paper 2. When given the choice of including diagrams to help explain their answers, many candidates very wisely chose to do so, and extra marks were gained by doing this. Some candidates showed that they probably had a satisfactory grasp of the subject matter, but then lost marks through inattention to detail. In particular, it is most important that candidates:

- include physical units where appropriate in numerical answers,
- take care in writing chemical symbols and formulae properly,
- avoid general, unscientific answers in favour of answers which demonstrate that they have learned the science which is relevant to the question.

Compared to some previous examinations, there was less evidence of candidates wasting time by re-writing sections of the questions. Colleagues should continue to advise candidates to look carefully at the mark allocation for each question and to adjust the quantity of writing accordingly. Written answers should easily fit onto the answer lines provided for each question.

Comments on specific questions

Question 1

(a) The majority of candidates correctly expressed the idea that the number of chromosomes in a cell after fertilisation would be 46. Incorrect answers suggested that the only reason for fertilisation was to introduce variation, and did not make any reference to numbers of chromosomes.

(b) (i) Most candidates answered this correctly, naming the ovary.

(ii) Most candidates correctly suggested either oviduct or Fallopian tube. Some common errors were to name the uterus or the vagina.

(c) Most candidates had learned the function of the amnion in protecting or supporting the embryo. The production or containing of the amniotic fluid was a point that many candidates could have included to gain the second marking point.

(d) (i) Candidates generally answered this well and appreciated the necessity for only one dominant allele, T, to show the unaffected phenotype. Correct reasoning as to which allele was dominant referred to the behaviour of the alleles, rather than to the capitalisation of the letter representing an allele in a diagram.

(ii) The construction of the genetic diagram was done very well by most candidates. Candidates from across the ability range did not realise that they needed to indicate which genotype would be found in a child with the disease. Consequently, most candidates scored three out of the available four marks here.

(iii) Most candidates scored at least one mark for indicating that haemoglobin transports oxygen. The second mark was not so often awarded, and needed candidates to relate the reduced oxygen-carrying ability of the blood with a reduced rate of respiration in cells. They could also have shown that they knew that respiration releases energy, although any suggestion that energy is produced or created did not score a mark.

Question 2

(a) (i) Most candidates scored this mark. The question required candidates to recall an observation and did not require an explanation in terms of particles. Those candidates who gained fewer marks often did not address the question correctly, writing about what they thought was happening to the ions, for example: 'the copper ions were moving to the cathode' or 'copper atoms were seen'.

(ii) Most candidates were able to state the 2+ charge on the copper ion. More candidates would have obtained the second mark if they had explained clearly the need for charge balance in ionic compounds.

(iii) Most candidates found it difficult to score both of the available marks. Having shown that they could explain that particle **L** would be negatively charged they then needed to explain movement to the anode in terms of the attraction between opposite electrical charges. Candidates who suggested particle **M** were still able to score a mark if they gave attraction between opposite charges as part of their explanation.

(iv) This familiar example of a dot and cross covalent molecule presented few problems to most candidates. There was no particularly common incorrect response.

(b) (i) Candidates generally interpreted the information in the question accurately and gave the correct response, carbon dioxide. There was no particularly common incorrect response.

(ii) The construction of this balanced equation was done accurately by many candidates. A version in which carbon monoxide was produced was allowed as an alternative. In questions like this one, candidates should always assume that the formulae provided in the question are correct and should not alter any formulae in an attempt to balance the equation.

Question 3

Candidates had learned radioactivity rather better than in some previous examinations and generally did well with this question.

(a) (i) Most candidates scored at least two marks for their answers to this question and many scored full marks. The least well-known part was the description of an alpha particle. Any reasonable indication that the ionising ability of beta particles is less than alpha but greater than gamma was accepted.

(ii) Candidates needed to discuss the low penetration of alpha particles, or give one of any of a number of consequences of the low penetration in order to gain the mark. Most candidates were able to do this.

(b) A variety of ways of arriving at the correct value for the half-life were seen and all gained credit. In questions like this, the mark for working can be gained either by writing mathematical expressions or by suitable annotation on the graph. Some candidates lost the mark for the correct numerical answer because they omitted the unit or gave an incorrect time unit. The required answer was **5 hours**.

Question 4

(a) This section of the syllabus had clearly been learned very well, and the wide variety of possible correct responses ensured that most candidates gained one or both marks. Some candidates gave answers which were a little too vague. Examples of vague answers are the two-word phrases 'dig ditches' or 'build walls'. Ditches or walls on their own would not prevent soil erosion; the direction of the ditches and walls relative to the land slope is a key detail. Candidates should be advised to include relevant detail in explanations where brief answers may be ambiguous

(b) (i) This question proved to be fairly challenging for candidates across the ability range. In discussing advantages of pesticides over biological control, candidates could have referred to the relative efficiency of pesticides in killing pests, and the avoidance of introducing a potentially damaging new organism. In discussing disadvantages candidates could have referred to the non-selective nature of pesticides, their toxicity to humans, the need for re-application and the risk of pests developing resistance. There was a tendency for candidates to suggest that pesticides would kill the crop, or even, all the animals in the ecosystem.

(ii) It was clear that the concept of a systemic pesticide was only partially understood by many candidates and was completely unfamiliar to a significant minority. Candidates needed to make the points that a systemic pesticide is absorbed and transported to all parts of the plant. This gives the systemic pesticide the advantage that it is far more selective in killing pests and does not have to contact the pests in order to kill them. Several candidates suggested that systemic pesticides would have to be individually injected into plants, and others interpreted systemic as relating to a computer controlled system.

Question 5

(a) (i) Candidates generally answered this question very well, most of them correctly identifying **K** and **L**.

(ii) Candidates generally answered this question very well. A few suggested that **K** and **L** would become dimmer. The implication that these lamps would still be switched on to some degree meant that the mark could not be awarded.

