CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General comments: Biology

In the biology section of this paper, the majority of candidates successfully selected the correct responses.

Comments on Specific Questions

Question 1

A number of the candidates on reading the reference in the question to “breaking down nutrient molecules” assumed that the question was testing their knowledge of nutrition. On further reading they would have seen that the question referred then to the release of energy, making the answer “respiration”.

Question 3

A significant number of candidates incorrectly believed that the duodenum forms part of the large intestine.

Question 5

Candidates should ensure that they have basic knowledge of blood vessel structure; an appreciable number confused the artery with the vein.

Question 6

In this question the common error was of confusing the effect of humidity on the transpiration rate.

Question 8

This question was correctly answered by the vast majority of candidates.

Question 10

Candidates need to think carefully about the meaning of the word “target”, to prevent the erroneous suggestion that the target organ is responsible for the production of hormones.

Comments on Specific Questions: Chemistry

Question14

The great majority of the candidates gave the correct response. They demonstrated that they had no difficulties in reading an analogue scale.

Question 15

The great majority of the candidates gave the correct response. They understood the diagram of sub-atomic particles and, in particular, which particles were the electrons.

Question 19

Option D was a popular incorrect response. It is thought that candidates did not link the acidic property of carbon dioxide to the basic property of potassium hydroxide, and that these two would react by neutralisation and not, as many supposed, by redox.

Question 25

More candidates chose option A than those who chose the key, C. Many candidates thought that carbon monoxide, rather than an oxide of nitrogen, contributes to the formation of acid rain.

Comments on Specific Questions: Physics

Question 29

This question concerned the extension of a spring, and the most common error was to confuse spring length with extension and therefore opt for D.

Question 30

The main challenge for candidates in this question was uncertainty over the unit for power.

Question 35

This question on reflection of light proved challenging. The majority of candidates chose option A; it should be noted that the angle of reflection is always measured between the ray and the normal.

Question 38

The most common incorrect answer to this question was B; some candidates believed that a fuse reduces the current to its rated value.

Question 40

Candidates need to be clear about the properties of β-particles, many believed them to be electromagnetic waves.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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

General Comments: Biology

All the questions in the biology section of the paper were competently handled by a large proportion of the candidates.

Comments on Specific Questions

Question 2

A sizeable minority of candidates believed that oxygen moves down a carbon dioxide gradient by diffusion.

Question 3

A clearer understanding of the effect of temperature on enzymes was required by a few candidates who believed that low temperatures would denature enzymes.

Question 4

Several candidates believed that energy is not required in order to make a protein molecule.

Question 7

The most common error was in confusing the effect of humidity on the transpiration rate in this question.

Question 9

This question was correctly answered by the vast majority of candidates.

Question 13

Candidates are used to seeing the producer at the beginning of a food chain; they must ensure that they look at the question very carefully before answering. A sizeable minority of candidates suggested that the producer in the food chain illustrated would be the Sun.

Comments on Specific Questions: Chemistry

Question 16

A large majority of candidates answered this question correctly. They were easily able to select a formula using information about the numbers of atoms of each element in phosphoric acid.

Question 19

A large majority of candidates answered this question correctly; they knew the gases produced in the reactions of hydrochloric acid with magnesium and with calcium carbonate.

Question 24

A large majority of candidates answered this question correctly; they demonstrated that they understood what sort of mixture constitutes and alloy.

Comments on Specific Questions: Physics

Question 29

A number of candidates calculated the density by dividing the mass of the stone by the volume indicated in the right hand measuring cylinder, rather than by the difference in levels between the two cylinders.

Question 30

This question concerned energy transfer; candidates should note that the energy *before* climbing would not be kinetic.

Question 32

A number of candidates opted for B; it should be noted that the boiling point of the substance cannot be above 65 °C if it is a gas at 65 °C.

Question 35

Total internal reflection was the topic here. The ray in B was travelling in air towards glass, this was the most common incorrect response; candidates must look carefully at a question before choosing an answer.

Question 40

Candidates need to be clear about the properties of β-particles, many believed them to be electromagnetic waves.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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

Comments on Specific Questions: Biology

Question 1

The stronger candidates realised that breathing is not a characteristic of all organisms; however almost as many candidates suggested that plants do not show movement.

Question 3

A sizeable minority of candidates suggested that enzymes are used up in the reaction they catalyse, but this was not a response made by the stronger candidates. Candidates must ensure that they have secure knowledge of enzymes / catalysts.

Question 4

Care must be taken to read the question carefully and work out what was happening in the experiment before selecting an answer. Most candidates are familiar with the colour change of iodine solution in the starch test, but more opted for the reverse of the correct answer than for the likely result.

Question 5

Candidates must ensure that they do not confuse the gall bladder with the urinary bladder. A sizeable minority of them believe that the gall bladder is situated near the entrance to the urethra.

Question 10

The effector was by far the least chosen response. A very large minority of the candidates believed that that the spinal cord is a structure that carries impulses towards the central nervous system; they need to recognise that the spinal cord is part of the central nervous system

Question 12

Candidates need to ensure that they understand the process of asexual reproduction; a considerable proportion of candidates suggested that the process involves the fusion of nuclei – even after correctly realising that only one parent is involved.

Comments on Specific Questions: Chemistry

Question 15

Roughly equal numbers of candidates chose each option. They found relating the types of bonding in two compounds to their expected physical properties challenging.

Question 16

A large majority of candidates answered this question correctly; they showed that they could easily understand and interpret displayed formulae.

Question 18

A large majority of candidates answered this question correctly; they showed a good understanding of the factors that affect the rate of a reaction.

Question 20

The stronger candidates knew the chemical test for nitrate ions. However, they also need to ensure that they know the positive result in the test for these ions.

Question 23

A large majority of candidates answered this question correctly, demonstrating that they could relate the uses and properties of aluminium well.

Question 24

Candidates found this question was challenging. Most chose key A, thinking that carbon monoxide is responsible for acid rain, rather than the oxide of nitrogen. Some of the stronger candidates, in choosing D, thought that water vapour contributes to acid rain.

Question 25

Candidates must ensure that they do not confuse the change in pH with the change in acidity when an acidic soil is treated with a base.

Question 27

Many candidates thought that ethanol is made by cracking, although the use of ethanol was well known.

Comments on Specific Questions: Physics

Question 28

In this question on average speed, candidates only had to divide the total distance by the total time. Weaker candidates found this challenging.

Question 29

Calculating density was straightforward for stronger candidates, but others divided the mass by the area of the base of the block, leading to option C.

Question 32

The stronger candidates nearly all chose correctly, while weaker ones often opted for A or B ; it should be noted that the boiling point of the substance cannot be above 65 °C if it is a gas at 65 °C.

Question 35

The topic of this question was the image formed by a plane mirror, a sizeable minority of candidates believed that the image was formed at position D, on the surface of the mirror.

Question 36

Candidates found this question challenging; they must ensure that they know the different magnetic properties of iron and steel.

Question 38

Candidates found this question about heating of wires in a circuit challenging. A minority of candidates gave the correct response. Even many strong candidates believed that using thicker insulation would reduce heating, showing that they had not realised that the source of the heating was the wire itself.

Question 40

Candidates need to be clear about the properties of β-particles; many believed them to be electromagnetic waves.

CO-ORDINATED SCIENCES

Paper 0654/21
Core Theory

Key Messages

A good standard of scientific knowledge and understanding was displayed by many of the candidates. Some candidates should be congratulated for their clear and accurate responses.

Some candidates were not able to gain full credit due to misinterpretation of the question. Candidates should take notice of command words such as *name*, *state, describe* and *explain* in deciding what response a question requires. This is particularly the case for questions asking candidates to *describe* or *explain* phenomena.

Calculations were frequently done well with working shown.

General Comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. There was a good range of credit gained on most questions. Candidates generally were awarded credit on all questions. Few gained no credit on any question but very few gained full credit on any question. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Some candidates only gained some of the credit available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum credit available.

Learning the definitions specified in the syllabus earns credit directly as well as being an aid to language used in explanations.

When drawing diagrams, candidates should be reminded to take care to draw clearly and to use the correct labels and labelling lines.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly, formulae consisting of a mixture of words, symbols and units should also be avoided.

Comments on Specific Questions

Question 1

(a) Many candidates suggested that wind energy was transformed into electrical energy.

(b) Many candidates identified that a black surface absorbs radiation. Some candidates incorrectly referred to light or the attraction of heat.

(c) Conduction was not well known. Many candidates incorrectly suggested convection.

(d) Few candidates gained full credit. A number of candidates included energy from the wind or Sun.

(e) This was quite well answered. Many candidates were able to explain that using solar energy depended on the Sun being out.

(f) Many candidates wrote infra-red in the correct box. A common error was to place it between X-rays and visible light. Some candidates completed the whole spectrum, whilst this was unnecessary it did not disadvantage the candidate.

(g) (i) and (ii) Candidates needed to draw their arrows carefully making sure that the arrow heads stopped at the correct place. A common error was show the amplitude going from a peak to a trough.

(h) Many candidates were able to use the information given in the question to describe the differences between the two sound waves.

Question 2

(a) (i) Some candidates completed this correctly. A number labelled the side view diagram.

(ii) A number of candidates were able to explain that the plant would be unable to pollinate other flowers. A few candidates incorrectly suggested that the plant would not be able to receive pollen.

(iii) Ovule was not well known. Ovary was a popular incorrect response.

(b) (i) The vast majority of candidates gave the correct temperature for the germination of the seeds. A common wrong answer was 45 °C.

