CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 2**, **4**, **14** and **17**. **Questions 18**, **23**, **27**, **33**, **34**, **39** and **40** proved the most difficult for candidates.

Comments on specific questions

Question 2

Most candidates recalled that diffusion is the movement of molecules down a concentration gradient from a higher concentration to a lower concentration.

Question 3

There was some uncertainty as to whether glycogen is made from glucose or glycerol, with a significant number also thinking it is made from fatty acids.

Question 4

In this question, candidates had to interpret a graph of enzyme activity. This caused little difficulty, and the majority of candidates selected the correct answer.

Question 5

Correctly filling in the gap in the word equation for aerobic respiration was achieved by almost all candidates.

Question 8

Candidates had little problem identifying limewater as the test for carbon dioxide.

Question 14

Most candidates knew that combustion of hydrocarbons is a chemical change.

Question 17

Most candidates identified the correct formula of an organic compound from its displayed structure.

Question 18

Candidates chose the incorrect options **A** and **B** more often than the correct option **C**. Candidates are required to know the gaseous products of the electrolysis of concentrated sodium chloride. They are also expected to know the tests for these gases, chlorine and hydrogen.

Question 19

Some candidates chose the incorrect options **A** and **B** rather than the correct option, **D**. Candidates should recognise that exothermic reactions release thermal energy, which increases the temperature of the test-tube and its contents.

Question 21

Stronger candidates chose the incorrect option **D** rather than the correct option, **B**. Candidates are expected to know that ammonia and sodium hydroxide are bases, and that bases react with acids and not with other bases.

Question 23

There was evidence that many candidates had guessed at the answer. Successful candidates understood that transition elements are positioned in the middle of the Periodic Table, and that these elements can catalyse chemical reactions.

Question 24

Candidates chose the incorrect option **A** more often than the correct option **B**. Candidates are required to know that aluminium is extracted from the ore bauxite and that it is extracted by electrolysis.

Question 27

There was evidence that many candidates had guessed at the answer. Candidates are expected to know that ethanol may be formed by reaction between ethene and steam.

Question 29

This question concerned addition of forces. A large proportion of candidates appreciated that the air resistance force was 40 000 N, but many of these believed that this force acts forwards, therefore opting for the incorrect option, **C**.

Question 32

There was some confusion here with many opting for **A** (wavelength) or **B** (related to wave speed). Stronger candidates were aware that amplitude is related to vertical motion, but several chose **C** (half of the period of oscillation).

Question 33

This question on refraction of light was not well answered, with even the strongest candidates frequently believing the angle of refraction to be that labelled Q (option **B**).

Question 34

Speed of sound was the topic here and many of the candidates incorrectly selected option **A**. These candidates made the common mistake of forgetting to double the distance to the wall in their calculation.

Question 38

Many candidates chose option **B**, failing to recognise the shape of the magnetic field around the wire.

Question 39

This question on half-life proved demanding for candidates of all abilities. They could not calculate that 20 minutes represented four half-lives and many apparently divided the final rate of emission by the total length of time taken to decay, leading them to arrive at 4.0 minutes (option **A**).

Question 40

In this question, options **A**, **B** and **C** were equally popular, suggesting uncertainty about the effect of emitting an alpha-particle on a nucleus.

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Paper 0654/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 14**, **21**, **22**, **25**, **27** and **37**. **Questions 20** and **37** proved the most difficult for candidates.

Comments on specific questions

Question 3

The majority of candidates correctly identified a protein molecule as containing carbon, hydrogen, oxygen and nitrogen.

Question 4

Most candidates realised that statement 1 was incorrect. Those that did not were equally divided on the possibility of the active site being no longer complementary in shape to the substrate or the enzyme being denatured.

Question 11

This question involved the interpretation of a pedigree diagram. Most candidates correctly identified the chance of a fourth child having the recessive condition as 25%.

Question 14

Candidates easily identified the chemical changes in the list of changes.

Question 20

Candidates chose the incorrect options **A** and **C** more often than the correct option, **B**. Candidates are required to know that oxidation is the loss of electrons. They should also understand that when bromide ions, form bromine molecules, they lose electrons and so are oxidised.

Question 21

Candidates knew well that damp red litmus is used to test for ammonia gas.

Question 22

Candidates knew well that Group I elements are relatively soft metals.

Question 25

Candidates understood very well that in the treatment of the water supply, chlorination is used to kill bacteria and filtration is used to remove insoluble substances.