(b) This was well answered, showing that candidates generally had a good understanding of parallel circuits and could apply their knowledge to solve this problem. In order to gain full marks candidates needed to specify that two 12 Ω resistors must be connected in parallel and then include the calculation to show that the resultant resistance would be 6 Ω.

(c) The principles of operation of the a.c. generator proved to be a very challenging part of the Physics section of the syllabus. Candidates tended to confuse the working of generators and electric motors. In part **(i)** candidates needed to state that the induced voltage arises when the coil cuts or moves relative to the magnetic field lines. Even when candidates had scored the mark in **(i)**, they were rarely able to explain the reason for the alternating voltage in **(ii)**. They needed to state that the direction in which the arms of the coil cut the magnetic field is reversed as the coil rotates.

Question 6

(a) The ionic equation for neutralisation of an acid with an alkali had been learned very well by most candidates. Some candidates attempted a specific equation and some gave a word equation.

(b) Most candidates gained a mark for stating that alkali should be added to the acid until a colour change was observed. The details of the colour change for litmus seemed to be unfamiliar, candidates usually suggesting that the neutral colour would be green.

(c) Most candidates scored one mark here for a discussion of heating and evaporation to obtain solid salt. Very few could suggest how colourless crystals could be produced. Marks were available for describing how the volumes of acid and alkali required to produce the neutral solution found in **(i)** could be used. The alternative of using a pH meter to find the neutral point was also allowed. A small number of ingenious suggestions as to how to solve the problem were seen from able candidates who applied practical processes with which they were familiar. Even if these processes might not be completely effective in practice, the marks were awarded.

Question 7

(a) (i) The context of this question about heat transfer may have distracted many candidates into suggesting unscientific responses. Typical of this type of response are phrases such as 'it acts like a blanket' and 'it keeps out the cold'. Candidates could have stated that fur acts as an insulator by trapping a layer of air. They could also have discussed that the air layer is a poor heat conductor and that the fur traps the air, to prevent convection losses.

(ii) In answer to this question, candidates needed to refer to the reduced losses through radiation when the radiating surface is white, in comparison with black, reducing the overall heat loss from the bear's body. Candidates should be reminded that questions about heat transfer must always be answered in terms of the flow of heat and that they should avoid scientifically incorrect statements such as 'white reflects the cold better'.

(b) (i) Success in this question relied on candidates being able to recall the accepted normal range of audible frequencies in humans. The lower limit is taken to be 20 Hz. Candidates needed to state 'below 20', or give a sensible numerical answer below 20.

(ii) This was generally well known. A fairly common error was to omit time from the explanation. For example, some candidates gave phrases such as 'it is the number of waves passing a point'.

(iii) Candidates were generally able to gain both marks here. One mark was for ensuring that the amplitude was the same and the second was for any waveform which had a longer wavelength.

(c) (i) Candidates generally were not very successful in identifying the focal length of the lens from the ray diagram. A common incorrect answer was 0.8 cm. The unit was frequently omitted from the correct answer, 1.6 cm, and consequently the mark was not awarded.

(ii) This question proved to be challenging for candidates across the ability range. Many candidates seemed to be unfamiliar with ray diagrams of this type and some misinterpreted the question, thinking that all they had to do was draw in the eye of the observer with no attempt to project the refracted rays. There were several examples of the enlarged image appearing where the eye of the observer would be.

(iii) The definition of virtual image had been learned by a majority of candidates. One commonly given incorrect answer was that a virtual image is 'an image that cannot be seen by the human eye'.

Question 8

(a) Candidates could usually draw a correct displayed formula for ethene. The most common error was the omission of the double bond. Any structure in which the carbon atoms were not joined or which did not show two hydrogen atoms bonded to each carbon was not credited.

(b) The candidates who scored three marks here correctly identified cracking and described how hot hydrocarbon vapour is passed over a catalyst. A fair number of candidates described fractional distillation despite the fact that the question clearly indicated that the fractions from which the unsaturated hydrocarbons are made had themselves been obtained by fractional distillation previously. A number of candidates gave answers which contained aspects of both cracking and fractional distillation.

(c) This was well answered and large numbers of candidates very wisely drew clear, accurate displayed formulae showing how ethene molecules polymerise. Many candidates picked up full marks from their diagrams alone. The most common mistake in diagrammatic answers was the failure to indicate clearly that long chain molecules are formed.

(d) The calculation of the relative formula mass of ethene presented few problems. The marks are for identifying the relative atomic masses and then showing the stoichiometry. The most common mistake, made by a relatively few candidates, was to use atomic numbers rather than relative atomic masses. Candidates should be reminded that the relative formula mass has no units. The required answer was **28**.

Question 9

(a) In general, candidates were familiar with the context of this question and had learned how to explain the observations very well. Careful wording was needed in order to gain full marks but most candidates could describe transpiration and the subsequent cooling and condensation of the water vapour released. Candidates needed to be very careful that they wrote about the release of water vapour and that the water vapour cools and then condenses to liquid water.

(b) (i) Most candidates had learned the structure of plant and animal cells very well and gained full marks on this question. It did not matter if they labelled either the cell wall, the vacuole or the chloroplast on the right hand diagram but they needed to be very precise in drawing their labelling line for the cell wall so that it did not touch the cell membrane, but did actually touch the cell wall. Cell wall labelling lines which stopped short of the cell diagram did not gain the mark.

(ii) This question was very well answered, showing that candidates had learned how to answer questions involving osmosis. There were several ways that candidates could score marks. They could state that water had moved out of the cell down a water potential gradient or from a dilute solution to a concentrated solution. Candidates needed to be very careful, when discussing osmosis in terms of concentration gradients, that it was made it very clear whether they were referring to the concentration of water molecules or the concentration of a solute. They could then state that water leaves through a partially permeable membrane causing the contents of the cell to shrink. They could also have stated that the cell wall does not change shape and so the membrane detaches from it.