(ii) Water and oxygen were commonly given as responses. Light was a common incorrect answer.

(iii) Many candidates correctly stated that the temperature was either too cold or too hot but did not explain why that was important. A reference to enzyme action was required.

(iv) Few candidates suggested why some seeds would not germinate. The commonest correct answers were that the seeds were dead or damaged.

Question 3

(a) (i) Many candidates correctly stated filtration as the process.

(ii) The vast majority of candidates were able to describe the risks to humans if microorganisms are not destroyed in the water.

(b) (i) Electrolysis was well known.

(ii) Many candidates knew the test for chlorine. The question asked for a safe test, therefore, smelling the gas was not accepted.

(iii) and (iv) Few candidates described the change in colour for the cathode in **(iii)** and fewer stated why there was a change in colour in **(iv)**. Many suggested that it was something to do with the chlorine.

(c) (i) Few candidates identified bromine as the orange substance. Bromide was not accepted as a correct response.

(ii) Few candidates explained that the orange substance was produced because chlorine was more reactive than bromine.

Question 4

(a) (i) Constant speed was the correct description of the motion. A number of candidates described it as either constant or constant motion.

(ii) Deceleration was the common correct response.

(iii) Almost all candidates used the graph correctly to determine the speed after 25 seconds.

(iv) Many candidates were able to find a point on the graph when the truck had stopped moving.

(v) Many candidates showed their data handling skills and carried out the calculation to determine the distance travelled between **C** and **D**.

(b) (i) Many candidates drew an arrow going in the opposite direction to the direction of motion to indicate the force acting to slow down the truck. However, few candidates labelled the arrow to describe the force acting.

(ii) A number of candidates knew that the kinetic energy lost was transformed into either heat or sound energy.

Question 5

(a) The processes in the carbon cycle were not well known. Decomposition was more commonly known for process **Y** than respiration was for process **X**.

(b) (i) Very few candidates gained full credit here, although many gained partial credit. Candidates seemed unclear about whether deforestation caused an increase or a decrease in carbon dioxide levels in the atmosphere.

(ii) Candidates needed to explain that the coal was burned or combusted in the power station to produce more carbon dioxide.

(c) (i) Some candidates identified the Sun as the source of the energy gained by the ecosystem.

(ii) Very few candidates stated that energy was lost from the ecosystem as heat.

Question 6

(a) (i) Many candidates identified the nucleus as the part of the atom that contains protons.

(ii) Many candidates stated one difference between an electron and a neutron. Common correct answers were that electrons have a negative charge and protons have a positive charge or that protons are heavier than electrons. Some candidates attempted to refer to **(i)** and state that the protons are found in the nucleus and that electrons are found in electron shells around the nucleus. This type of answer was accepted.

(b) (i) The meaning of the word exothermic was well known.

(ii) The stronger candidates gained full credit here and many gained partial credit. A common error was to state that the potassium atom gained an electron to become a negatively charged ion.

(c) (i) Candidates' responses suggested that some candidates did not really understand what the graph showed – for example *the more potassium chloride that dissolves, the higher the temperature rises.*

(ii) Most candidates were able to use information from the graph to determine the mass of potassium chloride that dissolved in 100 cm^3 of water at 70 °C.

(iii) Nitrogen and phosphorus were named by most candidates. A small number suggested potassium.

(iv) Although many candidates knew that water would dissolve minerals such as potassium chloride for uptake by plants, few candidates explained that this uptake was through the roots of plants.

Question 7

(a) Most candidates gained most of the available credit here. The only common error was to use copper to make a magnet.

(b) (i), (ii) and (iii) All three parts were generally well answered with no common errors.

(c) To gain the credit here, candidates needed to refer to both temperature and the change of state.

(d) The regular arrangement of the particles was the important point for candidates to mention here.

(e) The calculation of the density of iron was done well by many candidates. Many candidates were also able to state the correct units for density.

Question 8

(a) (i) The function of fat in the body was well known.

(ii) This part was well answered. The most common omissions were water and fibre.

(b) (i) The pancreas needed to be identified here.

(ii) Lipase was not well known as the enzyme.

(iii) The small intestine was needed to be identified here. Quite a few candidates suggested large intestine.

Question 9

(a) (i) Alloy, as the general term for a mixture of metals, was not well known. The common incorrect response was compound.

(ii) The idea that alloys are stronger or harder was well known.

(iii) Less than half the candidates stated transition metals. There was no common wrong answer.

(iv) The question was asking the candidates to compare a typical transition metal with a typical alkali metal. Candidates found this challenging. Few mentioned any of the typical properties of transition metals such as forms coloured compounds or can be used as catalysts.

(b) (i) Many candidates successfully wrote down the word equation. A small number attempted to write a balanced symbolic equation instead. Some attempted to write the equation partly in words and partly using formulae.

(ii) Very few candidates suggested iron oxide, but most of those did correctly explain why it had been reduced. All the other reactants and products in the reaction were common wrong answers.

(c) Few candidates were able to explain this and gain credit. Tube **A** contained dry air and a number of candidates suggested that tube **A** did not contain oxygen and so did not rust. The results for tube **B** were best explained with many candidates appreciating that there was no air or oxygen present. Few candidates were able to explain that the paint in tube **C** formed a barrier preventing both air and water from reacting with the steel nail.

Question 10

(a) (i) The angle of incidence was often correctly labelled.

(ii) Many candidates were able to state the correct angle of reflection.

(iii) Many candidates were awarded credit here for correctly identifying two properties of the image.

(b) (i) The ammeter was well known.

(ii) Many candidates were able to calculate the total resistance in the circuit as 20 Ω but few realised that they needed to deduct the value of the 12 Ω resistor.

(iii) The circuit symbol for a variable resistor was not well known.

Question 11

(a) (i) and (ii) Many candidates gained at least partial credit for identifying **FF** and **Ff** in **(i)** or **ff** in **(ii)**. Candidates needed to take care to avoid upper case and lower case letters being confused in the genotypes.

(b) (i) Many candidates gained some credit on this question. Few candidates gained full credit. Many candidates wrote the gametes in the spaces provided and then wrote different gametes in the Punnet square.

(ii) Most candidates found the explanation challenging and most tried to explain that long hair was dominant.

Question 12

(a) (i) Water, carbon monoxide and carbon were not well known as products of the combustion of alkanes or alkenes.

(ii) Gasoline (petrol) and diesel were well known as the liquid mixtures of alkanes used as fuels in cars. A few candidates suggested petroleum, which is crude oil and therefore incorrect.

(iii) Cracking was not well known as the process used to convert alkanes into alkenes

(b) (i) and (ii) The candidates needed to explain how they knew the identity of each gas from the information given. Many were confused between ethene and ethane in **(ii)**.

(c) (i) and (ii) Few candidates were able to describe what happened to ethene molecules when they formed a polymer in **(i)**. Poly(ethene) was not well known in **(ii)**.

(d) Bottle **M** (liquid paraffin / alkane) was the correct answer. Many candidates knew or had been told in the question that sodium reacted with substances in the air. Many went on to suggest that as there were oxygen atoms contained in water molecules that this was a problem. Few candidates referred to the reactivity of sodium with the water in bottle **N**. Few referred to the relative lack of reactivity of alkanes.

Question 13

(a) Palisade or mesophyll tissue was not well known.

(b) Xylem and/or phloem were well known.

(c) Some candidates knew that the stomata were the place where water loss occurred.

CO-ORDINATED SCIENCES

Paper 0654/22
Core Theory

Key messages

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Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. Candidates generally gained credit on all questions. Few gained no credit on any question but very few gained full credit on any question. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

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When drawing diagrams, candidates should be reminded to take care to draw clearly and to use the correct labels and labelling lines.

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Comments on specific questions

Question 1

(a) (i) Many candidates were able to correctly identify carbon dioxide as the gas released and state a suitable test for carbon dioxide. Hydrogen was a common wrong answer.

(ii) Most candidates were able to correctly identify magnesium chloride and hydrogen as the products of the reaction between magnesium and dilute hydrochloric acid. Some candidates gave the reactants in the reaction instead of the products.

(b) (i) The majority of candidates correctly identified reaction **B** or **C** and provided an explanation. A few candidates confused exothermic and endothermic and gave the incorrect reaction **D**.

(ii) Some candidates stated that there would be no reaction. Few gave any explanation in terms of copper being unreactive and so unable to displace hydrogen from dilute acid. A few described that there was no temperature change or that the reaction was very slow.

(c) Many candidates found this challenging. The difference between covalent and ionic bonding was not well known. Few candidates used the information given to predict the types of bonding present.

Question 2

(a) (i) The leaves or stomata were well known as the part of the plant from which most evaporation occurs

(ii) Transpiration was not well known.

(b) (i) The vast majority of candidates gave the correct time at which the rate of water loss was the greatest. Fewer identified the time at which the rate of water loss was the same as water uptake. This was often because candidates misread the graph.

(ii) This question proved more challenging for candidates to express their answers. Many tried to explain rather than describe the relationship. The best responses referred to the correlation between water loss and water uptake and the lag between them. Some candidates were awarded credit for a correct comparison of water loss and water uptake.

(c) (i) Photosynthesis was the only correct response seen.

(ii) Many candidates were able to state that xylem vessels transport water through the plant but very few explained that it was mineral ions in solution that were actually transported.

Question 3

(a) The majority of candidates gained full credit for this part.

(b) (i) Both of the correct answers – kinetic energy and gravitational potential energy – were well known. Most candidates gained credit here.