Question 27

Candidates knew well how to identify the names of individual alkanes and alkenes from their displayed structures.

Question 29

In this question on electrical power, some candidates forgot to convert the time from minutes to seconds and therefore selected option **C**, or more commonly still, divided the power by the time in minutes, leading to option **B**.

Question 33

The majority of candidates were able to choose the correct description of the image formed by a plane mirror.

Question 34

Although it was very widely known that refractive index is given by the ratio of the speeds of light rather than the frequencies, a common error was to choose option **B**, the reciprocal of the correct answer.

Question 37

This question was demanding for candidates. Many knew that the resistance of the thermistor decreases, but chose option **A**, indicating that the voltmeter reading also decreases. It is likely that they did not notice that the voltmeter was connected across the fixed resistor rather than the thermistor.

Question 38

A significant proportion of candidates selected option **D**, not appreciating that the 3 A fuse would be the most appropriate choice for a slow cooker that draws a current of 1.0 A.

Question 40

The topic here was nuclear change associated with beta emission. It was very widely known that the nucleon number remains constant, options **B** or **C**, but some candidates knowing this opted for **B**, being unaware that the proton number increases rather than decreases.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key messages

Some candidates did not completely answer the questions. To access the maximum marks available, candidates should read the question carefully and complete all the instructions contained in the question.

Any formula quoted should be in a standard form and use recognisable symbols.

General comments

A good standard of scientific knowledge was displayed by many candidates. There was a good range of marks on every question and on the paper as a whole.

Calculations were often done well with working shown.

Comments on specific questions

Question 1

(a) (i) Most candidates knew at least one of the parts. Few knew all three.

(ii) Many candidates identified at least one cell structure that is present in both animal and plant cells. All three correct answers **A**, **E** and **F** were seen.

(b) (i) Magnification was quite well known. Candidates had more difficulty describing image size. Length and height were often suggested.

(ii) Many candidates gained full marks. Vacuole and osmosis were the least known terms.

Question 2

(a) (i) Cracking was well known as the process. Combustion was a popular incorrect response.

(ii) Fermentation was well known.

(iii) Polymerisation was well known.

(iv) Chromatography was well known as the process. Filtration was a popular incorrect response.

(v) Electroplating was well known as the process. Rusting was a popular incorrect response.

(b) Few candidates were able to name a suitable acid and base. The most popular suggestions were sodium and chloride or chlorine.

(c) Some candidates drew very clear diagrams. The sodium atom was more often correct than the sodium ion.

(d) The only error here was that some candidates reversed left and right.

Question 3

(a) (i) Many candidates incorrectly suggested that ice, wood and plastic are good thermal conductors.

(ii) Most candidates correctly suggested copper and iron as the two materials that are good electrical conductors.

(iii) Iron was very well known as a material that a magnet attracts.

(b) A number of candidates found it difficult to determine the volume of the block of wood. Many candidates knew the correct formula for density but some did not know the units.

(c) This question required an answer in terms of the arrangement of the particles and not the separation or motion of the particles. Therefore, candidates needed to describe the regular arrangement of particles in ice and the irregular arrangement of particles in water.

(d) Electrons were not well known as the particles that are transferred.

Question 4

(a) (i) Relay neurone was not well known. Motor and sensory neurone were sometimes suggested.

(ii) Many candidates correctly identified the direction of impulses in parts **X** and **Z.**

(iii) Many candidates correctly identified the muscle as the effector but a few candidates suggested that the stimulus was a change in temperature or the hot object. Many candidates incorrectly suggested the hand.

(iv) Sensitivity and movement were well known as the two characteristics of life involved in the reflex action.

(b) (i) The brain was well known as the other part of the central nervous system.

(ii) The peripheral nervous system was not well known.

Question 5

(a) The percentage of nitrogen in clean air was well known. A number of candidates suggested 70%.

(b) (i) A number of correct explanations were seen, including full outer electron shell.

(ii) The use of argon in lamps and light bulbs was well known.

(c) (i) There were many possible answers. Most responses were too vague, for example, factories, industry and cars.

(ii) Many candidates were able to name another oxide that is a pollutant in the air.

(d) (i) Few candidates suggested that the acid rain is dilute or at a low temperature.

(ii) Calcium carbonate or limestone was a popular and correct answer. Fertiliser was often incorrectly suggested.

(iii) Neutralisation was well known as the type of reaction. Popular incorrect answers were endothermic and fertilisation.