COMBINED SCIENCE

Paper 0653/33
Extended Theory

General comments

The majority of candidates showed that they had learned and understood most of the subject matter and also that they had prepared very well for the examination. Only a relatively small proportion of the candidates scored a fifth or less of the available marks. These candidates may have been more suited for entry to the Core Paper 2. When given the choice of including diagrams to help explain their answers, many candidates very wisely chose to do so, and extra marks were gained by doing this. Some candidates showed that they probably had a satisfactory grasp of the subject matter, but then lost marks through inattention to detail. In particular, it is most important that candidates:

- include physical units where appropriate in numerical answers,
- take care in writing chemical symbols and formulae properly,
- avoid general, unscientific answers in favour of answers which demonstrate that they have learned the science which is relevant to the question.

Compared to some previous examinations, there was less evidence of candidates wasting time by re-writing sections of the questions. Colleagues should continue to advise candidates to look carefully at the mark allocation for each question and to adjust the quantity of writing accordingly. Written answers should easily fit onto the answer lines provided for each question.

Comments on specific questions

Question 1

(a) The majority of candidates correctly expressed the idea that the number of chromosomes in a cell after fertilisation would be 46. Incorrect answers suggested that the only reason for fertilisation was to introduce variation, and did not make any reference to numbers of chromosomes.

(b) (i) Most candidates answered this correctly, naming the ovary.

(ii) Most candidates correctly suggested either oviduct or Fallopian tube. Some common errors were to name the uterus or the vagina.

(c) Most candidates had learned the function of the amnion in protecting or supporting the embryo. The production or containing of the amniotic fluid was a point that many candidates could have included to gain the second marking point.

(d) (i) Candidates generally answered this well and appreciated the necessity for only one dominant allele, T, to show the unaffected phenotype. Correct reasoning as to which allele was dominant referred to the behaviour of the alleles, rather than to the capitalisation of the letter representing an allele in a diagram.

(ii) The construction of the genetic diagram was done very well by most candidates. Candidates from across the ability range did not realise that they needed to indicate which genotype would be found in a child with the disease. Consequently, most candidates scored three out of the available four marks here.

(iii) Most candidates scored at least one mark for indicating that haemoglobin transports oxygen. The second mark was not so often awarded, and needed candidates to relate the reduced oxygen-carrying ability of the blood with a reduced rate of respiration in cells. They could also have shown that they knew that respiration releases energy, although any suggestion that energy is produced or created did not score a mark.

Question 2

(a) (i) Most candidates scored this mark. The question required candidates to recall an observation and did not require an explanation in terms of particles. Those candidates who gained fewer marks often did not address the question correctly, writing about what they thought was happening to the ions, for example: 'the copper ions were moving to the cathode' or 'copper atoms were seen'.

(ii) Most candidates were able to state the 2+ charge on the copper ion. More candidates would have obtained the second mark if they had explained clearly the need for charge balance in ionic compounds.

(iii) Most candidates found it difficult to score both of the available marks. Having shown that they could explain that particle **L** would be negatively charged they then needed to explain movement to the anode in terms of the attraction between opposite electrical charges. Candidates who suggested particle **M** were still able to score a mark if they gave attraction between opposite charges as part of their explanation.

(iv) This familiar example of a dot and cross covalent molecule presented few problems to most candidates. There was no particularly common incorrect response.

(b) (i) Candidates generally interpreted the information in the question accurately and gave the correct response, carbon dioxide. There was no particularly common incorrect response.

(ii) The construction of this balanced equation was done accurately by many candidates. A version in which carbon monoxide was produced was allowed as an alternative. In questions like this one, candidates should always assume that the formulae provided in the question are correct and should not alter any formulae in an attempt to balance the equation.

Question 3

Candidates had learned radioactivity rather better than in some previous examinations and generally did well with this question.

(a) (i) Most candidates scored at least two marks for their answers to this question and many scored full marks. The least well-known part was the description of an alpha particle. Any reasonable indication that the ionising ability of beta particles is less than alpha but greater than gamma was accepted.

(ii) Candidates needed to discuss the low penetration of alpha particles, or give one of any of a number of consequences of the low penetration in order to gain the mark. Most candidates were able to do this.

(b) A variety of ways of arriving at the correct value for the half-life were seen and all gained credit. In questions like this, the mark for working can be gained either by writing mathematical expressions or by suitable annotation on the graph. Some candidates lost the mark for the correct numerical answer because they omitted the unit or gave an incorrect time unit. The required answer was **5 hours**.

Question 4

(a) This section of the syllabus had clearly been learned very well, and the wide variety of possible correct responses ensured that most candidates gained one or both marks. Some candidates gave answers which were a little too vague. Examples of vague answers are the two-word phrases 'dig ditches' or 'build walls'. Ditches or walls on their own would not prevent soil erosion; the direction of the ditches and walls relative to the land slope is a key detail. Candidates should be advised to include relevant detail in explanations where brief answers may be ambiguous

(b) (i) This question proved to be fairly challenging for candidates across the ability range. In discussing advantages of pesticides over biological control, candidates could have referred to the relative efficiency of pesticides in killing pests, and the avoidance of introducing a potentially damaging new organism. In discussing disadvantages candidates could have referred to the non-selective nature of pesticides, their toxicity to humans, the need for re-application and the risk of pests developing resistance. There was a tendency for candidates to suggest that pesticides would kill the crop, or even, all the animals in the ecosystem.

(ii) It was clear that the concept of a systemic pesticide was only partially understood by many candidates and was completely unfamiliar to a significant minority. Candidates needed to make the points that a systemic pesticide is absorbed and transported to all parts of the plant. This gives the systemic pesticide the advantage that it is far more selective in killing pests and does not have to contact the pests in order to kill them. Several candidates suggested that systemic pesticides would have to be individually injected into plants, and others interpreted systemic as relating to a computer controlled system.