(ii) Many candidates correctly suggested chemical energy but some incorrectly suggested fossil fuel.

(c) (i) Few candidates gained full credit, although were awarded partial credit. All four forces **P**, **Q**, **R** and **S** were commonly seen for both answers.

(ii) A few candidates knew this. A smaller number correctly explained their answer but this was not required.

(d) Most candidates found this challenging. Few referred to friction and a number of incorrect answers referred to positive electrons and electrons gaining an electric charge.

Question 4

(a) (i) Some responses were exactly correct. Many gave percentages which were close to the accepted value. Many responses were inaccurate.

(ii) Many candidates referred to the helium-filled airship. Some thought that the balloon contained propane gas. A reference to less oxygen and more carbon dioxide was what was required.

(b) (i) Most candidates gained partial credit here but very few gained full credit.

(ii) Candidates needed to state the meaning of both saturated and hydrocarbon. Saturated was quite well known but few stated the meaning of hydrocarbon.

(c) Many candidates correctly referred to safety in their answer. Some incorrectly suggested that helium was less dense than hydrogen.

Question 5

(a) Many candidates calculated the average area of deforestation per country during the five years; they added up the numbers and divided by four, whereas they should have added up the numbers and divided by five.

(b) Few candidates were able to state two other pieces of information. The area of the country was the most popular correct answer.

(c) (i) Many good answers were seen. Some candidates needed to be clearer with their answers. For example a response of "for building houses" could have meant to clear land for building houses or to use the wood to construct buildings.

(ii) Most candidates gained full credit here for a wide variety of answers.

Question 6

(a) (i) Many candidates wrote visible light in the correct box. Some candidates completed the whole spectrum, whilst this was unnecessary it did not disadvantage the candidate.

(ii) Gamma radiation was slightly more popular than the incorrect response of radio waves.

(b) (i) Ionising radiation was not understood. Any correct reference to what ionising radiation does to atoms or molecules would have been sufficient. For example radiation that causes atoms to ionise or lose electrons.

(ii) Most candidates were able to refer to cancer or mutation here.

(iii) Many candidates were able to give one difference. Some candidates wrote down the same difference twice. For example – "alpha is positively charged, gamma has no charge" is one difference.

(c) (i) and (ii) D was frequently incorrectly quoted for amplitude but **E** was correctly chosen for wavelength.

(d) Candidates should be reminded to read instructions carefully. Many candidates gave a good description of the error but did not circle it on the diagram, thus preventing them from gaining all the credit available. The most popular response identified the ray leaving the fibre.

(e) (i) The position of the principal focus was not well known.

(ii) The focal length was rarely correctly shown.

Question 7

(a) Some candidates correctly defined homeostasis. A number described in in terms of maintaining a constant internal temperature. This was given credit.

(b) (i) Receptor was not well known for **K** but many candidates correctly identified **L** as a sweat gland.

(ii) Fat or fatty tissue was not well known. Many candidates incorrectly suggested skin tissue.

(iii) Temperature control was not well understood. However, most candidates gained partial credit here, usually for capillaries in the third space.

Question 8

(a) Most candidates showed good data handling skills on this calculation. A few attempted to change the units to km / s.

(b) (i) Many gave the correct energy transfer as radiation; some tried to qualify this as light or heat. Other methods of heat transfer were also seen.

(ii) There was a common misconception that the particles only started to collide with the tyre wall when the air in the tyre was heated. Few candidates explained that the air particles would need to collide with tyre wall more often.

(c) To gain full credit here, candidates needed to refer to temperature and the change of state.

(d) The question asked for a simple test. Many candidates answered this by looking at the relative reactivity of the two metals. The best answer seen was to use a magnet because steel was magnetic and aluminium was not.

(e) (i) Many candidates knew this but many more gave answers which were far too low.

(ii) The question asked the candidates to describe the frequency of the sound. Many candidates described the wavelength and amplitude. Some candidates stated the frequency would be high. Other candidates attempted to put a value on the frequency based on their answer to **(i).**

Question 9

(a) (i) Proton number and nucleon number were quite well known. Some candidates assumed that because the question had given values to these quantities that they had to use the number and attempted to state how many electrons or neutrons there were in a lead atom.

(ii) The term isotope was quite well known.

(b) (i) The label line to the cathode needed to be drawn to the actual electrode rather than to the negative terminal of the power supply.

(ii) The lead bromide needed to be molten for the experiment to work. To say that it needed to be heated was not sufficient. Some credit was given to candidates who suggested that the lead bromide could be dissolved in water to make an aqueous solution even though lead bromide is only very slightly soluble in water. Most candidates incorrectly decided that the switch needed opening or closing.

(iii) Bromine and its colour were well known. Bromide was not accepted.

(c) (i) Some candidates gave a correct pH. These candidates usually gave the explanation of lithium hydroxide being alkaline. A few described lithium as being an alkali. There were also many candidates who thought that the solution was either neutral or acidic.

(ii) Hydrogen was well known and was a common response.

(iii) Many candidates successfully wrote down the word equation. However, a number of candidates attempted to write a balanced symbolic equation instead.

Question 10

(a) The question asked what was meant by the term recessive allele. Many candidates attempted the recessive part but did not say what an allele was.

(b) Few candidates seemed to understand what a genotype was. Many answered using single letters **N** or **n**. Many others incorporated **P**, **Q** and **R** into the genotype – for example **Pn** or **Np**.

(c) (i) Many candidates stated what a phenotype was.

(ii) Heterozygous was not a term that many candidates understood.

Question 11

(a) (i) Few candidates gave the correct response of molecule. The commonest answer was compound.

(ii) The majority gave the correct answer with a small minority giving answers such as $4S_2$. S, 8S or S_2.

(b) (i) Some candidates explained that the sulfur gained oxygen or had reacted with oxygen. A sizeable minority thought that the sulfur released oxygen.

(ii) Most candidates gave correct colours. A few gave blue or purple and a very small number of candidates gave a pH value. Those candidates who provided a correct colour generally were able to give the correct explanation of the solution or sulfur dioxide being acidic. A number incorrectly stated that sulfur was acidic.

(iii) Very few candidates gained even partial credit here. There were very few references to sulfur dioxide or acid rain. There were however a number of references to carbon monoxide production.

Question 12

(a) (i) and (ii) The majority of candidates were awarded most of the available credit on this question with good knowledge of component symbols seen. A few candidates included the incorrect number of lamps or more commonly cells. Fewer still added extra symbols such as an ammeter. Most candidates placed the voltmeter in series rather than in parallel with the lamp.

(b) (i) Few candidates stated why the current was not proportional to the lamp. The best answers seen simply suggested that the line was curved and should have been straight.

(ii) The majority of candidates were able to read the value of the current from the graph.

(c) The majority of candidates gained full credit for this question. A few candidates attempted to calculate the total resistance of two resistors in parallel and a few others calculated the average resistance of the resistors.

Question 13

(a) Benedict's solution was quite well known. Candidates needed to mention that the solution should be heated with the plant root. The colour change was quite well known.

(b) (i) Many candidates scored well on this question. There were no common wrong answers.

(ii) The cell wall was not well known as the structure in a plant cell that contributes fibre.

(iii) Prevention of constipation was not well known.

CO-ORDINATED SCIENCES

Paper 0654/23
Core Theory

Key messages

A good standard of scientific knowledge and understanding was displayed by many of the candidates. Some candidates should be congratulated for their clear and accurate responses.

Some candidates were not able to gain full credit due to misinterpretation of the question. Candidates should take notice of command words such as *name*, *state, describe* and *explain* in deciding what response a question requires. This is particularly the case for questions asking candidates to *describe* or *explain* phenomena.

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. Candidates generally gained some credit on all questions. Few gained no credit on any question but very few gained full credit on any question. Although it appeared that candidates often knew the answers to the questions, their answers were sometimes vague. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Some candidates only gained some of the credit available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum credit available.

Learning the definitions specified in the syllabus earns credit directly as well as being an aid to language used in explanations.

When drawing diagrams, candidates should be reminded to take care to draw clearly and to use the correct labels and labelling lines.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly, formulae consisting of a mixture of words, symbols and units should also be avoided.

Comments on specific questions

Question 1

(a) (i) Many candidates were able to correctly identify malleability as the property of aluminium that allows it to be rolled into thin sheets.

(ii) Some candidates were able to describe aluminium as unreactive. Ideas such as resistant to corrosion were accepted. However some candidates did not describe the property clearly enough, for example, a statement such as “copper is not very reactive” does not mean the same as “copper is unreactive”.

(b) (i) The term alloy was quite well known.

(ii) Candidates found this part challenging. Some candidates were able to suggest that alloy would be stronger but very few described why this was important.

(c) (i) Electrolysis was well known.

(ii) The label line to the cathode needed to be drawn to the actual electrode rather than to the negative terminal of the power supply.

(iii) Oxygen was quite well known as the element in the gas bubbles.

(d) (i) The idea of electron loss occurring when a metal atom is converted into an ion was not well known.

(ii) Many candidates were able to write down the chemical formula of aluminium oxide from the information given.

Question 2

(a) (i) Most candidates were able to name part **X** as a red blood cell and part **Y** as plasma.

(ii) Most candidates knew that the function of part **X** was to carry oxygen.

(iii) Most candidates were able to name at least one other component of the blood not shown in the figure.

(b) Most candidates scored partial or full credit. The common incorrect answer was coronary for the artery leading to the kidney

Question 3

(a) Many candidates were able to explain why oil floated on top of the seawater.