(e) Carbon dioxide and methane were frequent correct answers.

Question 6

(a) (i) Coal was well known as the energy source that produces carbon dioxide when it is used to generate electricity in a power station.

(ii) Tidal, wind and waves were all commonly suggested as another renewable energy source.

(iii) Some candidates correctly identified chemical energy as the form of energy stored in coal. Thermal energy was often incorrectly suggested.

(iv) This question was well answered.

(b) (i) Gamma rays were quite well known as the emission which is part of the electromagnetic spectrum.

(ii) Most of the candidates who correctly suggested gamma rays in **(i)**, were able to place it in the correct position in the electromagnetic spectrum.

(iii) This question was correctly answered by many candidates.

(iv) Candidates were uncertain about the nature of an α-particle.

(c) (i) Many candidates successfully divided 96 000 by 24 000 but did not seem to realise that this meant that there were four half-lives.

(ii) Many candidates were unable to complete the word equation correctly.

Question 7

(a) Few candidates were able to define the term gene as a length of DNA that codes for a protein. A number of candidates did, however, refer to a length of DNA.

(b) (i) Almost all candidates correctly identified the wrinkled yellow peas as the most frequent pea colour and shape.

(ii) Almost all candidates correctly stated the frequency of wrinkled green peas as three. Eight was the only other answer suggested.

(iii) Very few candidates were able to explain why pea colour and shape are examples of discontinuous variation.

(iv) Examples of continuous variation were not well known. Many candidates gave examples of discontinuous variation.

(c) Few candidates gave a good description of selective breeding. The marking point mentioned most often was for the farmer selecting smooth green pea plants.

(d) Natural selection was well known.

Question 8

(a) (i) Some candidates knew that methane is the main constituent of natural gas. Other candidates suggested gas or coal.

(ii) Covalent bonding was well known. Ionic bonding was a popular incorrect answer.

(iii) Many clear and accurate dot-and-cross diagrams were drawn.

(b) (i) Almost all candidates balanced the symbol equation correctly.

(ii) Many candidates were able to show an understanding of oxidation.

(iii) Many candidates were able to describe the adverse effects of carbon monoxide on the health of humans.

(c) Most candidates showed an understanding of the differences between an element and a compound.

Question 9

(a) (i) Although many candidates were able to indicate a time when the penguin was accelerating, some did not indicate the time when the penguin had the greatest acceleration.

(ii) Most candidates were able to indicate a time when the penguin was swimming at constant speed. Fewer candidates were able state this speed.

(b) (i) Few candidates stated both the quantities. Area was the least known quantity.

(ii) Uses of infrared radiation were not well known.

(c) Few candidates correctly stated two frequencies.

(d) Many candidates gained at least two marks. The marking point frequently missed was to make a loud sound.

Question 10

(a) Most candidates were awarded one mark, either for trachea or diaphragm. The trachea was often confused with the oesophagus. The diaphragm was often confused with the ribs or rib cage.

(b) (i) The most popular and also correct response was 5%. Incorrect answers were 23.8 and 20.96.

(ii) The limewater test for carbon dioxide was quite well known.

(iii) Respiration was quite well known as the chemical reaction.

(c) The idea that an increased depth of breathing is required during physical activity was not well known. An increased heartbeat or pulse rate was often suggested.

(d) (i) Most candidates were able to state at least other major component of blood

(ii) This question was not well answered. Few candidates referred to pathogens, viruses or bacteria being killed, destroyed or engulfed.

Question 11

(a) (i) Most candidates were able to suggest a suitable pH value for dilute sulfuric acid.

(ii) Most candidates identified magnesium as the most reactive metal.

(iii) Few candidates identified hydrogen as the gas produced. Carbon dioxide and sulfur dioxide were frequently suggested.

(iv) The formula of sulfuric acid was well known.

(b) (i) Some candidates were able to state that an alloy was either a mixture of metals or a mixture of a metal and other elements.

(ii) Some candidates correctly determined the mass as 83 g or 82.5 g.

(c) (i) Most candidates were awarded at least one mark.

(ii) Most candidates deduced the number of electrons as 30.

(iii) Most candidates deduced the number of neutrons as 34.

(d) Few candidates were able to state what is meant by a finite resource.

Question 12

(**a)** Many candidates were awarded two marks.

(b) Many candidates were able to calculate the wasted energy. 10 J was a common error.

(c) (i) Only candidates who showed the ray of light bending towards the normal were awarded the mark.