Question 5

(a) (i) Candidates generally answered this question very well, most of them correctly identifying **K** and **L**.

(ii) Candidates generally answered this question very well. A few suggested that **K** and **L** would become dimmer. The implication that these lamps would still be switched on to some degree meant that the mark could not be awarded.

(b) This was well answered, showing that candidates generally had a good understanding of parallel circuits and could apply their knowledge to solve this problem. In order to gain full marks candidates needed to specify that two 12 Ω resistors must be connected in parallel and then include the calculation to show that the resultant resistance would be 6 Ω.

(c) The principles of operation of the a.c. generator proved to be a very challenging part of the Physics section of the syllabus. Candidates tended to confuse the working of generators and electric motors. In part **(i)** candidates needed to state that the induced voltage arises when the coil cuts or moves relative to the magnetic field lines. Even when candidates had scored the mark in **(i)**, they were rarely able to explain the reason for the alternating voltage in **(ii)**. They needed to state that the direction in which the arms of the coil cut the magnetic field is reversed as the coil rotates.

Question 6

(a) The ionic equation for neutralisation of an acid with an alkali had been learned very well by most candidates. Some candidates attempted a specific equation and some gave a word equation.

(b) Most candidates gained a mark for stating that alkali should be added to the acid until a colour change was observed. The details of the colour change for litmus seemed to be unfamiliar, candidates usually suggesting that the neutral colour would be green.

(c) Most candidates scored one mark here for a discussion of heating and evaporation to obtain solid salt. Very few could suggest how colourless crystals could be produced. Marks were available for describing how the volumes of acid and alkali required to produce the neutral solution found in **(i)** could be used. The alternative of using a pH meter to find the neutral point was also allowed. A small number of ingenious suggestions as to how to solve the problem were seen from able candidates who applied practical processes with which they were familiar. Even if these processes might not be completely effective in practice, the marks were awarded.

Question 7

(a) (i) The context of this question about heat transfer may have distracted many candidates into suggesting unscientific responses. Typical of this type of response are phrases such as 'it acts like a blanket' and 'it keeps out the cold'. Candidates could have stated that fur acts as an insulator by trapping a layer of air. They could also have discussed that the air layer is a poor heat conductor and that the fur traps the air, to prevent convection losses.

(ii) In answer to this question, candidates needed to refer to the reduced losses through radiation when the radiating surface is white, in comparison with black, reducing the overall heat loss from the bear's body. Candidates should be reminded that questions about heat transfer must always be answered in terms of the flow of heat and that they should avoid scientifically incorrect statements such as 'white reflects the cold better'.

(b) (i) Success in this question relied on candidates being able to recall the accepted normal range of audible frequencies in humans. The lower limit is taken to be 20 Hz. Candidates needed to state 'below 20', or give a sensible numerical answer below 20.

(ii) This was generally well known. A fairly common error was to omit time from the explanation. For example, some candidates gave phrases such as 'it is the number of waves passing a point'.

(iii) Candidates were generally able to gain both marks here. One mark was for ensuring that the amplitude was the same and the second was for any waveform which had a longer wavelength.

(c) (i) Candidates generally were not very successful in identifying the focal length of the lens from the ray diagram. A common incorrect answer was 0.8 cm. The unit was frequently omitted from the correct answer, 1.6 cm, and consequently the mark was not awarded.

(ii) This question proved to be challenging for candidates across the ability range. Many candidates seemed to be unfamiliar with ray diagrams of this type and some misinterpreted the question, thinking that all they had to do was draw in the eye of the observer with no attempt to project the refracted rays. There were several examples of the enlarged image appearing where the eye of the observer would be.

(iii) The definition of virtual image had been learned by a majority of candidates. One commonly given incorrect answer was that a virtual image is 'an image that cannot be seen by the human eye'.

Question 8

(a) Candidates could usually draw a correct displayed formula for ethene. The most common error was the omission of the double bond. Any structure in which the carbon atoms were not joined or which did not show two hydrogen atoms bonded to each carbon was not credited.

(b) The candidates who scored three marks here correctly identified cracking and described how hot hydrocarbon vapour is passed over a catalyst. A fair number of candidates described fractional distillation despite the fact that the question clearly indicated that the fractions from which the unsaturated hydrocarbons are made had themselves been obtained by fractional distillation previously. A number of candidates gave answers which contained aspects of both cracking and fractional distillation.

(c) This was well answered and large numbers of candidates very wisely drew clear, accurate displayed formulae showing how ethene molecules polymerise. Many candidates picked up full marks from their diagrams alone. The most common mistake in diagrammatic answers was the failure to indicate clearly that long chain molecules are formed.

(d) The calculation of the relative formula mass of ethene presented few problems. The marks are for identifying the relative atomic masses and then showing the stoichiometry. The most common mistake, made by a relatively few candidates, was to use atomic numbers rather than relative atomic masses. Candidates should be reminded that the relative formula mass has no units. The required answer was **28**.

Question 9

(a) In general, candidates were familiar with the context of this question and had learned how to explain the observations very well. Careful wording was needed in order to gain full marks but most candidates could describe transpiration and the subsequent cooling and condensation of the water vapour released. Candidates needed to be very careful that they wrote about the release of water vapour and that the water vapour cools and then condenses to liquid water.

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(ii) This question was very well answered, showing that candidates had learned how to answer questions involving osmosis. There were several ways that candidates could score marks. They could state that water had moved out of the cell down a water potential gradient or from a dilute solution to a concentrated solution. Candidates needed to be very careful, when discussing osmosis in terms of concentration gradients, that it was made it very clear whether they were referring to the concentration of water molecules or the concentration of a solute. They could then state that water leaves through a partially permeable membrane causing the contents of the cell to shrink. They could also have stated that the cell wall does not change shape and so the membrane detaches from it.

