CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Question 14**, **28** and **32**. **Question 20**, **27**, **30** and **34** proved the most difficult for candidates.

Comments on specific questions

Question 5

This question on the rate of photosynthesis required candidates to identify which variables needed to remain constant. Some candidates incorrectly selected an option which included light intensity. These options could not be correct as light intensity was the independent variable in the experiment.

Question 6

In this question on dentition, many candidates confused premolar and molar teeth.

Question 8

Candidates often had difficulty interpreting the graph of volume of air breathed in and out over time. Although almost all correctly decided breathing rate increased, many were uncertain about the breathing volume.

Question 9

Almost all candidates knew that adrenaline increases the pulse rate so could narrow their choice to options **C** and **D**. Fewer candidates knew that adrenaline causes the pupil to dilate so the size will increase.

Question 11

A significant proportion of candidates incorrectly believed that all sperm cells contain an X chromosome, rather than all egg cells. Sperm cells can contain an X chromosome or a Y chromosome.

Question 12

A proportion of the candidates selected each option. This suggests that candidates were uncertain of the term consumer. In this food web, the plants are producers and all the other organisms are consumers.

Question 13

The majority of candidates believed that deforestation would lead to an increase in carbon dioxide because less trees were respiring, suggesting they have mixed up respiration and photosynthesis.

Question 15

A significant proportion of candidates chose the incorrect option, **A**. Candidates are expected to be able to deduce the formula of a simple compound from the relative numbers of atoms present.

Question 16

A number of candidates incorrectly chose option **B** rather than the correct option, **D**. Candidates are required to be able to use the terms electrode, electrolyte, anode and cathode. In this question, candidates confused the anode and the cathode.

Question 17

Some of the more able candidates chose the incorrect option **A**, rather than the correct option, **C**. When interpreting energy level diagrams, it's important to remember that in exothermic reactions the products have less energy than the reactants.

Question 18

Some candidates chose the incorrect option **A** rather than the correct option, **B**. With the same concentration of acid, the volume of gas would be the same, but the gas would be collected in a shorter time.

Question 20

Candidates incorrectly chose options **A** and **B**, more often than the correct option **D**. Some of the more able candidates chose the incorrect option **C**. Candidates are required to know the reactions of acids and also that a salt, which can be made by reaction with an acid, does not itself react with the acid.

Question 21

Although candidates chose the correct option, **A**, most often, some of the more able candidates chose the incorrect options **C** and **D**. The fact that carbon dioxide was evolved would indicate that substance X contained carbonate ions. The precipitate with sodium hydroxide solution remained in excess which identifies the metal ion as calcium. If the metal ion had been zinc, the precipitate would have redissolved in excess.

Question 25

The majority of candidates knew that carbon dioxide is a greenhouse gas and therefore selected option **A** or **B**. Fewer candidates knew that methane is also a greenhouse gas.

Question 27

All three statements about ethanol were correct and therefore option **A** was the correct choice. Candidates chose the incorrect options **B** and **C** indicating that facts about ethanol were not fully understood.

Question 28

This question on determining the period of a pendulum caused little difficulty.

Question 30

The topic here was moments. Although a large proportion of candidates correctly multiplied the force by the perpendicular distance to the pivot, some forgot to convert the distance into metres, leading them to select option **D**.

Question 31

A common mistake here was to choose the correct force (1.0 N) then to combine this with the incorrect distance (10.0 m).

Question 32

Candidates correctly interpreted the cooling curve to choose the correct section, **B**, in which both water and ice were present.

Question 34

This question about a converging lens proved demanding with few candidates selecting the correct option, **A**. In this case, the image would be larger than the object and position X represented the principal focus.

Question 38

The majority of candidates were familiar with the magnetic field pattern due to a current in a straight wire and identified option **A** as showing the correct pattern.

Question 39

In this question on atomic structure, the most able candidates were divided between the atoms having the same number of neutrons (correct) and the same number of ions. The question stated that the atoms were neutral so ions could not be the correct choice.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 14**, **15**, **23**, **26**, **28** and **37**. Only **Question 13** proved particularly difficult for the candidates.