(ii) Some candidates correctly labelled either the angle of incidence or angle of refraction, both were required for the mark.

(d) (i) Some candidates drew the double headed arrow accurately. The arrow needed to go from one peak to the next.

(ii) Some candidates drew the double headed arrow accurately.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key messages

There are several skills that would benefit candidates to practise to access the maximum credit available.

- One of these skills is the ability to convert units. This skill was essential for question **6(a)** which required the conversion of days to seconds and **9(a)(iii)** which required the conversion of millimetres to metres. Candidates should state the formula used in all calculations.
- Describing data is another key skill. To aid in their descriptions, candidates should refer carefully to the stimulus material provided and in particular the axes titles and information contained within any graphical stimulus. Using table headings and axes titles in descriptions of data ensures greater accuracy in their responses. This skill was beneficial in questions **6(b)(ii)**, **10(a)(i)** and **11(b)(i)**.
- Candidates should be encouraged to practise balancing equations. This is an important skill across the scientific disciplines and was essential for accessing the maximum number of available marks in questions **2(a)(iii)**, **5(a)(iii)** and **11(c)**.

General comments

There was a high standard of scientific knowledge and understanding seen with many candidates providing detailed and accurate responses. Most candidates attempted all of the questions on the paper.

Whilst many candidates had a broad knowledge of the syllabus, it was evident that some areas of the syllabus were better known than others. For general guidance, the syllabus can be used as a guide of what content needs to be covered and can provide an excellent revision tool for candidates.

Comments on specific questions

Question 1

(a) Most candidates were able to identify the tube transporting excretory products as **B**. A common misconception was to identify part **D** as the one which secreted fluid for the formation of semen instead of the part labelled **E**. Occasionally candidates incorrectly identified part **E** as the location of meiosis instead of part **D**.

(b) (i) This question asked for the arrangement of the chromosomes and not the number. Many candidates stated that there were a haploid number of chromosomes, but this did not answer the question posed. Stronger candidates were able to describe the chromosomes as being unpaired.

(ii) Candidates should use the correct terminology as stated in the syllabus. The part should have been identified as the flagellum. A wide variation of spelling was seen. Most candidates were able to identify the function as being used for movement.

(c) Many excellent responses were seen. The cells responsible for phagocytosis was the least well known.

(d) Many excellent responses were seen with plasma or platelets nearly always given.

Question 2

(a) (i) The correct order of reactivity of the three metals was commonly seen.

(ii) Many correct responses were seen. A common incorrect colour given was yellow.

(iii) This question involved identifying the correct products and then balancing the equation. Common errors included giving one of the products as NaO or O_2. Candidates were generally able to balance the equations that they provided.

(b) (i) Very occasionally candidates attempted to draw sodium and chloride ions as being covalently bonded. Most candidates were able to draw ions with the correct number of electrons in their outer shell. Very occasionally the charges were muddled or absent.

(ii) Several candidates misinterpreted this question and described the bonding of sodium chloride, referring to the loss and gain of electrons to form an ionic bond. Stronger candidates described the structure with reference to a regular or lattice structure. Very few candidates described the structure in terms of alternating positive and negative ions.

(iii) A common misconception was to explain the conduction of electricity in terms of the movement of delocalised electrons rather than mobile ions.

Question 3

(a) (i) The majority of candidates were able to state 2.0 cm as the original length of the spring. Very occasionally 12.0 cm was given.

(ii) Some candidates did not consider the original length of the spring, using the value of 12.0 cm for the extension. However, credit was available for the correct use of the formula.

(iii) Most candidates were able to state that point **X** identified the limit of proportionality. Elastic limit was an acceptable alternative.

(b) A number of candidates identified that mass and volume were required to calculate the density but did not explain how these values were measured. Candidates that did describe how to measure the volume, often gave a good description of using displacement. It is important for candidates to use the correct names for apparatus. A weighing balance or scales were appropriate to measure the mass rather than a weighing machine. Almost all candidates were able to provide a correct formula for calculating the density.

(c) (i) There were some inaccuracies seen in drawing the amplitude, with many candidates drawing the arrow too short.

(ii) Many candidates were able to identify the oscillations as being perpendicular to the direction of the transfer of energy in a transverse wave.

Question 4

(a) (i) Commonly seen incorrect responses included giving the value of 7 instead of 2 for the number of individuals with homozygous recessive genotypes and identifying the number of people with XX chromosomes as 5 instead of 4.