COMBINED SCIENCE

Paper 0653/51

Practical Test

General Comments:

The overall standard of answers was good and similar to previous years. No question appeared to be unduly difficult and all parts of the questions were answered by most candidates. The work of supervisors in preparing the examination is appreciated, as is the completion of the question paper with a set of results. The latter is most important and should always be as full and complete as possible. The majority of candidates were able to complete the experiments within the time allocated.

Comments on Specific Questions:

Question 1

This question was usually well answered with the majority of observations correct. The action of biuret solution produced a blue colour with **A**, **B** and **D** and a purple colour with **C** and **E**. A variation on the colour purple was acceptable so long as it showed a clear difference from the unreacted solutions. The majority of candidates were able to correctly deduce which solutions contained protein. A similar comment applies to the iodine test and Benedict's test. A small number either did not record the observations with Benedict's or did not obtain the correct observation. Credit for **(c) (ii)** could not be awarded in such cases. Answers to part **(d)** were usually good enough to suggest candidates understood what to do and were able to score one of the two marks. A complete answer would have included the fact that amylase produces a positive result.

Question 2

Clearly no two lamps are identical and appropriate allowance was made. For example, when measuring the current with two lamps in series, the figure did not have to be exactly half that for one lamp. The recorded figures for current and potential difference needed to be realistic. Some candidates placed the decimal point in the wrong place or misread the meter thereby recording a current in excess of 1 amp. A small number transposed their readings of current and potential difference. Two marks were awarded in part **(c)** to those candidates who performed a good experiment, producing results that supported the statement taking into account experimental error. Candidates who decided that the statement was incorrect only scored one mark. Part **(d)** was marked in a similar manner to parts **(a)** and **(b)** in respect to the comparison of the current when two lamps were in use. Many candidates needed to demonstrate a greater familiarity with the unit for power. As in the earlier part, two marks were only awarded to those who were able to produce results that supported the statement. Again an allowance was made for experimental error.

Question 3

Candidates needed to heed the instruction to heat strongly. The given compound needed to be heated for several minutes to completely decompose. The majority of candidates produced a white solid indicating the loss of water but not completing the break down to the red brown solid. Part **(b)** was correctly answered by most candidates as was part **(c)**. Candidates need to know the meaning of the word precipitate and to use it to avoid answers such as 'milky' or 'cloudy'. Answers to part **(d)** were very good and it was particularly pleasing to see that most were able to report ammonium rather than ammonia as an ion.

COMBINED SCIENCE

Paper 0653/52

Practical Test

General Comments:

Candidates had opportunity to show their practical ability as all three questions were readily accessible. The overall standard of achievement was very satisfactory. There were a few very high scores. Supervisors played their part in preparing the examination and providing a set of results. Supervisor's results are very important, enabling the Examiners to have before them a reliable set of results against which candidates responses can be compared.

Specific Comments:

Question 1

There were some surprising results for the mass of protein as weighed by the candidate. The instructions required candidates to be given about 40 g of protein material which had to be cut into four roughly equal amounts. This would mean that each weighed mass should have been of the order of 10 g; candidates were not expected to record their weights to the nearest gram, and it was not expected that the masses should be all equal to each other. A mark was given for masses in the range 5 g to 15 g. The question required the type of juice to be recorded which meant the name and not just a number. Tables were generally well constructed; candidates need to remember to include appropriate units in their table headings. Candidates need to take careful heed of experimental instruction; many of the masses appeared to gain in weight after the second measurement and this may have resulted from excess liquid left on the mass if the candidates ignored the instruction to 'blot the protein dry'. Part **(c)** simply required a candidate to realise that the greatest protease activity would correspond to the fruit juice in which the protein piece losing the greatest mass was submerged. Providing the results showed a loss in mass most candidates were able to relate this to the appropriate fruit juice.

Question 2

Candidates do need to be reminded that when measuring a quantity the unit is important and in answering a question they should ensure the recorded unit corresponds to that given in the question paper. A significant number recorded $\mathbf{d}_1$ in centimetres. Otherwise part **(a)** was answered well. Part **(b)** was generally well answered with few silly readings. None appeared deterred by having an angle that could not be read directly from the table. Plotting points on the graph was excellent and many realised that the origin (0,0) was a point to be plotted. The commonest acceptable answer for part **(ii)** was a reference to the difficulty in producing a clear image in part **(a)**.

Question 3

Part **(a)** was well answered and only a few candidates were unable to link the effervescence with the presence of an acid. Many missed the significance of the silver nitrate test. Candidates need to be reminded that questions of this type cannot be 'hedged'; there is either a white precipitate or not, indicating the presence or absence of a chloride. There is no halfway answer to this kind of question. Many candidates successfully identified the solutions, gaining credit.

COMBINED SCIENCE

Paper 0653/61

Alternative to Practical

General comments

Questions 2 and **3** are based on the corresponding experiments in the Practical examination, paper 51, so this paper is also firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated a good practical knowledge. Others showed a weaker appreciation of the principles and practice of science, especially in the chemistry **Questions 3** and **5**.

Comments on specific questions

Question 1

The effect of light on the mass of seedlings is explored in this question.

(a) Batches of ten seeds are placed in different lighting conditions and their mass measured over a number of days. Candidates had to read the scale on two balance readings, which most were able to do.

(b) Candidates then had to calculate the average mass of a single seed by dividing by ten; again this was achieved by most candidates.

(c) The graph of average mass of seeds against time had to be drawn. Many candidates plotted the points correctly but less success was achieved in drawing the curves. Candidates need to appreciate the importance of drawing lines of best fit that are also smooth. Duplicate lines or a series of lines connecting the points will not gain credit.