Comments on specific questions

Question 13

In this question, candidates had to choose the correct label for the *y*-axis of a graph showing changes during eutrophication of a lake. All three of the statements were possible labels for the *y*-axis so option **D** was the correct choice.

Question 15

Candidates understood very well how to interpret the electronic structures of isotopes, and they also knew that isotopes have the same properties because they have the same number of electrons in their outer shell.

Question 19

Candidates chose the incorrect option **A** more often than the correct option, **C**. Candidates are required to define oxidation in terms of electron loss, and identify such redox reactions from simple equations. They should also be able to define and identify an oxidising agent as a substance which oxidises another substance during a reaction.

Question 23

Most candidates knew that transition elements form coloured compounds.

Question 28

This question on determining density by the method of displacement caused little difficulty. Most candidates determined the volume of the stone from the displacement in the measuring cylinder and then correctly calculated density.

Question 29

The topic here was moments. Although a clear majority of candidates correctly multiplied the force by the perpendicular distance to the pivot, some forgot to convert the distance into metres, leading them to select option **D**.

Question 30

A significant proportion of candidates did not convert the time given into seconds, leading them to choose option **D**.

Question 31

Most candidates could identify the process as convection, but some thought that hot air is more dense than cool air.

Question 32

The most common misconception here was to believe that a gas expanding at constant temperature would show an increase in both the average speed of its molecules and the number of collisions each second, option **B**. At a fixed temperature the average speed of the molecules would be unchanged and in a larger volume the number of collisions per second would decrease.

Question 33

This question about a converging lens proved demanding for some with few selecting the correct option, **A**. In this case, the image would be larger than the object and position X represented the principal focus.

Question 35

A common error here was to define an electric field as a region in which a current experiences a force, rather than a charge, whether moving or stationary.

Question 37

The majority of candidates were familiar with the magnetic field pattern due to a current in a straight wire and identified option **A** as showing the correct pattern.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key messages

If candidates are to be awarded maximum marks, they should carefully read the stimulus material and each question and ensure they follow all the instructions.

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

General comments

A good standard of scientific knowledge was displayed by many candidates. Calculations were usually of a good standard with working shown.

Comments on specific questions

Question 1

(a) This concept of a balanced diet was well understood.

(b) Few candidates scored full marks but many scored one or two marks. A common error was to confuse carbohydrate and fats.

(c) Carbon, hydrogen and oxygen were well known as the three chemical elements that make up carbohydrates. Water was a common incorrect response.

(d) Most candidates correctly recalled that Benedict's solution tests for reducing sugars.

(e) Fibre was not well known as the component of the diet that prevents constipation.

(f) Most candidates correctly described the brushing of teeth as a way of taking care of teeth.

(g) Most candidates identified ingestion as one of the processes that occurs in the mouth. Few identified digestion as the other process. Egestion was a common incorrect response.

Question 2

(a) The question required candidates to identify two properties of transition elements that are not shown by other metals. Candidates that read all the information carefully successfully identified **A** and **B**.

(b) (i) Some candidates were able to identify the reactants and products in the reaction.

(ii) Few candidates were able to state the chemical test for carbon dioxide and give the positive result.

(iii) Some candidates knew that a basic oxide was a metal oxide.

(c) This question was well answered and most candidates understood the process of electrolysis.

(d) (i) Very few candidates knew the description of an alloy.

(ii) Few candidates were able to suggest that bronze is harder or tougher than pure copper which is why it is used to make coins but pure copper is not.

Question 3

(a) (i) The adverse effects of ionising radiation on the human body were well known.

(ii) The use of X-rays in hospitals was well known.

(iii) Some candidates were able to place both X-rays and γ-radiation in the correct places. Some candidates attempted to complete the electromagnetic spectrum by inserting visible light and microwaves. This was not required.