(ii) The correct response was **Dd**. Heterozygous was an accepted alternative. It was evident that some candidates did not understand the meaning of the term genotype.

(iii) Many candidates gave the correct percentage of 25%. Incorrect responses of 50% and occasionally 0% were seen.

(b) Most candidates were able to provide at least one disease caused by protein-energy malnutrition. Other incorrect deficiency diseases such as scurvy were occasionally seen.

(c) Amino acids were commonly given as the smaller molecules that make up proteins. A minority of candidates misinterpreted the question and gave the elements that each example was composed of. The smaller molecules that starch is made from proved the most troublesome.

(d) The correct enzyme of protease was commonly seen. Occasionally examples of proteases were given such as pepsin or trypsin. These were also acceptable.

Question 5

(a) (i) The majority of candidates were able to identify the correct terms of anode and cathode and get them the correct way round.

(ii) Oxygen was commonly seen. A common incorrect response was sulfur.

(iii) The incorrect charge of $^{2+}$ was often seen on the hydrogen ion. Sometimes the hydrogen ion was not given a charge. Stronger candidates were able to complete the equation.

(iv) Few candidates gave the incorrect response of oxidation. Occasionally reduction was paired with the explanation of loss of electrons rather than gain.

(v) It was evident that some candidates confused the tests for oxygen and hydrogen, referring to a glowing splint. Most candidates identified the result as a 'pop sound'.

(b) Many candidates were able to calculate the moles of hydrogen as being 0.25. Fewer calculated the molecular mass as 2, often giving the overall mass as 0.25 instead of 0.5 g. Very occasionally the formula used was incorrectly rearranged.

Question 6

(a) This question proved more demanding for candidates. Almost all candidates realised that to show the speed, the distance needed to be divided by time. Many candidates were able to show how time could be calculated. The showing of the calculation of distance proved more challenging, with few candidates able to show that distance was calculated using the formula $2\pi r$.

(b) (i) The correct notation for a beta particle was commonly seen.

(ii) Fifty billion years was commonly identified from the graph. Occasionally the incorrect units of Bq or years were provided.

(iii) A frequent error was to not subtract the value the candidates received by 100, giving a value of 93% rather than 7%.

Question 7

(a) (i) The majority of candidates gave the correct value. Occasionally the value of 62 bubbles per minute was given.

(ii) This question was very well answered. A few candidates confused decreasing the distance of the lamp with decreasing light intensity. A minority of candidates described the products of photosynthesis as being carbon dioxide.

(iii) The majority of candidates recognised that a reduction in carbon dioxide would result in less oxygen production due to less photosynthesis.

(b) Some candidates simply referred to temperature and pH and needed to provide some additional detail. A minority of candidates described low temperatures as resulting in denaturation.

(c) (i) The correct response of phototropism was commonly seen.

(ii) The correct response of auxin was commonly seen.

Question 8

(a) (i) Hydrogen gas was commonly seen.

(ii) A temperature in the acceptable range was commonly seen. Providing a reasonable value for pressure proved more difficult for candidates with values of 2 atmospheres occasionally seen.

(iii) This question was well answered, with the use of iron as a catalyst commonly seen.

(b) A significant number of candidates had difficulty calculating the relative molecular mass. Incorrect values of 560 were often seen.

(c) (i) Candidates could generally describe the first part of the process of removing impurities from iron using calcium oxide. Several candidates had issues with naming the correct compound of calcium silicate. Slag was an acceptable alternative. Few candidates were able to identify the impurities as being acidic.

(ii) Occasionally candidates attempted to explain this in terms of hydrogen ion donation. However, many candidates were able to recognise that a basic oxide formed because a metal was used, and an acidic oxide formed with a non-metal.

Question 9

(a) (i) Many candidates described the black colour as absorbing radiation while the white colour reflected radiation, rather than comparing their absorption ability. Several candidates referred to the absorption of light rather than radiation.

(ii) Many candidates described the reflection of light rather than radiation. Some candidates described emission.

(iii) Difficulties included using the wrong value for the speed of electromagnetic radiation and not converting the units from mm to m for the length. This resulted in a value of 4.0×10^8 Hz being frequently seen.

(iv) Several candidates described the vibrations of electrons. Candidates should be reminded that conduction takes place through delocalised electrons in addition to the passing on vibrations through neighbouring atoms in the material.

(b) (i) Only the strongest candidates were able to gain credit. Most candidates were not able to give a description to a suitable level of detail.