(b) (i) and (ii) Most candidates were able to determine the amplitude and wavelength of the wave. Giving an amplitude of 1.0 m was a common error.

(iii) Very few candidates were able to calculate the frequency of the waves. The common incorrect answer was 0.05 Hz.

(c) (i) and (ii) These parts were well answered, with many candidates gaining full credit.

(d) (i) and (ii) Many candidates knew this but many more gave answers which were far too low.

(iii) Most candidates forgot to divide their answer by two to determine the depth of the sea below the oil tanker.

Question 4

(a) Many candidates constructed a suitable food chain containing four organisms based on the information given in the question. A number of candidates incorrectly drew it in a circle.

(b) (i), (ii) and (iii) These parts were well answered.

(c) (i), (ii) and (iii) These parts were well answered.

Question 5

(a) The credit available for this part should be noted. Most candidates made at least one mistake; therefore in most cases only partial credit was awarded. Many candidates did not appreciate that the headlamps were connected in parallel. Many did not give the correct symbol for the battery.

(b) Most candidates answered this well; they placed visible light in the middle between ultraviolet and infra-red. Some candidates completed the whole spectrum, whilst this was unnecessary it did not disadvantage the candidate.

(c) It was encouraging to see many candidates using the information given and their knowledge to work out the answer to the question.

(d) Candidates found this challenging. There were a number of points required; very few candidates gained partial credit.

(e) Candidates found this challenging. There were a number of points required; very few candidates gained partial credit.

Question 6

(a) (i) and (ii) These parts were answered well by many candidates with most candidates gaining at least partial credit.

(iii) and (iv) Candidates found this challenging. Those who wrote down an answer generally gained partial credit.

(b) The term zygote was not well known. Embryo was a common answer.

(c) (i) The oviduct as the place where fertilisation occurs was not well known.

(ii) Many candidates were able to identify **R** as the oviduct and **S** as the ovary.

(iii) The function of part **S** was well known.

Question 7

(a) Oxygen was not well known as the gas produced. Hydrogen was a more common but incorrect answer.

(b) (i) Almost all the candidates answered this part, showing good data handling skills.

(ii) Candidates found this part challenging. Many candidates suggested that a catalyst should be used.

(iii) Candidates found this part challenging.

(iv) Candidates found this part challenging.

Question 8

(a) (i) Most candidates showed a good understanding of convection and correctly showed the movement of the cooled air.

(ii) The term convection was well known.

(b) Candidates showed good data handling skills to complete the calculation.

(c) Although many candidates knew that the correct diagram was **A**, they did not explain why. The correct explanation needed to link the ideas of a regular arrangement and touching particles.

(d) (i) This was another calculation which was well answered.

(ii) Candidates needed to explain their answer to gain credit. Many successfully did this.

(e) (i) To gain credit any correct reference to what ionising radiation does to atoms or molecules would have been sufficient, for example radiation that causes atoms to ionise or lose electrons.

(ii) Most candidates were able to name one type of ionising radiation.

(iii) Most candidates were able to refer to cancer or mutation here.

Question 9

(a) (i) The third period was quite well known.

(ii) Sodium was often identified as the most reactive metal that was in the same period as the elements in the table.

(iii) This was not as well known. A number of candidates attempted to use the proton number to locate silicon in the periodic table (14^{th} place).

(iv) Most candidates were able to use the proton number to determine the number of electrons in a phosphorus atom.

(v) Many candidates who correctly answered **(iv)** found this part challenging.

(vi) The general trend in melting points was well described by most candidates.

(b) (i) Noble gases were well known.

(ii) Most candidates managed to gain at least partial credit here. Either they were able to suggest that argon was highly unreactive or that oxygen in the air would react easily with caesium.

(c) (i) Only a few candidates suggested that iodine was produced.

(ii) Candidates found this part challenging. A few candidates explained that chlorine would kill bacteria. Very few made any reference to removing the risk of disease.

Question 10

(a) Many candidates gained partial credit here for a reference to growth, movement or sensitivity.

(b) (i) Phototropism was not well known. A common incorrect answer was photosynthesis.

(ii) Candidates found giving an explanation challenging. They needed to explain that the stem would grow upwards anyway, growing against gravity.

(iii) Many candidates explained this satisfactorily. The best answers included a sensible reference to photosynthesis.

Question 11

(a) (i) Most candidates drew a correct speed / time graph and gained full credit. There were no common errors.

(ii) Both chemical energy and kinetic energy were quite well known. However, few candidates gained maximum credit.

(b) Correct arrows were drawn by many candidates. Many candidates gained full credit and almost all gained some credit, usually for identifying the direction of the athlete's weight.

(c) (i) Some candidates were able to label the angle of incidence. Some thought that the whole 90° angle was the angle of incidence. Some labelled the incident ray instead of the angle of incidence.

(ii) Many candidates were able to deduce the angle of reflection, but fewer explained their answer.

Question 12

(a) (i) Examples of fossil fuels were well known.

(ii) Many candidates gained full credit here; candidates who did not must ensure that they follow the instructions given, they were asked to write a tick if the sentence was correct or a cross if the answer was incorrect.

(b) (i) Few candidates gained credit here. Good answers referred to separating the compounds in petroleum and the fractions produced being useful whereas the petroleum is not useful.

(ii) Most candidates knew that the change was a physical change but very few explained why.

(c) (i) Cracking was not well known. There were a lot of different answers given. The most popular incorrect answer was halogenation.

(ii) Candidates often gained partial credit here. Either they knew that molecule **O** was a hydrocarbon or they knew that it was unsaturated.

Question 13

(a) The idea of humans depending on the plants for food was well understood. Few candidates suggested the alternative answer of humans depending on the plants for oxygen.

(b) (i) Some candidates were able to explain that if a planet is further from the Sun then there will be less light or warmth.

(ii) Few candidates suggested any of the possible reasons why water is needed to keep plants alive.

(iii) A number of candidates were able to explain why the carbon dioxide concentration on Mars would increase plant growth.

(iv) The idea that there would be more oxygen or less carbon dioxide was quite well known. Fewer explained why. A reference to photosynthesis was required.

CO-ORDINATED SCENCES

Paper 0654/31
Extended Theory

Key messages

Extended answers to questions were generally expressed well and with good use of English. Most scripts were legible. Diagrams were drawn or annotated with care. The calcualtions of better performing candidates were accurate and easy to follow.

Most questions were attempted by all candidates. There was no evidence that candidates were short of time.

General comments

Better performing candidates used the term force rather than push in their responses, hydroelectricity rather than waterpower and filtration rather than infiltration. These candidates could explain the meaning of terms specified in the syllabus using standard terminology. This enabled them to successfully apply the term to subsequent parts of the question. Candidates should beware of using the term they are defining to explain its meaning.

Candidates should avoid giving a list of answers, unless this is specifically asked for.

Where a question requires a comparison, the answer is less ambiguous if a description of both entities is provided rather than a single statement. For example: ‘a proton has a positive charge’ allows the possibility that an electron has a negative charge or no charge at all.

Space for a formula and working are provided to encourage candidates to explain the stages in their calculation. Where an error is made, some credit can often be given if a correct stage can be identified in the working. Formulae should be written wholly in words or in symbols, not in units or using ‘formula triangles’.

Comments on specific questions

Question 1

(a) Most candidates knew that white surfaces are better reflectors or poorer absorbers of thermal energy. Others discussed the reflection of light, or by used terms such as attract, repel or deflect.

(b) The energy transformation in the wind turbine was usually given as kinetic to electrical. Wind energy was a common incorrect response.

(c) (i) There were many correct calculations of the energy gained; the most common error was to divide the energy input by the mass. Candidates should be aware that it is not always necessary to use all the data supplied in the stem in every part of the question.

(ii) Many candidates could quote a formula involving temperature change and specific heat capacity in symbols or in words. Some could not rearrange the formula for energy transfer.

(d) Two examples of renewable energy sources were often supplied, using technical language like hydroelectricity rather than a vague description such as water or dams.

(e) (i) Knowledge of the position of visible light in the electromagnetic spectrum was common.

(ii) Fewer candidates could quote the speed of light.

(f) The majority of responses identified the amplitude of the current with a carefully drawn arrow.

Question 2

(a) (i) Many candidates correctly identified the sepal and stamen on the horizontal section rather than the side view.

(ii) Many candidates knew that the stamen produces pollen or that the flower could no longer pollinate; others incorrectly stated that the plant could not be pollinated or that it could not reproduce.

(iii) Candidates often observed that the presence of petals or the enclosure of reproductive parts were evidence of insect pollination. Some responses did not refer to features which were visible in the figure, as required by the question.

(b) (i) Most candidates used the chart to find the number of fruits that landed in the stated range.

(ii)(iii) The distance range in which most fruits landed was usually correctly identified. A minority realised that the range was greater than the others and described features of the structure of the fruit.

(iv) This question was well answered with many candidates stating the advantages of fruit dispersal as colonisation of new areas and prevention of competition.

(v) Most candidates gave a good example of a method of fruit dispersion, avoiding discussion of intentional human involvement.

(vi) Many stated that the fruits would be dispersed further in both cases. Some correctly suggested that the fruit falling from the taller tree would be subject to the wind for a longer time. A few candidates mentioned the greater force exerted by a stronger wind.

(c) There were a few excellent diagrams of the plant embryo. Many other candidates were challenged by this question.

Question 3

(a) (i)(ii) Most candidates knew that filtration is the process used to remove insoluble materials from water, and that the destruction of microorganisms avoids disease.