(iv) Few candidates knew that all electromagnetic waves travel at the same speed.

(b) Very few candidates were able to determine the half-life of the isotope. A common error was to divide 24 hours (the total time shown on the graph) by 2, giving an answer of 12 hours.

(c) (i) Some candidates were able to define frequency correctly. The number of waves passing a fixed point per second, being a suitable definition.

(ii) Many candidates were able to suggest a frequency for ultrasound waves. Any value above 20 000 was accepted. Most candidates were able to state the unit of frequency as Hertz / Hz.

(iii) Some candidates gained full marks, although some forgot to convert 21 cm to 0.21 m.

Question 4

(a) (i) 3900 was often correctly calculated as the difference in number of infections.

(ii) Many good responses were given and candidates clearly understood the measures taken to reduce HIV infections.

(iii) Most candidates knew that HIV can be transmitted through breast milk.

(b) (i) The nucleus was correctly identified by many candidates.

(ii) Red blood cells were correctly identified by most candidates.

(iii) Very few candidates could name two functions of white blood cells. Phagocytosis and antibody production were rarely seen.

(iv) Plasma was not well known as the part of the blood that transports hormones.

Question 5

(a) Many candidates correctly identified the trend in the melting points. A few candidates misunderstood the question and calculated the difference between the melting points.

(b) (i) Protons and neutrons were correctly suggested by many candidates. Other candidates changed these particles around.

(ii) Many candidates correctly stated the electronic structure as 2, 8, 1.

(c) Many candidates gained one mark but few gained all three. Candidates frequently forgot to show a positive charge on the sodium ion and a negative charge on the chloride ion.

(d) This question was not well understood and explanations were often too vague. Candidates should remember that an element contains one type of atom whereas a compound contains two or more elements chemically bonded together.

Question 6

(a) Many candidates were able to explain the difference between mass and weight in terms of the units used for these quantities.

(b) Few candidates were able to explain that the combined resistance of two resistors connected in parallel is less than that of either resistor by itself. Most candidates calculated the combined resistance of the two lamps connected in series.

(c) Many candidates gained at least one mark, although few gained full marks**.** A larger current, more coils and a greater magnetic field were all correctly given.

(d) (i) This question was not understood by most candidates. Many drew arrows outside the saucepan.

(ii) The expansion of railway tracks was seen but candidates were generally unfamiliar with the problems caused by the thermal expansion of metals.

(e) (i) 100°C was known by most candidates.

(ii) Some candidates were able to explain that the boiling point of a substance is the temperature that the liquid substance turns into a gas.

Question 7

(a) Xylem and phloem were frequently identified but some candidates transposed them.

(b) (i) Cell **C** was a root hair cell. This was well known by most candidates. A few stated that it was a root cell but that was too vague to be accepted.

(ii) Many candidates correctly suggested water as the other substance absorbed by cell **C**.

(c) (i) Magnesium was not well known as the mineral ion needed to make chlorophyll.

(ii) The word equation for photosynthesis was not well known.

(d) (i) Some candidates correctly drew the two arrows although some drew diagonal arrows.

(ii) Some candidates were able to state that the root was responding to gravity.

(iii) Many candidates were able to state at least one environmental condition that seeds need to germinate. Water, oxygen and a suitable temperature were all seen.

Question 8

(a) (i) Many candidates knew that molecule **X** was unsaturated because it contained a carbon-carbon double bond.

(ii) Many candidates were unable to identify molecule **X** as ethene.

(iii) Bromine was not recognised as the element used to test for unsaturation.

(iv) The aqueous bromine test was not well known.

(b) (i) Many candidates were able to balance the equation.

(ii) Some candidates correctly described an exothermic reaction as a reaction that releases thermal energy.

(c) (i) Few candidates could explain why ethanol is not a hydrocarbon. Ethanol is not a hydrocarbon because the molecule contains oxygen. Hydrocarbons contain carbon and hydrogen only.

(ii) A few candidates knew that ethanol can be produced by fermentation or the addition of steam to ethene.