(ii) It appeared that candidates felt they needed to place a tick in each column, incorrectly identifying that only potential difference is measured with a voltmeter.

Question 10

(a) (i) Candidates should use the axes labels to describe the trends on a graph. Some candidates were not precise enough in their responses to gain credit with some not referring to the percentage of energy used. Very occasionally candidates confused aerobic respiration with anaerobic respiration.

(ii) The correct value of 3.5 arbitrary units was routinely identified.

(b) Many candidates described the disadvantages of anaerobic respiration in terms of the production of lactic acid and the resultant oxygen debt. A number of candidates also stated that anaerobic respiration releases less energy than aerobic respiration. However, to achieve this marking point candidates needed to have specified that anaerobic respiration releases less energy per glucose molecule than aerobic respiration.

(c) (i) Many candidates identified the correct statements. However, some candidates thought that a double circulatory system allows higher pressure of blood to the lungs.

(ii) This question was very well answered with many specifying contraction of the muscle rather than just referring to pumping of the heart.

Question 11

(a) Very occasionally the term unsaturated rather than saturated was given. More commonly seen was single bonds as one bond.

(b) (i) A minority of candidates misidentified that a higher number of carbons resulted in a larger amount of energy released.

(ii) The correct response of exothermic was commonly seen.

(c) The majority of candidates were able to deduce the correct product.

(d) Fuel oil was often given as the correct fraction. However, a few candidates explained this in terms of having the most supply rather than identifying that the supply was greater than the demand.

Question 12

(a) Some candidates did not consider the gravitational field strength and gave a value of 18 000 J.

(b) (i) This question proved demanding for all but the strongest candidates. The magnetic field was sometimes drawn as a continuation of current joining one end of the solenoid to the other. It was common to see the magnetic field not being drawn through the centre of the solenoid. There were also difficulties in drawing the arrows in the correct direction.

(ii) Some candidates had difficulty in calculating charge correctly, several giving a value of 150 C. Some candidates struggled with identifying the correct units, with V, A/S and J seen.

(iii) This question was generally very well answered. Some candidates calculated the voltage as 250 V but did not continue the calculation to calculate the power.

(c) Most candidates recognised the ability of an electromagnet to turn on and off.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

Key messages

It is advisable for candidates to read all questions carefully to ensure they have answered the whole question. This will ensure that numerical answers are given to an appropriate number of significant figures or decimal places and that written responses cover all aspects of the question.

Proportionality of variables was not well understood.

General comments

Candidates were generally well prepared for this examination and were familiar with several experimental techniques. Answers to the planning question were sometimes detailed and logical. Candidates found interpreting and evaluating experiments demanding.

The standard of graph drawing was quite good although candidates need to remember that axes need to be labelled with a quantity and a unit, scales must be linear and begin at the origin. A line of best fit needs to be a single line and not dot-to-dot. The equation for the gradient of a line needs to be learned and indications of how values were found need to be shown clearly on the graph.

It is important to include either precipitate or solution when completing qualitative analysis observations.

Comments on specific questions

Question 1

(a) (i) Most candidates completed the experiment well. The main issue was recording the values to the nearest 0.5 cm^3, where the value should end in .5 or .0.

(ii) Most candidates calculated the volumes correctly.

(b) (i) Stronger candidates appreciated that the hydrogen peroxide is being used up during the experiment. Common incorrect responses stated that all the gas is lost so there is no more to collect, gas escapes and catalase is either used up or denatured.

(ii) Most candidates appreciated that the results supported the suggestion but many either restated the stem of the question or did not quote data in their answer or discussed the volume decreasing with each reading.

(c) Identifying or excluding anomalies were well known by stronger candidates, Common incorrect responses included more accurate and reduces errors.

(d) Many candidates appreciated that gas was lost before the stopper was replaced. Few gave an improvement to the apparatus but described replacing the stopper more quickly. Using a lid or cap and repeating the experiment were also common. A small number used a thistle funnel or had help from another person, both of which were accepted. Few candidates described either a divided flask or a small tube inside the flask on a piece of string.

(e) Most candidates stated a correct colour for universal indicator and described the solution as acidic. Few described the solution as weakly acidic.

Question 2

Some candidates found the plan demanding. However, some addressed the bullet points and gave a logical description of the investigation.

A common error was only considering time whereas the question required rate to be investigated.