(b) (i) Nearly all candidates identified the process as electrolysis.

(ii) Many candidates knew that the other gas was hydrogen.

(iii) The bleaching of litmus paper was correctly described as the test for chlorine by the majority of candidates. Some confused the test for chlorine with that for the chloride ion.

(iv) Those who realised that sodium hydroxide remains in the cell after electrolysis gave the correct pH change. Others gave explanations based on the removal of acidic chlorine.

(v) There were some good bonding diagrams for a chlorine molecule. Other candidates misread the question and gave the electronic structure of a chlorine atom.

Question 4

(a) (i)(ii) Most candidates knew the formulae and were usually successful in calculating the acceleration and force. Most candidates knew the unit of force.

(iii) Some candidates calculated the distance travelled correctly from the area under the deceleration section of the graph, while some measured the area under the whole graph. Others applied the maximum speed to the formula: distance = speed × time.

(b) (i) Many candidates knew that vehicles can become charged and some explained its cause in terms of friction. There were many suggestions about the source of the friction other than friction between tyres and road, between the bodywork and air or between the braking surfaces. Misconceptions were evident when candidates attempted to describe what happened when the driver received a shock, with few stating that electrons flowed through the driver to or from earth, discharging the vehicle.

(ii) The formula for charge was quite well known and a few candidates applied it correctly by converting the units of time.

Question 5

(a) Most candidates could name the processes in the carbon cycle.

(b) (i) There were some good answers to this question. The most common answer was that cutting down trees reduces the amount of carbon dioxide removed by photosynthesis. Carbon dioxide production by the burning or decomposition of timber was seen less often.

(ii) It was well known that combustion of fuels in power stations produces carbon dioxide.

Question 6

(a) (i) A good definition of proton number was sometimes given, involving the number of protons in a nucleus or atom of an element rather than in the element.

(ii) Two valid differences between a proton and an electron were usually supplied. Where only one of the particles was described the property of the other had to be obvious. So a proton has a larger mass was acceptable, while a proton has a positive charge was not, as it would leave the possibility of an electron having a negative or no charge.

(b) (i)(ii) Many candidates realised the relationship between Periodic Table group numbers and numbers of outer shell electrons and so could work out the formula and predict the type of bonding.

(iii) Those who knew that caesium iodide is ionic explained that the caesium atom donates an electron to an iodine atom. Others described covalent bonding.

(c) (i) Most candidates correctly described the trend shown by the graph as the higher the temperature, the greater the mass that dissolved. Those who described the relationship as a positive trend, positive correlation or proportionality were usually successful. Direct proportion was not acceptable.

(ii) The mass of caesium iodide dissolving was usually read from the graph accurately.

(iii) There were a few well-presented solutions to the problem clearly showing the stages in the calculation. Some candidates could find the number of moles in the mass of caesium iodide. Some could convert units from cm^3 to dm^3. A common source of error was the use of incorrect relative atomic masses to calculate the relative formula mass.

Question 7

(a) Many candidates could match all the materials to their uses. Matching the metals proved to be more challenging.

(b) (i) Many candidates could find the nucleon number from the data supplied.

(ii) Those who understood the significance of the word notation often wrote the correct symbol for the nuclide.

(iii) There were some good definitions of half-life. Other responses described it in terms of the decay of a single nucleus or atom rather than in the bulk material.

(c) Many candidates stated one of the differences between evaporation and boiling. Some were not successful when attempting to compare the need for an external source of heat energy. Although a single, clear statement was often sufficient, there was less ambiguity in answers which included features of boiling and of evaporation.

(d) There were few explanations of the attraction of the iron bar to the magnet which involved induced magnetism. Some candidates simply described the attraction between poles while others confused magnetic poles with electric charge.

(e) The correct diagram was usually chosen as representing the arrangement of particles in a solid, and some explanations described the regular arrangement. Reference to shape was assumed to describe the external features of the material rather than the internal organisation. Some candidates described details such as mobility which were not evident from the diagrams, or suggested that the particles in a liquid are not in contact.

(f) There were many well written methods of measuring the volume of the iron by immersion in water in the measuring cylinder or by using a displacement can. Melting the iron was not an acceptable description.

Question 8

(a) The majority of candidates knew at least one of the effects of fat in the diet. Blocking blood vessels was often mentioned without specifying the effect on the coronary artery.

(b) (i) The liver or gall bladder was often labelled as the gland that secretes bile. Labelling the pancreas was a common error. This question was sometimes omitted. Candidates should check that all questions have been answered.

(ii) The few correct answers described the role of bile in emulsifying fat which increases the surface area subject to enzyme action, enabling more efficient digestion.

(iii) Many candidates recognised that the large surface area of the villi helps in the efficient absorption of fats. Some commented on the thin walls while others incorrectly described the villi, rather than its wall, as being one cell thick. A few mentioned lacteals in their role of transporting lipids rather than capillaries which transport other nutrients.

Question 9

(a) (i) Most candidates knew that iron and nickel are transition metals.

(ii) Some stated typical properties of transition metals, while many gave properties common to all metals.

(iii) Iron particles were often suggested as those that are oxidised when iron rusts. Iron atoms were rarely identified. Some candidates knew that oxidation involves loss of electrons but statements such as iron loses electrons alone did not answer either part of the question.

(iv) This question was generally not answered well. There were some incorrect suggestions that nickel protects iron from exposure to oxygen and water, or that involved a sacrificial role.

(b) (i) Many identified the apparatus as a blast furnace.

(ii) When the correct symbols for reactants and products were written, the equation could usually be balanced. Equations were often written involving species which do not exist in order to balance the equation. Candidates should use their chemical knowledge to write the symbols before attempting the balancing.

Question 10

(a) (i)(ii)(iii)
Most diagrams were drawn accurately, using a ruler.

(iv) A minority of candidates chose the three correct items to describe the image. A common error was to select real rather than virtual.

(b) Correct descriptions of the difference between compression and rarefaction involved comparison of density of the medium or pressure variation, rather than modulation of the frequency of the wave.

(c) (i) The ammeter and voltmeter were usually correctly identified. Candidates should take care to spell scientific terms correctly.

(ii) There were many well-presented calculations of the total resistance. Common errors involved not working out the reciprocal in the final stage and the use of incorrect formulae such as R = R1 + R2 or R = 1/R1 + 1/R2.

Question 11

(a) (i) Many candidates stated the correct possible genotypes of a brown mouse, rather than listing all the possible combinations of the alleles.

(ii) Satisfactory explanations involved recognition that a mouse would have white fur if it had the homozygous recessive genotype. Others stated the need for the brown parents to have a heterozygous genotype without completing the explanation.

(b) (i) Most candidates knew that camouflage is an advantage to mice having brown fur, or compared visibility to predators.

(ii) Correct comparisons of the likelihood of white and brown mice passing on their alleles involved discussion of the degree of adaptation to the environment and chances of survival. Not all went on to explain that this factor would influence reproduction rate. Most candidates incorrectly interpreted the question as requiring an analysis of the chances of a white mouse passing on its recessive alleles to its offspring.

(c) There were many perfect answers to this question. In others, alleles in the gametes were not listed in the parents section, or were confused with genotypes. X and Y were sometimes substituted for H and h. Marks were awarded for the deduction process used at each stage of the completion of the diagram.

Question 12

(a) (i) Many candidates correctly assigned the structures of diamond and graphite.

(ii) Most knew the definition of an element but some incorrrectly implied that an element consists of a single atom or of non-bonded atoms. Candidates should beware of using the term element to define an element.

(iii) The best responses explained that the carbon atoms in graphite are arranged in layers which can slide off because of the weak forces between those layers. Some candidates did not distinguish between the strong forces between atoms in a layer and the weak forces between layers.

(b) (i) The best explanations of why the reactants must possess the larger amount of chemical potential energy involved the transfer of energy from the reactants during the reaction. Terminology such as the loss of energy or the use of energy was sometimes ambiguous. Some candidates realised that energy is transferred in the form of thermal energy or stated that the reaction is exothermic.

(ii) Most candidates explained the higher rate of reaction of powdered charcoal as due to its larger surface area. Better performing candidates described the greater rate of collision of molecules rather than there being more collisions. Some answers were ambiguous by using the term successful collision which sometimes implied that the state of division was affecting the kinetic energy of molecules.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

Key messages

A high standard of scientific knowledge and understanding was displayed by many of the candidates. Many candidates provided clear, articulate and accurate responses.

Candidates should take notice of command words such as *state, define, describe, explain* and *deduce* in deciding what response a question requires. This is particularly the case for questions asking candidates to *describe* or *explain* phenomena.

Calculations were generally done well with working shown. It is expected that correct units are given with answers and answers are rounded up or down to an appropriate number of significant figures.

General comments

Some candidates did not answer the question completely. In these cases, candidates did not read the stimulus material and each question carefully and did not complete all of the instructions contained within the question.

Candidates generally showed good use of English, expressing their ideas in continuous prose. When answering extended questions, better performing candidates used correctly spelt scientific terminology. These candidates had learnt the definitions specified in the syllabus, which enabled them to use this language in their explanations.

When drawing diagrams, some candidates did not draw these clearly and did not use the correct labels and labelling lines.

Comments on specific questions

Question 1

(a) (i) Many candidates were able to correctly identify experiment **C** and carbon dioxide as the compound. Some candidates incorrectly stated that experiment **A** would react to produce hydrogen gas.