Question 9

(a) Most candidates scored the first marking point but less scored the second marking point, where the candidates needed to identify the forces involved in the acceleration of the aircraft.

(b) (i) Most candidates correctly identified a part of the flight when the aircraft was accelerating.

(ii) Many candidates correctly identified a section of the graph when the aircraft was not accelerating and explain their answer in terms of the aircraft moving at a constant speed.

(c) (i) Chemical energy was not well known as the form of energy stored in aircraft fuel. Kinetic energy was often suggested.

(ii) Most candidates were able to name at least one renewable energy source.

Question 10

(a) (i) Continuous variation was known by some candidates.

(ii) There was a wide range of marks on this question. All four words were known to some candidates but the least known idea was that it is the smaller offspring that are selected.

(iii) Selective breeding was known by many candidates.

(b) (i) Most candidates were able to state the correct sex chromosomes.

(ii) A ratio of 1:1 was well known.

(c) Candidates were unsure of the definition of a gene. A suitable definition is that a gene is a length of DNA that codes for a protein.

Question 11

(a) (i) The pH of pure water was not well known. A common incorrect response was pH 0.

(ii) Gases that cause acid rain were not well known. A common incorrect response was carbon monoxide.

(iii) Universal indicator was well known as the indicator used to find the pH of a liquid. Litmus paper was not accepted as it only indicates if a solution is acidic or alkaline. Using a pH meter was also not accepted.

(b) Most candidates were able to interpret the data to determine the correct order of reactivity**.**

(c) (i) Many candidates were able to name one of the two products, either magnesium sulfate or hydrogen.

(ii) Most candidates suggested at least one way of increasing the rate of reaction, with increasing the temperature being the commonest answer.

(iii) Many candidates identified carbon dioxide as a greenhouse gas. Some also identified methane.

Question 12

(a) (i) Many candidates gained full marks for their drawing of the circuit diagram. A common error was to connect the two lamps in series.

(ii) Some candidates correctly calculated the current as 0.5 A. A common error was to invert the formula and calculate the current as 2 A or to multiply the resistance by the potential difference and calculate the current as 18 A.

(b) (i) Using a magnet was rarely seen. Some candidates who did suggest using a magnet omitted to explain how they would use the magnet to decide whether the bicycle frame was made from steel or aluminium.

(ii) Most candidates gained full marks showing good data handling skills. A few candidates used the wrong formula and multiplied the mass by the volume.

(c) Many candidates found it difficult to describe lateral inversion or suggested just inversion, which was not specific enough to be accepted.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key messages

The number of marks available for each question and the number of answer lines provided is a good indicator of the level of response required by the candidate. For instance, a question worth two marks requires candidates to make two relevant points.

Candidates should be reminded to carefully read the stimulus material and complete all the instructions contained within each question. Candidates should avoid writing answers that are scientifically correct but that do not answer the question asked.

Some areas of the syllabus were better known than others. Candidates should be reminded to revise all the material detailed in the syllabus. A useful guide is to use the syllabus as a revision tool and encourage candidates to go through the syllabus ensuring that they have covered each learning objective in their revision.

General comments

A high standard of scientific knowledge and understanding was displayed by many of the candidates.

In general, candidates expressed reactions in the form of balanced chemical equations correctly. There were occasional inaccuracies in the balancing. This is a skill that candidates should practise and would be useful in **Question parts 1(a)** and **5(d)**.

It would be beneficial for candidates to practise expressing values in standard form and converting units as this proved problematic for some. Forgetting to convert the units was particularly evident in **Questions 3(a)(i)** and **3(b)**.

Correct scientific terminology should always be used. There was some confusion, particularly in **Question 2(c)**, between atoms, ions, molecules, different types of bond and intermolecular forces.

Comments on specific questions

Question 1

(a) The balanced equation for photosynthesis was generally well known. Very occasionally candidates gave the word equation for respiration. Candidates should be reminded to take care when writing the formula for CO_2 so that it does not resemble Co_2, which is incorrect.