A list of apparatus is unable to score unless the apparatus needed for the investigation is used in the plan. Many measured length or mass or volume without mentioning the apparatus they would use to measure it. Scale or scales is not creditworthy. The quantity being measured needs to be clear e.g., weighing scale, ruler.

Many candidates used the three fertilisers on separate seedlings and left them for a stated amount of time. Many did not mention a growing medium such as soil or left the seedlings for a matter of hours rather than days or weeks. A significant number discussed germination of seeds rather than the growth of seedlings.

Many candidates measured the growth of the seedling without specifying what they would measure i.e., length or height. More successful candidates used many seedlings in each fertiliser or repeated the test several times for each fertiliser.

Control variables were well known, and candidates tended to score the maximum number of marks in this section. Some discussed variables without either describing them as control variables or stating that the variable was the same each time.

Candidates find processing results and reaching conclusions challenging. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Very few candidates calculated a rate of growth for each seedling. Some drew a graph without specifying the quantities on each axis. A small number measured the heights daily and plotted a graph of height against time for the three fertilisers on the same graph and then made a comparison. The use of the results to formulate a conclusion for the details of their investigation is required, for example stating the fertiliser which gave the highest rate of change of height.

Question 3

(a) (i) (ii) The majority of candidates completed the experiment very well. Some did not give their times to the nearest second.

(b) (i) Most candidates calculated the rate correctly. Many did not give their answer to two significant figures.

(ii) Candidates found this very demanding. The answer needed to be specific to this experiment and so simply stating to compare was insufficient. Incorrect responses included: to control the reaction, to slow down the reaction, to manipulate the results and to control the rate of the reaction.

(iii) Most candidates interpreted the results to give a correct order. Incorrect responses included inverting the order and omitting a metal ion by adding distilled water.

(c) (i) Most candidates recorded a correct time.

(ii) Stronger candidates used the data in the question and appreciated that the rate was too fast to be measured. The number of drops being a control variable for all of the metal ions was also accepted. Non-creditworthy responses included to compare, unfair but without any qualification, and more accurate.

Question 4

(a) Candidates completed the qualitative analysis generally quite well. For the addition of aqueous ammonia, some candidates omitted the word precipitate or solution. Milky or cloudy is not acceptable for white precipitate. A blank box or a dash are not acceptable to indicate no reaction.

(b) Stronger candidates identified both compounds. Many identified two or three of the ions present mainly as error carried forward from their results.

Question 5

(a) (i) Almost all candidates measured the distance correctly. A small number did not give their value to the nearest 0.1 cm.

(ii) Almost all candidates calculated the magnification correctly. Some did not record their value to one decimal place.

(b) Most candidates drew the image inverted but many drew it either the same size as the object or smaller.

(c) Almost all candidates completed the repeats correctly. A small number had the value increasing.

(d) (i) The standard of graph drawing was generally good. Some did not label the axes either with the quantity or more often with the unit. Some reversed the axes. Some gave scales which were too small so that the plotted points did not cover at least half of the grid. A significant number gave non-linear axes. The plotting of points was good. Where the scales were linear, but awkward, the points were often plotted incorrectly. The scale on the *x*-axis was sometimes reversed.

(ii) Few candidates drew a straight line of best-fit. Many joined the points dot-to dot and so did not draw one line. Some drew a curve or a line which was not the line of best fit.

(iii) Most candidates did not show on the graph the values chosen. The best way to do this is to draw a triangle between the points chosen for the gradient calculation. The points chosen must cover at least half of the line between the plotted points. Many candidates did not use at least half of the line or inverted the calculation.

(e) An explanation of avoiding parallax was well known. Non-creditworthy responses included looking directly, looking straight and looking parallel to the ruler.

Question 6

(a) (i) Almost all candidates gave a reading from the ruler. A small number did not give the value to the nearest 0.1 cm.

(ii) Candidates found this demanding. Some drew a diagram with either no spring or no ruler and few know how the set square should be used.

(b) Almost all candidates gave a full set of readings. Many had the readings decreasing.

(c) Candidates found this exceptionally demanding. Most candidates gave yes, and stated that as the mass increases, the reading on the ruler increases, or no, as the difference between the readings is not the same. However, these variables are not proportional because the division of the variables is not a constant or because as the mass doubles, the reading on the ruler does not double.

(d) (i) Almost all candidates recorded a reading, between their readings for 100 g and 200 g.