(d) The seedlings left in the dark increased in mass, as did the ones left in the light. Candidates were expected to realise that as water was provided, this was taken up by the seedlings as they germinated. When left for a few weeks, however, the seedlings would die as they would be unable to carry out photosynthesis.

Question 2

In this question, candidates are comparing the power used by one lamp with that used by two similar lamps in series and in parallel.

(a) The applied voltages, around 1.5 V, must be accurately read from the voltmeter dials and then multiplied by the current to give the power in Watts. Some candidates did not know that the unit of power is the Watt.

(b) A circuit must be completed showing two lamps in parallel. Then the ammeter dial is read to find the current and the power output found as before. Most candidates gained credit for this section.

(c) A comment is needed on two statements: two lamps in series use only half the power of a single lamp, and two lamps in parallel use twice the power of the single lamp. Candidates are expected to state that when the data obtained from parts **(a)** and **(b)** are compared, these statements are true. The slight discrepancies can be explained by the slightly varying applied voltages, due to internal resistance of the cells used. Some candidates gave acceptable answers.

(d) What other piece of apparatus must be used, in order to find the total energy used by the lamps in a circuit? The best answers suggested a timer of some sort.

Question 3

In the practical examination, compound **X**, a light green crystalline solid, was analysed. The same tests are used in this question. Candidates must complete the descriptions of the test, results and conclusions. The Examiners expect candidates to be able to recall the standard tests for cations and anions and to deduce the composition of a mixture of ions using these logical steps.

(a) Only one strong-smelling gas, ammonia, is liberated when sodium hydroxide reacts with a salt. Thus ammonium ions must be present.

(b) A green hydroxide precipitate that turns brown in air should always indicate to candidates that iron(II) ions are present, which are oxidised to iron(III) in the air.

(c) This was based on the standard test for a sulfate.

(d) A chloride is detected by the use of silver or lead nitrate in the presence of nitric acid.

Some candidates who had experience of the use of these analytical tests scored well.

Question 4

The temperature of 50 g of cold water can be increased by passing in steam, an observation that forms the basis of this question.

(a) to **(d)** Diagrams of the thermometer scales and the balance windows before and after passing the steam enable candidates to find the increase in temperature, 21.6 °C, and in mass, 2.1 g, of the cold water. Most candidates scored well here.

(e) If steam at 100 °C becomes water at 100 °C, heat is liberated. Candidates had to describe this as condensation and then use their knowledge of the kinetic theory to explain why heat is given out. There were many confused answers, with some saying that this process is 'boiling'. Others said that collisions between molecules gave out energy.

(f) The condensed steam gives 2.1 g of water that is still at 100 °C, so when it cools down to the final temperature of the water, 44.8 °C, more heat is liberated. Few candidates suggested this source of heat; many said that heat was radiated from the Bunsen burner or the surroundings.

Question 5

Although this question was headed to be about the diseases kwashiorkor and diabetes, in effect it was examining simple food tests.

(a) Candidates were told which two of five solutions tested with biuret solution contained protein and they were asked to record the expected colours in a table. Many answers featured different colours for these tubes other than the expected: purple for positive and blue for negative.

(b) Similarly, candidates were told that one tube contained starch and they were expected to know the colour of iodine solution in the presence of starch (blue / black) and its absence (brown). As in **(a)** this proved challenging for many.

(c) This part stated that one of the two remaining solutions contained glucose and the question required a choice between the red and blue test results with Benedict's solution. Most candidates answered this well.

(d) It was suggested that one of the two protein solutions contained amylase. Candidates were told that amylase breaks down sugar to starch and they were asked to plan an experiment to find which of the two solutions contained this enzyme. Candidates should be aware that planning an experiment requires careful thought and correct detail. In the description they should avoid giving vague answers as full credit cannot be awarded.

Question 6

Study of the Periodic Table should include the properties of Groups of elements such as the halogens.

(a) Few candidates knew the colours of liquid bromine and solid iodine.

(b) More knew that chlorine bleaches litmus or turns it white.

(c) (i) Starch solution is turned blue or black by the displaced iodine. This was well answered by most candidates.

(ii) Few candidates gave a properly constructed equation for the reaction between chlorine and potassium iodide solution.

(d) Which hydrocarbon gas reacts with bromine, and why? Good candidates answered this well.

(e) Heated iodine crystals vapourise and then turn back to a solid. Better-prepared candidates knew the colour of the vapour and the name of the process.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

General comments

Questions 3, **4** and **5** are based on the corresponding experiments in the Practical examination, paper 52, so that this paper is also firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated a good practical knowledge. Others showed a weaker appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. There were a number of instances of candidates not attempting the questions.

Comments on specific questions

Question 1

Some fruit juices were being investigated in this question and the loss in protein mass used as a measure of the activity of the enzyme protease.

(a) Two balance windows showing the mass of two of the juices had to be read and recorded, and then the change in mass for each fruit had to be calculated. This was no problem for most candidates, although a few lost a mark for not recording 1.0 to one decimal place.

(b) Candidates then had to choose which of the four juices showed the greatest protease activity and explain why. Pineapple juice caused the greatest loss of protein mass, so this was the expected answer.

(c) It was suggested that as the orange and lemon juices are both acidic, it was the acid that caused the protein to lose mass rather than the enzyme. Candidates were asked to plan an experiment to find out if it was the acid rather than the protease that caused the loss. Correct answers described the acid alone being added to the protein and the change in mass measured after ten minutes as in the original experiment. Some candidates mentioned only fruit juice and enzyme and so gained no credit.

Question 2

In this question, samples of two elements were being tested in a variety of ways.