(b) (i) Nearly all the candidates were able to identify the temperature that resulted in the fastest rate of photosynthesis.

(ii) Many candidates were able to identify statements that explained the results shown in the table. The most common error was to also tick the statement that 'the number of bubbles produced increases as more substrate is produced'.

(iii) There were some excellent explanations seen with many candidates able to relate the deformation of an enzyme's active site to the inability of the substrate to combine with the enzyme, thereby reducing the rate of photosynthesis.

(iv) Responses were less successful to this question, with many candidates giving vague answers referring to control variables without explaining why light intensity should be controlled. The best responses stated that light intensity also affects the rate of photosynthesis and that this should be controlled so that only the effect of temperature would be shown.

Question 2

(a) Nearly all the candidates were able to give the correct names of the particles. Very occasionally the incorrect responses of alpha, beta and gamma were seen.

(b) (i) Many candidates did not give the most obvious correct answer to the first part and omitted to state that the proton number was 12 because a magnesium atom has 12 protons. The second part of the question was more successful with most candidates stating that the neutron number of 24 was due to the presence of 12 protons plus 12 neutrons.

(ii) Nearly all candidates could state the correct electronic structure of a magnesium atom.

(c) Only the most able candidates were able to successfully answer this question. There was much confusion between ions and atoms and the bonds between molecules. Very few candidates talked about the forces of attraction between the ions in magnesium oxide. Description of the weak intermolecular forces between water molecules, and relating this to the differences in energy requirements for melting, was more successful.

(d) A common omission by candidates was to attempt to calculate the mass of magnesium chloride without calculating the molecular mass of magnesium oxide. Candidates that calculated the molecular masses of both magnesium oxide and magnesium chloride were generally able to calculate the maximum mass of magnesium chloride that could be made.

Question 3

(a) (i) How to calculate kinetic energy was generally well known and understood. The most frequent error was to not convert 56.25 g into 0.056 kg, resulting in an answer of 1800 J. A useful skill for candidates to practise is converting units from one form to another.

(ii) Several candidates stated potential energy rather than gravitational potential energy.

(b) The force was generally calculated correctly. The principle of error carried forward was applied for candidates that had used the incorrect mass in **(a)(i)**.

(c) (i) Almost all candidates were able to identify the correct force of 33 N.

(ii) Hooke's law was well known by most candidates. Some referred to mass applied rather than force applied.

(iii) Several very good descriptions were seen with many candidates successfully relating a lack of a straight line as evidence that the force applied was not directly proportional to the extension of the string.

Question 4

(a) (i) Most candidates were able to interpret the graph to suggest the number of meals as three.

(ii) This question was particularly well answered with candidates understanding the role of the liver and the pancreas. Identifying the compound glycogen was less successful. It's easy to confuse glycogen, glucagon and glucose and candidates should practise the correct spelling of these substances.

(b) The hormone adrenaline was frequently identified, with the hormone glucagon less commonly seen.

(c) Many candidates were able to state the correct mechanism of negative feedback.

(d) (i) Many candidates simply reiterated the information given in the stem or tried to explain absorption in terms of glucose. Absorption is the movement of digested food across the wall of the small intestine into the blood.

(ii) Some excellent descriptions of the adaptations of the small intestine were seen. Very occasionally candidates misidentified villi as cilia.

Question 5

(a) Differences in boiling points were commonly stated, with a minority of candidates incorrectly referring to melting points.

(b) Occasionally candidates did not provide enough information to make their answers specific. For example, when stating a use of diesel oil, references to 'in cars' is too vague and some reference should be made to its use as a fuel in cars. Similarly, the use of naphtha as 'chemicals' rather than as a feedstock or for the production of chemicals.

(c) Some good structural diagrams were seen. Common errors were to include the incorrect number of carbon atoms or to only include three bonds on the end carbon atoms.

(d) Many correct equations were seen. Occasionally equations were not balanced.