(ii) Most candidates were able to correctly identify experiment **B** and that a displacement reaction had occurred. A few candidates gave the correct experiment of **B** but incorrectly described the colour change to blue.

(b) (i) The majority of candidates correctly identified reaction **B** and provided an explanation. A few candidates confused exothermic and endothermic and gave the incorrect reaction of **C**.

(ii) Most candidates were able to identify that reaction **C** would result in a decrease in the speed of the molecules. The majority of these were able to provide a partial explanation of a temperature decrease. Only the better performing candidates explained in terms of a decrease in kinetic energy or conversion to chemical energy.

(iii) Many candidates stated that there would be no reaction. Better performing candidates gave good explanations in terms of copper being less reactive than hydrogen so unable to displace hydrogen from the acid. A few simply described that there was no temperature change or that the reaction was very slow.

Question 2

(a) (i) The majority of candidates were able to give the correct term of transpiration. Incorrect answers of respiration, osmosis and photosynthesis were also seen.

(ii) The vast majority of candidates were able to link the idea of more stomata leading to more evaporation.

(iii) This question was answered less well. Some candidates described that the advantage was for more photosynthesis on the upper surface. Some candidates were confused about water entering the stomata if they were on the upper surface. Better performing candidates described that there would be a reduction in water loss and explained this was due to less exposure to sunlight or temperature.

(b) (i) The vast majority of candidates gave the correct time at which the rate of water loss was the greatest. Fewer were able to identify the time at which the rate of water loss was the same as water uptake. Some of these simply misread the graph and some of these gave times that were seemingly random.

(ii) Candidates found this question more challenging to express their answers. Many tried to explain rather than describe the relationship. Better performing candidates referred to the correlation between water loss and water uptake and the lag between them. Many candidates gave a correct comparison of water loss and water uptake.

(c) The vast majority stated large surface area and some gave thin or permeable membrane. Some candidates incorrectly described the cell walls as being thinner. There were also some confused references to water potential and size of vacuole.

Question 3

(a) (i) The vast majority of candidates answered the calculation correctly. The most common error was to not square the velocity.

(ii) Most candidates answered this correctly. A few candidates tried to use the formula F = ma.

(b) Most candidates gave a correct response. A few only answered one of the forms of energy correctly. Almost all incorrect forms of energy were seen, including sound and heat.

(c) Candidates expressed their answers in many ways. Most were able to identify that only velocity includes direction. A small number of candidates were confused between acceleration and velocity.

(d) This calculation was answered very well with many candidates gaining the full available marks. Very few candidates used the incorrect formula. It was pleasing to see that many candidates remembered to account for the number of wheels in their responses.

(e) This question asked for factors that would increase the rate of evaporation. Several candidates did not take this into account and gave correct factors without a comparative term. The most common being temperature, wind and surface area rather than increased temperature, increased wind speed and increased surface area.

(f) Some candidates referred to the correct transfer of electrons but did not include friction in their responses. Some candidates incorrectly referred to the transfer of positive electrons.

Question 4

(a) Several good responses were seen with some recognising that helium was unreactive and so safer to use than hydrogen. A few candidates missed this and instead tried to explain helium's use by reference to density, cost factors or the use as a fuel.

(b) Most candidates were able to draw a clear diagram of propane. A few candidates included the wrong number of hydrogen atoms. Some did not read the material carefully and drew different hydrocarbons, despite being told that propane contained three carbon atoms.

(c) There was much confusion amongst candidates between intermolecular forces and the covalent bonding between atoms. Many candidates described the bonding between atoms as needing to be broken for a substance to boil. Better performing candidates referred to the intermolecular forces between the molecules and more energy required to break these forces.

Question 5

(a) (i) The vast majority of candidates correctly stated four trophic levels. A small number of candidates missed the food chain that included insects and tree frog and gave the incorrect number as three.

(ii) The majority of candidates gave the name of a correct organism. The most common incorrect response seen was tree frog.

(iii) Most candidates recognised that energy decreased between the trophic levels. Fewer described that there would not be sufficient energy for more than five trophic levels. A few candidates tried to explain that there would not be any predators big enough, which was not accepted.

(iv) A variety of incorrect responses were seen including predator, omnivore, named carnivores and human. Better performing candidates commonly used the correct term of decomposer, with fewer giving a named example of a decomposer.

(b) (i) Several clear responses were seen with most candidates linking a decrease in photosynthesis with a decrease in the removal of carbon dioxide. Some candidates simply reworded the question and referred to an increase in carbon dioxide concentration. Fewer candidates described the decomposition or combustion of trees producing carbon dioxide, which was also acceptable. Candidates should be encouraged to use the correct terms and not to describe trees as breathing carbon dioxide in and oxygen out.

(ii) Most candidates correctly stated that carbon dioxide would be produced as a result of combustion of timber as a fuel. Some candidates gave vague answers of harmful gases or pollution.

Question 6

(a) The vast majority wrote visible light in the correct box. Some candidates completed the whole spectrum, which was unnecessary.

(b) (i) Correct responses of mutation often linked to cancer were widely seen. A few candidates were too vague in their responses, referring to damage or harm of the body.

(ii) A wide variety of correct answers were seen. Many candidates referred to differences in charges, ionisation and penetrating ability. Some vague answers were seen such as references to power, strength and ability to cause damage.

(c) Candidates should be reminded to read instructions carefully. Many candidates gave good descriptions of the errors but did not circle them on the diagram. A common error was to think it was impossible for two successive reflections to be on the same side of the fibre. Better performing candidates commonly identified the ray leaving the fibre and the ray travelling in a curve at the end. Fewer were able to identify the incorrect angle as the second angle on the diagram.

(d) (i) Many candidates answered this correctly. A number of candidates inverted the formula to give the incorrect answer. Some candidates struggled with using the correct power of 10.

(ii) Some candidates thought that a calculation was required to answer this question. The vast majority of candidates that gave the correct speed were also able to give the correct explanation.

Question 7

(a) Many candidates struggled to express their answers fully. Many candidates were too vague in their responses, referring to changes in the body; there was some confusion with reflex reactions. The better performing candidates commented on a change to the internal conditions that are at a set point and that a change in these conditions results in a change to return to the set point or to counter the variation.

(b) (i) Most candidates were able to identify the pancreas. Some incorrectly labelled the stomach, gall bladder or liver as the pancreas. Better performing candidates used a straight line without arrow heads that touched the structure that they are labelling when labelling biological diagrams. Some candidates circled the pancreas rather than using a label line.

(ii) Some candidates gave the incorrect hormone as adrenaline. A common error was to give the kidney as the site of insulin production. Some candidates muddled glycogen and glucagon.

Question 8

(a) (i) Many candidates gave the correct energy transfer as radiation; some tried to qualify this as light or heat. Other methods of heat transfer were also seen.

(ii) The most common incorrect answer seen was nuclear fission. Many candidates had difficulty with the correct spelling of the term fusion. Some candidates gave examples of methods of energy transfer including radiation and convection.

(iii) Many candidates identified that the black surface absorbs heat/radiation without providing a comparison that black surfaces were better absorbers than white surfaces. Some candidates incorrectly referred to light or the attraction of heat.

(b) Many candidates confused the generator with a motor, referring to the current causing the coil to turn. Some candidates did have the idea of the coil cutting lines of force and a few of inducing e.m.f. rather than current. Many described the coil reversing direction every half turn and some thought the slip rings caused the coil to turn, rotated the coil in opposite directions, controlled the output or generated electricity through friction with the coil.

(c) (i) Most candidates defined frequency well with a few candidates referring to pitch and some to speed. Some candidates gave number of waves passing a certain point with no reference to time period.

(ii) The vast majority of candidates gave the correct answer. A few referred to amplitude being larger.

(iii) Most candidates gave good answers, referring to the spacing between the particles. Many candidates referred to waves rather than particles and a few referred to sound particles.

Question 9

(a) (i) The vast majority chose to draw a diagram as well as describing the electronic configuration. There were many good diagrams seen, with the majority of candidates answering this correctly. A very few candidates drew an atom with 23 electrons.

(ii) The majority of candidates answered this correctly. A few candidates referred to the chemical properties of the elements rather than the similarity in their electronic configurations.

(b) Many candidates referred to sodium being positive rather than sodium ions. Most had the idea that sodium went to the cathode; some gave discharge of chlorine. Better performing candidates included an equation. A number of candidates did not read the question properly or ignored the word molten and referred to hydrogen being discharged as it was less reactive than sodium.

(c) (i) Most candidates gave a correct pH. These candidates usually gave the explanation of sodium hydroxide being alkaline. A few candidates described sodium as being an alkali and a very small number gave sodium hydroxide as being an acid.

(ii) Many correctly balanced formulae were seen with only a few of those giving correct formulae incorrectly balancing the equation. The most common error was a singular atom of H rather than H_2. There were some other errors including NaOH given as $NaOH_2$ and Na_2O.

(d) Many candidates found this challenging. These candidates did not multiply by 2, multiplied the M_r by 2 and then multiplying again by 2 and using the M_r for carbon dioxide or lithium carbonate. Most gave the answer in grams with a few converting the answer to kg.

Question 10

(a) Most candidates gave the correct answer of a change in the gene or chromosome. Very few gave any additional detail.

(b) (i) Few candidates gave a correct response for **P**; most by adding additional incorrect genotypes. **Q** was answered with more success with only a few candidates including the incorrect genotype of **nn**. A few candidates did not read the question carefully and did not state all the possible genotypes for **Q**.