(a) Candidates were shown an incomplete electrical circuit, and asked to draw two different symbols to show that a current was flowing. Many candidates drew one correct symbol, usually a lamp, with some drawing two different symbols. Most realised that the current flowed due to the presence of a metallic element, and a few gave the name of a particular metal, usually iron.

(b) How can iron be separated from the mixture? Most candidates gave the expected answer of using a magnet.

(c) Most candidates were able to draw a simple diagram of the mixture being heated in a test-tube or crucible, but surprisingly a large number did not indicate adding water or an acid and so did not gain full credit. Only the most able candidates could state that the heating supplies the energy required and that the reaction was exothermic.

(d) A test to show that the compound produced is different from its elements was asked for. Any physical or chemical test was acceptable; the easiest and most common answer was to use a magnet.

Question 3

In the practical examination, candidates had to determine the refractive index of a semi-circular glass block; this was adapted here.

(a) Although the distances to be measured were indicated by arrows, a number of candidates were unable to measure the two lengths correctly or accurately. In **(a)(iii)** most scored the refractive index mark, since the relative lengths recorded in **(a)(i)** and **(ii)** were correct.

(b)(i)(ii) Two angles had to be measured and recorded in the table, and this proved difficult for some candidates who did not have access to a protractor. Although the values for sines were given in the table, they were frequently mis-read.

(iii) A graph then had to be drawn; three points were already given and candidates were asked to draw the best straight line. Those who attempted to plot points on the graph needed to realise that their values for sine r were wrong if they did not fit the straight line. Many lines were drawn which almost ignored the three points which had already been plotted. The gradient had to be calculated, and candidates were expected to show their x and y values on the graph to gain credit. A value of about 1.5 should have been found.

(c) Candidates had to suggest which one of the two methods would be the more accurate. Many left this blank. Answers were expected suggesting that it was difficult to see and measure the correct distances on the graph paper in method one or that using several values, as in method two, would be more accurate than just the one.

Question 4

In this experiment a potometer was being used to study transpiration.

(a) Candidates were shown diagrams of the air bubble in the capillary tube and told to measure distance from the top of the bubble. Despite this many measured from the bottom of the bubble and some tried to estimate a half way point. Then after calculating the distance moved by the bubble they had to divide by four to find the rate of water lost per minute.

(b) (c) Only a few candidates answered these two sections of the question, a number just repeated the values from **4(a)(ii)** without explaining their meaning. Some stated that the wind blew the water vapour away from the leaf while a few referred to the effect this would have on the leaf through increased evaporation.

The precautions taken were little understood. Most candidates suggested the reason why the stem should be kept under water was that it would lose water, while some stated it would go dry or the plant would die. Very few realised that the plant would continue to draw liquid up the stem and create an air bubble.

Few candidates suggested that the stomata would get flooded or blocked if the leaf got wet; those that answered thought the leaf would rot.

Question 5

In this question four solutions had to be identified. The names of the solutions were known, but not their order. Two tests were carried out on the samples and their identities discovered.

(a) Each of the samples was tested with sodium carbonate solution. The possible names were given and candidates were required to state the observations expected. Effervescence or bubbling was expected with the acids, and no change with the others.

(b) Test two was adding silver nitrate solution. This time the observation was given and candidates invited to name the possible solutions. Sodium chloride or hydrochloric acid gave white precipitates while no change occurred with nitric acid and potassium nitrate.

(c) Candidates were now expected to be able to name the four solutions. A number of those who attempted the question used made-up names such as hydrogen nitric or sulfur nitrate, suggesting a lack of both understanding and reading of the question.

(d) The test for nitrates was attempted by a few of the best candidates; fewer mentioned the flame test for potassium.

Candidates need to be able to demonstrate an understanding of chemical analysis.

Question 6

A question on electromagnetism.

(a) A simple question to start with: two numbers when multiplied together make 5. For this candidates needed to read the question more carefully.

(b) Two ammeter readings were required here; most scored a mark for 0.75, but candidates also needed to write 0.90 to two decimal places, in line with the other readings in the column.

(c) Most candidates explained that an increase in resistance would result in a reduced current. The best answers quoted Ohms law, referring to the inverse proportionality of current to resistance.

(d) Most candidates plotted their points correctly and most drew a straight line. Candidates should be discouraged from drawing two lines, one connecting one point to the next alongside the single line of best fit.

(e) When asked why the straight line drawn on the graph did not pass through the origin the majority suggested that a piece of card was left on the pan rather than that the pan itself had mass.

(f) Candidates were told that both soft iron and steel are magnetic materials and asked to suggest why soft iron was used in preference to steel. Most suggested that steel would be too heavy for the electromagnet to hold. A number thought it was something to do with steel or iron not being able to conduct electricity. The most able candidates referred to temporary and / or permanent magnetism.

(g) The final part asked candidates to explain why the copper wire was insulated. Some answers suggested there would be a risk of an electric shock; others mentioned that a short circuit would occur. Both responses were credit-worthy.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

General comments

Questions 1 and **3** are based on the corresponding experiments in the Practical examination, paper 53, so that this paper is also firmly associated with experience at the laboratory bench. Candidates from many Centres demonstrated a good practical knowledge. Others showed a weaker appreciation of the principles and practice of chemical analysis in **Question 2**.

Comments on specific questions

Question 1

Four test-tubes, with different coverings, were filled with hot water. As the water cooled temperatures were taken for five minutes.

(a) Two thermometers had to be read and the readings recorded in the table. Most candidates gained full credit.

(b) A second table required candidates to calculate the total temperature drop and the average temperature drop per minute. Again the vast majority of candidates gained full credit in this part.

(c) Suggestions were asked for why there was an initial large drop in temperature. The expected answer, that the heat was transferred to, or used to heat up, the cold tube, was not often seen.

Tube **D** was set up without any covering; candidates were asked the purpose of this tube. 'As a control' was all that was required, but credit was also given to many candidates who wrote two or three sentences about a reference or comparison.