(e) It was clear that the majority of candidates understood what is meant by an exothermic reaction.

(f) (i) This question proved problematic for some candidates with a number identifying only the bonds between the atoms of oxygen as needing to be broken.

(ii) The biggest misconception was that energy is released during bond breaking. Some candidates implied that energy is released during both bond making and bond breaking. This particular concept requires clarification for many candidates.

Question 6

(a) (i) Most candidates were able to identify fossil fuels as a non-renewable source of energy.

(ii) A substantial number of candidates incorrectly stated wind as a source of energy that was not dependent on the Sun.

(b) Several excellent responses were seen. Candidates were able to display a very good understanding of why gases are able to fill the container they occupy with correct references to motion, distance between the molecules and the forces involved.

(c) (i) Candidates generally had a very good understanding of how a generator produces an a.c. output. The vast majority of candidates were able to gain at least partial credit for their descriptions. Occasionally they lacked precision when referring to when the current changed direction by omitting that this occurred every half turn.

(ii) Many accurately drawn sine waves were seen.

Question 7

(a) A very good understanding of the structure of a leaf and its function was evident. The most common error was to confuse the xylem and the phloem.

(b) Candidates should have identified a spongy mesophyll **cell**. A number identified the layer of tissue rather than an individual cell.

(c) (i) Phloem was frequently identified as the part responsible for translocation with xylem being a common incorrect answer.

(ii) Sucrose was commonly seen with amino acids being less frequently seen. Water and mineral ions were the most common incorrect answers.

(d) Many candidates were able to give the correct features of transpiration and translocation with little confusion between the two processes.

Question 8

(a) (i) Most candidates were able to use the graph to state the correct mass of 0.3 g. A mass of 0.17 g was the most common incorrect answer seen.

(ii) Occasionally there were some inaccuracies in stating the correct number of seconds. Care should be taken when reading values from graphs.

(b) Many candidates had the right idea but struggled to express it adequately. Many candidates referred to fewer particles without specifying in terms of particle density. Similarly, many responses referred to fewer collisions rather than less frequent collisions.

(c) The test and positive result for the presence of carbon dioxide was well known by the majority of candidates.

(d) Calculations were generally correct with workings clearly shown. The step that caused the most issues was the calculation of the number of moles of carbon dioxide, with some candidates multiplying the molecular mass of carbon dioxide by the mass.

Question 9

(a) Some responses lacked precision when describing a transverse wave. Candidates should refer to vibrations or oscillations of particles rather than just direction. Responses such as 'the wave is perpendicular to the movement' were not clear enough to be awarded credit.

(b) (i) Some very good ray diagrams were seen with correct refraction of the ray. Occasionally the ray was shown moving away from the normal or not emerging in parallel with the incident ray.

(ii) The majority of candidates stated the correct answer of refraction.

(iii) Some candidates were not specific enough and simply stated that refraction was caused by the ray of light passing through different media, rather than explaining in terms of different densities of media or reference to the changing speed of light.

(c) The correct answer of 5.4 W was frequently seen.

(d) (i) Occasionally candidates did not appreciate that there were two lamps in the circuit and that current would be split equally between them.

(ii) This calculation was generally completed correctly. some candidates gave the incorrect unit.

Question 10

(a) (i) The majority of candidates were able to interpret the graph to identify the correct number of people.

(ii) Some vague responses were seen and some incorrectly described blood groups as having a range. The best responses identified the limited number of phenotypes, or blood groups, and that there were no values in between these groups.

(iii) Many responses correctly identified genes but there were some incorrect references to mutation.

(iv) A number of examples of continuous variation were seen with height being the most commonly stated.

(b) The functions of the components of blood were generally well known.

(c) Some excellent descriptions of the adaptations of red blood cells were seen.

Question 11

(a) The majority of candidates were able to describe how sodium and chloride ions were formed in terms of loss or gain of an electron.

(b) This question proved challenging, with many candidates simply reiterating the information they gave in response to **(a)**. Few candidates described the attraction between oppositely charged ions.