(ii) Candidates struggled to express their ideas clearly. Many gave vague responses, referring to the lack of prevalence of cystic fibrosis; of these candidates most generally referred to the possibility of normal parents having a child with cystic fibrosis. Fewer gave enough detail in terms of alleles.

Question 11

(a) (i) The vast majority gave the correct answer with a small minority giving answers such as $4S_2$, S or S_2.

(ii) Many candidates recognised that there was only one type of atom. Few made the mistake of referring to only one atom. Some candidates incorrectly tried to use the term element in their explanation.

(b) (i) Most candidates gave colours at the correct end of the Universal Indicator range spectrum. Few gave blue or purple and a very small number gave a pH value. Those candidates that provided a correct colour generally were able to give the correct explanation of the solution or sulfur dioxide being acidic.

(ii) Few candidates knew the correct concentrations of oxygen and nitrogen in the air. Some were within a few percent and some gave nitrogen as the smaller percentage.

(iii) The vast majority of candidates correctly predicted an increase in the rate of burning.

(iv) Many candidates had the correct idea of a greater percentage of oxygen. Fewer were able to gain maximum marks by referring to collision frequency. Some candidates referred to the number of collisions and some described in terms of increased energy of the collisions.

(c) (i) Most candidates recognised that vanadium oxide was used as a catalyst. A few simply described it as a filter. Better performing candidates explained that it is not used up. Responses such as *it does not take part in the reaction* were not sufficient.

(ii) Many candidates gave the correct answer of sulfuric acid. A variety of other incorrect sulfur products were seen, including sulfur hydroxide and sulfur dioxide.

(d) Many excellent diagrams were seen. Some candidates just removed the extraneous electrons from the hydrogen but added no electrons to sulfur, whilst some added electrons to sulfur but did not remove the extraneous electrons from the hydrogen atoms. A small number of candidates repeated the errors in the original.

Question 12

(a) The majority of candidates had good knowledge of the component symbols seen. A few candidates included the incorrect number of lamps or more commonly cells. Fewer still added extra symbols such as a voltmeter.

(b) Many candidates used the correct equation. The most common error was to omit the conversion of minutes to seconds. There was a variety of spellings seen for the unit coulomb.

(c) The majority of candidates answered this correctly. A few candidates omitted to invert the calculation in final stage.

(d) Several variations of tick placement were seen. The most common error was to place the ticks in the opposite boxes.

Question 13

(a) Many candidates recognised the advantage of having access to more sunlight for photosynthesis. Some candidates referred to the plant being away from the bacteria at the bottom of the pond. Some candidates tried to include access to oxygen and carbon dioxide in their responses.

(b) There were some excellent explanations of eutrophication seen. Most candidates had the idea that plants would grow faster. Some candidates also had the idea of later death due to competition for light. Several thought the bacteria and fish would be poisoned by the fertiliser; most thought the bacteria would increase in number. Many candidates were able to recall that bacteria were decomposers and that they would use up oxygen, often adding that it was through respiration. Most knew that fish would die because of oxygen shortage; some incorrectly attributed this to the lack of plants rather than the respiration of bacteria.

CO-ORDINATED SCIENCES

Paper 0654/33
Extended Theory

Key messages

Candidates appeared to have sufficient time, as there was no evidence that performance deteriorated near the end of the paper. Some scripts had a large number of questions which were left unanswered.

Candidates who were unable to complete a calculation, often gained credit for demonstrating a correct method.

General comments

Answers were reasonably legible in most cases and the use of language to express ideas was good. Relationships between quantities were generally described well. Candidates should ensure that when describing the factor which causes a specific change in a variable, they should describe the change in the factor rather than just naming it.

Where the appropriate formula was quoted in a calculation, correct quantities were usually substituted and arithmetic processes carried out free of error.

Comments on specific questions

Question 1

(a) (i) Many candidates knew that aluminium is malleable; some did not understand the meaning of the term property.

(ii) The property of aluminium that makes it suitable as a material for food containers was sometimes correctly described as its resistance to corrosion. Low reactivity was accepted but resistance to rusting was not.

(b) (i) Some candidates knew that a mixture of metals is an alloy.

(ii) The correct reason for the use of an alloy, that it is stronger than pure aluminium, was common. Some candidates stated that this is necessary due to the increased pressure in the can.

(c) (i) A minority of candidates correctly stated that heat is required to melt the electrolyte or to enable mobility of the ions. The link between these statements was rare.

(ii) A few candidates could use the valency of aluminium or its position in the Periodic Table to state the number of electrons transferred to the ion from the cathode and to explain in terms of ionic charge.

(iii) Some candidates wrote the equation for the reaction causing the loss of mass of the anode.

Question 2

(a) (i) Many candidates could identify the red blood cell.

(ii) Some candidates recognised phagocytosis as a reaction to a foreign particle; a description such as engulfing or surrounding was less common.

(iii) There were responses which implied that the blood cells are rejected but the involvement of antibodies was rarely mentioned. Answers often just suggested an effect on the general health of the individual.

(b) (i) Correct comparisons of the functions of the blood vessels discussed the direction of blood flow to or from the heart. Others compared the oxygen content of the blood in arteries and veins.

(ii) Several candidates explained why arteries have thick walls by noting the high blood pressure. Good attempts to describe what would happen if the artery walls were not thick focussed on prevention of bursting rather than resisting penetration or leakage.

(iii) The function of elastic tissue in the artery wall was often stated as allowing stretching or expansion. Smoothing of variations in the rate of blood flow was rarely mentioned.

Question 3

(a) (i) The calculation of the volume of the layer of oil was generally done well.

(ii) Many candidates quoted the correct formula for density and obtained the right answer for the mass.

(b) Most candidates could identify the non-renewable and renewable energy resources in the table.

(c) (i) The audible frequency range was not well known.

(ii) Many candidates calculated the distance travelled by the sound. A minority divided by 2 to obtain the depth of the sea.

(iii) Most diagrams of the wave correctly showed the increased wavelength. A few showed an arrow denoting the magnitude of the wavelength placed precisely between the centres of adjacent compressions or rarefactions.

Question 4

(a) The organisms were usually placed in the correct order in the food chain with arrows in the right direction.

(b)(i)(ii)(iii)
Many candidates could match the terms ecosystem, trophic level and decomposer with their definitions. Trophic level proved to be the most challenging for candidates.

(c) Those that realised that grass has the most energy flowing through it often noted the loss of energy at each stage. Others answered the question in terms of energy flow through a single organism so concluded that the lion had the greatest energy flow.

Question 5

Some parts of this question were not attempted by a large number of candidates.

(a) (i) Those candidates who used the description in the stem, drew a good circuit diagram with lamps in parallel, in series with a battery, switch and fuse, using recognised symbols. Others copied the wiring diagram or tried to construct a circuit diagram based on that information alone. Such diagrams often showed third connections to the middle of a lamp or a fuse.

(ii) Candidates who knew the formula for charge often obtained the correct answer and unit.

(b) (i) More candidates knew the relationship between speed, frequency and wavelength.

(ii) A few candidates could state a property of electromagnetic waves, rather than a property of waves in general.

(c) Some candidates explained the spread of the paint in terms of the attraction between the negatively charged bodywork and the positive droplets. Very few highlighted the repulsion between droplets with the same charge.

(d) Candidates needed to describe a characteristic of the image rather than describe the image itself. Successful responses described the image as laterally inverted, upright or virtual, rather than BUS appearing backwards or the driver on the wrong side.

(e) Many candidates could identify one or more factors, such as temperature, affecting the rate of evaporation. Since factors that increased the rate were required, the changes in these factors, such as increased temperature, had to be stated.

Question 6

(a) (i) Some candidates correctly labelled a diploid and a haploid cell.

(ii) Many named the type of cell division mitosis rather than meiosis.

(iii) The numbers of chromosomes in the egg cell before and after fertilisation were often correct.

(b) (i) Some candidates knew that mutation can produce new varieties.

(ii) There were some good explanations of how variety can be important for survival, based on greater tolerance of drought and resistance to antibiotics. Answers implying adaptation over time were not accepted.

(c) (i) Most candidates correctly identified blood group A as the most common.

(ii) The name of the type of variation shown by blood groups was not well known.

(iii) Different genes or DNA were sometimes correctly stated as the cause of different blood groups, rather than just inheritance.

Question 7

(a) Many candidates knew that oxygen relights a glowing splint.

(b) (i) Some candidates identified the point on the line where the gradient is greatest as the time when the speed of reaction is greatest. Others chose the point when the maximum volume of gas had been collected.

(ii)(iii) Most candidates stated that the reaction finished when the volume of gas was no longer increasing. Others chose a point where the rate of reaction was decreasing.

(c) Those who knew that a catalyst is not used up during a reaction suggested that the mass of **Q** would not change.

(d) Many candidates stated that higher concentration would increase the rate of reaction. There was sometimes reference to increased frequency of collision rather than more collisions. This was rarely related to the larger number of molecules per unit volume colliding with the surface of the catalyst.

Question 8

(a) A few explanations of the movement of air involved the reduced speed of molecules in cold air. Most responses described the convection current with no explanation.

(b) Diagram **B** was usually identified as representing the arrangement of particles in a liquid. It was not always recognised that the particles are in contact in liquids and solids. Better performing candidates included a description of the random arrangement in liquids. Comments about the motion of particles were not relevant as it was not apparent from the diagrams.

(c) Explaining why energy is required to melt ice at 0 °C in terms of overcoming attractive forces proved to be a challenge to most candidates.

(d) A few candidates knew a method for calculating the total of two resistances in parallel. The most common error was to add the resistances.