(d) The absorbent paper wrapped around two of the test-tubes represents skin; one of them was soaked with water to represent sweat. Candidates were asked to compare the results of the two tubes and describe the benefits of sweating. Many candidates noted that the tube cooled down or there was heat loss. This was insufficient to gain credit as all the tubes cooled down. The Examiners were looking for explanations that the process happened more quickly if the paper was wet. The heat transfer process involved was evaporation, although conduction was also allowed.

Question 2

A mixture of chemicals had to be separated by simple physical means followed by standard chemical analysis techniques.

(a) A mixture of sand, iron filings and zinc sulfate powder had to be separated. A magnet will separate out the iron. Adding water dissolves the zinc sulfate and filtering will separate out the sand. A labelled diagram was required. Examiners expected to see, either in the diagram or in the labelling, a piece of filter paper inside the funnel. Candidates then had to describe how dry crystals of zinc sulfate could be obtained. Two processes were required: heating to evaporate some of the water, and then drying, e.g. by using a desiccator or filter paper.

(b) A straightforward analysis question then followed. Candidates need to be able to recall the sulfate test, where barium chloride gives a white precipitate, and the test for zinc ions, in which a white precipitate soluble in excess of sodium hydroxide is produced.

(c) It was stated that if lead sulfate was used instead of zinc sulfate the process would not work. The idea that the lead sulfate is insoluble was given by the better candidates.

Question 3

The relationship between potential difference, current and resistance of a wire was investigated in this question.

(a) Apparatus **X** changes the potential difference and current by altering the resistance in the circuit, therefore it is a rheostat or variable resistor.

(b) A table of voltmeter and ammeter readings needed completing by reading two dials. Most candidates had little problem here.

(c) A graph of the readings now had to be plotted. Candidates were told that the voltmeter readings should be on the vertical axis; a few ignored this instruction. However many candidates correctly plotted their points and drew acceptable lines of best fit. Incomplete or missing labelling the axes resulted in credit not being awarded. The mathematical relationship expected was 'proportional'; answers stating that as the current increased so did the potential difference gained no credit.

(d) The idea that something had gone wrong for the reading to suddenly fall to zero was looked for, and ideas that a wire had melted, the ammeter had broken or burned out were acceptable.

(e) Finally candidates were asked to suggest what would happen to the ammeter readings if an increased length of wire was used. Many incorrectly stated it would increase.

Question 4

This question used potato pieces and salt solutions of various concentrations to investigate osmosis.

(a) Potato pieces were placed in different concentrations of salt solution and left for thirty minutes. Their mass was recorded before and after and the candidate was required to calculate the change in mass.

(b) A grid was provided for candidates to plot the points, which was completed with very few errors.

(c) Candidates were required to read the value from the graph at the value equal to the concentration of salt solution that produced no change in mass, i.e. where the line crosses the x-axis. Most candidates scored well here.

(d) Candidates had to describe a source of error in the experiment, and how this could be improved. Answers should have considered that drying of the potato pieces might be inadequate before weighing or that the surface area exposed might be different in each sample. A number of candidates gave rather vague or too general answers to gain credit.

(e) Red blood cells were placed in distilled water. Candidates were then invited to suggest and explain what would happen. Although many answers stated that the cells would expand, few said they would burst. Candidates also omitted to link this test back to the potato experiment, where plant cells have a cell wall that prevents plant cells from bursting.

Question 5

The effect of concentration on the reaction between marble chips and hydrochloric acid was investigated in this question.

(a) Two times were missing from the table and the candidate had to read two stop clocks and transfer the times to the table. The readings were in minutes and seconds but had to be recorded in seconds. Most candidates scored well here.

(b) Some of the marble chip remaining in the test-tube would show that marble was in excess in the experiment.

(c) The reacting test-tubes were set up with graph paper behind them, the idea being that the effervescence makes the tube opaque. As the reaction is finishing the tube clears and the time can be taken. This is a rather inaccurate way of experimenting, hence part **(f).**

(d) The four points were plotted on a grid with scales and labels supplied. The points were chosen to be slightly off a perfect straight line, which is a more realistic situation, especially with the method given.

Most candidates drew a single straight line of best fit, as required by the question. A minority drew a second zigzag line joining up the points, and so gained no credit.

Candidates were then asked to read off from their graph a value corresponding to a reaction time of ten minutes. It was important here to convert the time to seconds before the correct answer could be found.

(e) Many candidates drew the line correctly, i.e. below that in **(d)**, to represent a set of results carried out at a higher temperature, which will shorten the reaction time. Some lines were wrongly drawn above the first line, and a few intersected it. Some candidates omitted this part.

(f) As already mentioned in **(c)** above, use of the graph paper would make the timings inaccurate. Comments such as 'human error' failed to score. More precise answers such as the varying surface areas of marble chips were credit-worthy.

Question 6

The subject of the last question on the paper was a rather unusual way of finding the density of an object. It was an adaptation of a question on the practical paper. The use of a toy dog was to avoid the confusion that might arise from using blocks of metal at both ends of the metre rule.

(a) Measurements had to be made and entered into tables. This was accurately done by most candidates. Some answers did not gain credit because the measurements were not written to one decimal place in line with the numbers already in the table. Candidates should be reminded to check significant figures in their answers.

(b) In this section the candidates were provided with a graph and asked to find the gradient. They were instructed to show on the graph how they did the working. This proved challenging to many. A few candidates showed the 'triangle' beneath the line and determined the gradient.

(c) The last part asked how the volume of a toy dog could be measured. As there are a number of ways this could be achieved many candidates gained credit. Some candidates confused mass with volume and so gained no credit. Others gave answers without referring to the use of a measuring cylinder to measure the volume of water. In general, candidates needed to be more specific in answering this question.