(c) Most candidates determined the correct formula of aluminium chloride by balancing the charges.

(d) Some good descriptions were seen. However, candidates should be encouraged to read the question carefully and complete all the instructions contained in the question. A number of candidates gave very detailed descriptions of the process of electrolysis without reference to the starting materials or the conditions required for electrolysis and so were only able to gain partial credit.

(e) The most common misconception evident was that reducing agents gained electrons.

Question 12

(a) Most candidates calculated the distance using the area under the graph. A number of candidates tried to calculate the distance using the formula speed multiplied by time and the values of 100 m / s and 10 s, resulting in the incorrect value of 1000 m.

(b) The majority of candidates were able to calculate the correct value of 0.1 m/s^2.

(c) There were inaccuracies in some candidates' descriptions with some confusing acceleration with speed. Some candidates correctly described the train travelling at a constant speed for the last section of the graph, but there were a number that thought the train had stopped moving. The biggest misconception was that at 135 seconds the train slowed in speed rather than decreasing in its acceleration.

(d) (i) The magnitude of the force was generally identified correctly.

(ii) The mass of the train was generally correctly calculated with the occasional incorrect values of 1.96×10^6 kg or 1.96×10^7 kg seen.

(e) There were a number of inaccurate statements referring to reflection or absorption of light. Some candidates did not qualify their statements and simply stated that white reflects thermal energy or that grey absorbs thermal energy.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

Candidates are advised to practise drawing tables during class practical activities. It is important to use detailed column headings and only include units in the column header, not in the body of the table.

Candidates are encouraged to show their working for all calculations. This ensures that some credit can be awarded even if the final answer is incorrect.

Candidates would benefit from reading through the plans they design to investigate a hypothesis. Additional details, such as the number of repeats, should be clear and concise.

Candidates would benefit from more opportunities to practise interpreting experimental data and evaluating experimental methods as they found these skills challenging.

General comments

Candidates were generally well prepared for this Alternative to Practical paper and were familiar with the experimental techniques.

The standard of graph drawing was good although candidates should remember that both axes need to be labelled with a quantity and an appropriate unit.

Candidates performed well on the planning question, describing their investigation in a logical sequence and making reference to the bullet points in the question.

Comments on specific questions

Question 1

(a) The majority of candidates named a piece of apparatus with suitable graduations. Pipette should be qualified as either graduated pipette, volumetric pipette or a pipette of a specified volume.

(b) Most candidates read the time correctly. A small number incorrectly recorded 137 seconds.

(c) (i) The standard of graph drawing was generally good. Some axes were either totally unlabelled or had the units missing.

(ii) Lines were generally well drawn but some were too far from the plotted points or drawn point-to-point rather than best fit.

(d) (i) The relationship was well described by most candidates. A small number discussed rate rather than time.

(ii) The majority of candidates read the value from their graph correctly, those with more difficult scales often misread the value. A significant number did not show on their graph how they determined their answer. A vertical line from the *x*-axis at 4.5% and a horizontal line to intercept the *y*-axis is the clearest way to show this.

(iii) Candidates found this question demanding. The answer needed to include a comparison of times. Many candidates repeated the stem of the question, stated the relationship between concentration and rate or quoted 192 s with little or no explanation.

(e) Most candidates could state one variable and many stated two. Incorrect responses included enzyme or milk with no qualification, such as concentration or volume.

Question 2

(a) (i) Food tests were well known and most candidates knew that biuret solution tests for protein and iodine solution tests for starch.

(ii) Most candidates gave appropriate conclusions from the results.

(b) (i) Reducing sugar was well known. A significant number of candidates simply stated sugar rather than reducing sugar.

(ii) The colours for different concentrations were quite well known. Some candidates incorrectly gave blue for low concentration.

(iii) Most candidates named a suitable safety precaution. Fewer explained what was being protected or what it was being protected from.

Question 3

(a) (i) The majority of candidates rounded the values to one decimal place correctly. A small number copied the values into the table without rounding. This shows the importance of reading the question carefully.