(e) Those who knew the formula for specific heat capacity could usually substitute numerical values and obtain the correct answer.

(f) Some candidates knew that a current in a coil produces a magnetic field. The explanation of the working of an electric motor was not well known. Common errors included the idea of attracting magnetic fields, oscillation of the coil and confusion with the generator.

Question 9

(a) (i) Correct explanations of the meaning of proton number stated that it is the number of protons in the nucleus or atom rather than in the element. Few candidates described the relative atomic mass in terms of the comparison with that of an atom of hydrogen or carbon-12.

(ii) Many candidates could use the relative atomic mass of fluorine to find the relative molecular mass of F_2.

(iii) Neon was usually identified as being the element not forming compounds. Most of these responses recognised the significance of a full outer shell.

(b) (i) Many candidates knew that electrons are arranged in shells in an atom. Some showed the correct distribution of electrons in the shells, usually with the help of a diagram.

(ii) Most diagrams demonstrated knowledge of the concept of shared electrons and some showed the correct distribution of bonding and non-bonding electrons.

Question 10

(a) Better performing candidates stated the general definition of sensitivity as quoted in the syllabus, rather than just giving an example.

(b)(i)(ii) The term phototropism was not well known. A few candidates noted that gravity, rather than light may be responsible for the direction of growth and that a control is required.

(iii) Very few candidates could describe the role of auxins in causing the plant stem to change direction.

Question 11

(a) (i) Many candidates used the graph to find the correct distance travelled by the athlete. Those who made an error sometimes successfully showed evidence of the use of the area under the graph in their working.

(ii) Those who knew the formula for kinetic energy usually obtained the correct answer.

(b) Most candidates drew the correct arrows to show the direction of forces acting on the athlete.

Question 12

(a) (i) Fractional distillation was indicated by some. Identification of the cracking process was less common.

(ii) Few features of an alkane molecule were described and this question was often omitted.

(b) There were a few correct diagrams of an ethene molecule. Diagrams of methane and ethane were common.

(c) (i) The reaction between ethene and bromine was rarely described as an addition reaction.

(ii) Some candidates stated that the dibromoethane is colourless. The most common suggested colour was brown.

(iii) There were a few good calculations of the mass of dibromoethane produced. Others could not find the relative molecular mass or apply the information provided by the equation.

(iv) Some candidates knew that bromine does not react with ethane.

Question 13

(a) Most candidates explained that plants would provide food or energy on Mars.

(b) (i) Better performing candidates described the relationship between light intensity or temperature and distance from the Sun, rather than just stating that plants need light. They explained that sufficient light or high enough temperature was required for photosynthesis.

(ii) An acknowledgement that carbon dioxide is required for photosynthesis was required rather than just that it is needed for growth.

(iii) Many candidates realised that plant cultivation would increase the percentage of oxygen or reduce the percentage of carbon dioxide in the Martian atmosphere. This was not always explained in terms of photosynthesis.

CO-ORDINATED SCIENCES

Paper 0654/04
Coursework

General Comments

The majority of Centres had made very good choices of tasks, and assessed their candidates entirely appropriately in each of the four skill areas. Consequently, relatively few marks were adjusted.

Centres need to act on feedback given earlier in order to avoid problems. The choice of task needs to be appropriate. For example, some Centres had chosen a very small set of tasks, in which two or more were extremely similar to one another. If students have done an experiment investigating the effect of a factor on the resistance of a wire, then it is not a good idea to give them a C4 task that also investigates the effect of a factor on the resistance of a wire. Candidates need to have the opportunity to demonstrate their full abilities in planning an experiment. With such a wide-ranging syllabus, there is a huge range of possibilities for devising suitable tasks for the assessment of these skills.

Care needs to be taken that the criteria are met when assessing C3 and C4. To access higher credit for C3, candidates need to be able to appreciate the difference between a source of experimental error (uncertainty) and a human mistake. They should be able to recognise the most significant sources of error and comment on these. For example, in an experiment involving the timing of a colour change, by far the most significant source of error is likely to be deciding the precise moment when this colour change occurs.

For C4, the full range of criteria can only be accessed using a task that involves investigating the effect of one variable on another. In a few cases, attempts were made to assess candidates using tasks that did not include this, which meant that the candidates could not demonstrate all aspects of the criteria, particularly at the higher levels.

It is important that the way that assessments are made in the three science areas is consistent. Although there are some genuine differences between the practical skills required in the three sciences, the criteria are the same for all of them, and this should be reflected in the methods of assessment. It is very important that teachers of candidates in the same cohort work together to ensure that the assessments made within the Centre are all done to the same standard.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

General comments

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

Comments on specific questions

Question 1

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

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

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

(d) was well answered.

Many candidates suggested acceptable safety precautions in **(e)**; a significant number did not provide an acceptable reason for the precaution.

The use of **A** was not well understood in **(f)** and greater understanding of the reason for control experiments is needed.

Candidates are not confident when proposing plans for similar experiments and they would be well advised to have a check list to choose from when constructing relevant answers. Such a check list should include an equipment list, values for the variable, which variables are to be kept constant, the dependant variable to be measured and how the results will be used.

Question 2

Most candidates obtained useful results with the least concentrated acid taking more than 180 seconds. In **(b)** the same comments about planning found in **Question 1** apply here also. Universal indicator was allowed for a titration but not simply to test the pH of the acids as the pH values would be –0.3, 0 and +0.3 giving the same colours.

The use of barium chloride and silver nitrate, which appears in the Notes for Qualitative Analysis, was well known and generally the results were good. Sulfates can give a slight white precipitate with silver nitrate but nothing like the heavy one with barium chloride. Candidates should be encouraged to describe the formation of solids as precipitates qualified by a colour, e.g. white, rather than using the terms “milky” or “cloudy”. “Milky” should be reserved for the appearance of limewater when carbon dioxide is bubbled through it.

Explanations provided for **(d)** demonstrated a good understanding of the reaction between magnesium and acid.

Question 3

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

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

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

(d) and **(e)** were usually well done. Candidates must follow the instruction about m_1 being to the nearest gram. Care must also be taken with rounding.

In **(f)** candidates found it challenging to describe two acceptable difficulties. Many candidates described non-practical difficulties.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

General comments

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

A positive iodine test for starch is best described as blue-black in colour.

Comments on specific questions

Question 1

Most candidates knew which food group was tested for by each reagent and consequently sensible conclusions were made in many cases. The most common error was to state sugar rather than reducing sugar or glucose for the Benedict's test.

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

In part **(c)** most candidates were able to describe a safety precaution. Often the reason was missing or not related to the precaution.

The steps for carrying out the test for fat were sometimes muddled and lacked structure. The most common omission was the water.

Question 2

The reaction in part **(a)(i)** did not cause problems for most candidates; not every candidate described the resulting solution. Some candidates chose to uses sodium hydroxide, which was not on the list. The majority used ammonia solution and obtained at least one of the expected observations allowing them to correctly conclude the presence of the copper ion. Better performing candidates took great care when describing shades of blue in the tests.

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

Most candidates selected sodium hydroxide in part **(d)**.

Question 3

This experiment gave results that were consistent and could be easily processed. A common error here was to insert room temperature as the value for the temperature of the hot water at t = 0. It was rare to see that a candidate had converted the times to minutes. The units of temperature, °C, were frequently incorrect as C or C°.

Candidates were proficient at calculating the overall temperature rise and converting this into an average rate. Some rounding errors were seen. Candidates were less good at using this information to justify their choice of the better insulator. The fact that they had already calculated the average rate of fall for both containers was usually ignored.

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

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

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key messages

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

General comments

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

Comments on specific questions

Question 1

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

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

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

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

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

Question 2

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

(ii) Stronger candidates gained credit on this question.

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

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

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

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

Question 3

(a) Most candidates read the rule correctly.

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

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

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

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

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

Question 4

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

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

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

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

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

Question 5

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

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

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

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

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

Question 6

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

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

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

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

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

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

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

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. The standard of graph drawing was generally high although candidates need to be reminded to plot all points of data, but drawing of curves proved challenging for some candidates. Designing an experiment proved to be difficult for many candidates. Knowledge of identification tests for ions was limited. Aspects of safety specific to the experiment being described were not well known.

Comments on specific questions

Question 1

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

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

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

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

Question 2

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

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

(ii) Stronger candidates gained credit for this question.

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

(d) This was generally well known.

Question 3

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

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

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

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

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

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

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

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

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

Question 4

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

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

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

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

(d) Many candidates gained credit.

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

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

Question 5

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

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

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

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

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

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

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

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

Question 6

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

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

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

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

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key messages

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

General comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard, although sometimes not given to the accuracy requested. The standard of graph drawing was generally good but chosen scales need to cover at least half of the grid and anomalous points should not be included in lines. Designing an experiment proved to be very difficult for many candidates. Knowledge of identification tests for ions and gases were limited. Data and calculations in tables should be recorded to the same number of decimal places as the rest of the data in the table and needs to be correctly rounded. When planning experiments the prompts in the question will help ensure that all aspects of the plan are considered.

Comments on specific questions

Question 1

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

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

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

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

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

Question 2

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

(ii) These terms were well known.

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

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

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

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

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

Question 3

(a) Many candidates read the voltmeter correctly.

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

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

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

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

Question 4

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

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

(ii) Most candidates measured their line correctly.

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

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

(ii) Cell components were well known.

Question 5

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

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

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

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

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

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

Question 6

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

(ii) Most candidates read the thermometer correctly.

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

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

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

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