(ii) Most candidates placed the metals in the correct order. A small number reversed iron and zinc.

(iii) Most candidates could state one variable and many stated two. Incorrect responses included salt solution with no qualification, such as concentration.

(b) (i) The results table was generally well drawn. Some candidates omitted headers in their columns. A few omitted the ‘quite’ in ‘quite fast’ for zinc and a small number omitted the ‘very’ in ‘very fast’ for magnesium.

(ii) Candidates found this order of reactivity more challenging than that in **(a)(ii)**. Some reversed iron and zinc and many did not give iron and copper as having the same reactivity.

(c) (i) Candidates found this question difficult. Many thought that the method in experiment 2 gave a better order as the bubbles were easier to see. Experiment 1 would give a better order of reactivity because the results are quantitative and allow all of the metals to be separated.

(ii) Candidates found this very difficult. Many suggested measuring or using the same volume of acid and of those who suggested collecting the gas, few appreciated that the time for collection also needed to be measured.

(d) The test for hydrogen gas was generally well known. A small number of candidates gave either the test for oxygen or the test for carbon dioxide.

Question 4

There were five aspects which needed to be included in the plan. Candidates needed to address at least one point from each aspect and then any two others in order to gain full credit.

Some candidates measured the volume of gas produced, the time or the mass of the reactants but did not include the apparatus required. Many candidates measured time for an amount of gas to be produced but did not describe starting and stopping a timer. Few repeated the experiments to increase reliability. Of those who went on to draw a graph few had five different concentrations of hydrochloric acid. A safety precaution was usually included but few explained it in the detail required.

Control variables were well known. A small number kept the concentration of hydrochloric acid constant.

Candidates continue to find processing results and drawing conclusions difficult, many giving a conclusion from prior knowledge rather than explaining how the results could be used to find a pattern. If a graph is to be drawn, the quantities on both axes need to be given.

Question 5

(a) (i) Most candidates measured the diameter correctly. A small number of 1.1 and 0.16 were seen.

(ii) Most candidates measured the length correctly. A small number of 12.0 and 13 were seen.

(iii) Most candidates calculated the volume correctly. A significant number did not give the value to two significant figures.

(b) (i) Most candidates measured the volumes correctly. A small number of 70.9 and 50.8 were seen.

(ii) Many candidates calculated the volume correctly. Some multiplied or divided the values and 82 was seen quite often.

(iii) Candidates found this quite difficult. Common incorrect responses described rounding to two significant figures, inaccuracy of measuring cylinders, contamination, misreading values and human error unqualified.

(c) More able candidates appreciated that either the rounded bottom meant the test-tube was not a cylinder, or that the external volume had been calculated since the glass is included in the measurement. Many candidates discussed the values being rounded to two significant figures or restated that the test-tube was considered to be an approximate cylinder without explaining why this would give an over-estimate of the value.

Question 6

(a) Most candidates drew the correct symbol for a voltmeter. A small number drew a line through the symbol. More able candidates connected the voltmeter in parallel. A significant number connected it in series and some added two voltmeters, one across each lamp.

(b) Most candidates read the voltmeter correctly.

(c) (i) The unit for power was well known. Common incorrect responses included J, N, Ω, V and P.

(ii) Most candidates calculated the power correctly. A very small number rounded their values incorrectly.

(d) Candidates found this very challenging. Most omitted to calculate 2 × power output of circuit 1 or ½ × power output of circuit 2 in order for the comparison to be made. Only the strongest candidates calculated 10% of either value in order to determine whether the values were within 10%. Weaker candidates discussed current rather than power.

(e) Candidates found this quite difficult. Incorrect responses included more power, less power, check the wires or take one bulb out and see if the other lights.

(f) (i) Most candidates drew a correct circuit. A small number drew two lamps in series with the third in parallel to them.

(ii) The majority of candidates drew a correct circuit. A small number included 4 or 6 bulbs or a short circuit wire.