(ii) Almost all candidates predicted a mass in the acceptable range.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

It is advisable for candidates to read all questions carefully to ensure they have answered the whole question. This will ensure that numerical answers are given to an appropriate number of significant figures or decimal places and that written responses cover all aspects of the question.

Proportionality of variables was not well understood.

When recording values, in a partially completed table, candidates are expected to follow the number of significant figures or decimal places of the rest of the data.

General comments

Candidates were generally well prepared for this examination and were familiar with several experimental techniques. Answers to the planning question were sometimes detailed and logical. Candidates found interpreting and evaluating experiments demanding.

The standard of graph drawing was quite good although candidates need to remember that axes need to be labelled with a quantity and a unit, scales must be linear and begin at the origin. A line of best fit needs to be a single line and not dot-to-dot. The equation for the gradient of a line needs to be learned and indications of how values were found need to be shown clearly on the graph.

It is important to include either precipitate or solution when completing qualitative analysis observations.

Comments on specific questions

Question 1

(a) (i) Many candidates recorded the volumes correctly. 15.5 and 20 cm^3 were common incorrect responses. Where values need to be given to the nearest 0.5 cm^3, the value should end in .5 or .0.

(ii) Most candidates calculated the volumes correctly, often by error carried forward from **(a)(i)**.

(b) The apparatus suitable for measuring the volume was well known. Common incorrect responses included beaker, test-tube and measuring cylinder with no size given.

(c) Candidates found this very demanding. Many gave goggles or gloves but few appreciated that a corrosive substance would cause burns.

(d) (i) Stronger candidates appreciated that the hydrogen peroxide is being used up during the experiment. Common incorrect responses stated that all the gas is lost so there is no more to collect, gas escapes and catalase is used up.

(ii) Most candidates appreciated that the results supported the suggestion but many either restated the stem of the question or did not quote data in their answer.

(e) Candidates found this very demanding. Many stated that more gas would be lost but didn't give an effect on the results. Few could give an improvement to the apparatus but described replacing the stopper more quickly. Using a lid or cap and repeating the experiment were also common. A small

number used a thistle funnel or had help from another person, both of which were creditworthy. A very small number described either a divided flask or a small tube inside the flask on a piece of string.

(f) Identifying or excluding anomalies were well known by stronger candidates. Common incorrect responses included, more accurate, reduces errors and larger spread of data.

(g) The test for oxygen was quite well known. Many thought a lighted splint would relight. Some gave the test for hydrogen gas.

Question 2

Candidates were generally well prepared for this question. Many addressed the bullet points and gave a logical description of the investigation.

A common error was only considering time whereas the question required rate to be investigated.

A list of apparatus is unable to score unless the apparatus needed for the investigation is used in the plan. Many measured length or mass or volume without mentioning the apparatus they would use to measure it. Scale or scales is not creditworthy. The quantity being measured needs to be clear e.g., weighing scale, ruler.

Many candidates used the three fertilisers on separate seedlings and left them for a stated amount of time. Many did not mention a growing medium such as soil or left the seedlings for a matter of hours rather than days or weeks. A significant number discussed germination of seeds rather than the growth of seedlings.

Many candidates measured the growth of the seedling without specifying what they would measure i.e., length or height. More successful candidates used many seedlings in each fertiliser or repeated the test several times for each fertiliser.

Control variables were well known and candidates tended to score the maximum number of marks in this section. Some discussed variables without either describing them as control variables or stating that the variable was the same each time.

Candidates continue to find processing results and reaching conclusions challenging. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Very few candidates calculated a rate of growth for each seedling. Some drew a graph without specifying the quantities on each axis. A small number measured the heights daily and plotted a graph of height against time for the three fertilisers on the same graph and then made a comparison. The use of the results to formulate a conclusion for the details of their investigation is required, for example, stating the fertiliser which gave the highest rate of change of height.

Question 3

(a) The majority of candidates appreciated the need for swirling the flask. Incorrect responses included, to get an even temperature, to start the reaction and to make the reaction go to completion.

(b) The majority of candidates recorded the times correctly. Common incorrect responses included 7, 8 and 7.7, 70 s or transferring the full readings to the table.

(c) (i) Most candidates calculated the rate correctly. Many did not give their answer to two significant figures. The most popular response being 12.8.

(ii) Candidates found this very demanding. The answer needed to be specific to this experiment and so to compare was insufficient. Incorrect responses included: to control the reaction, slow down the reaction, to manipulate the results and to control the rate of the reaction.

(iii) Many candidates interpreted the results to give a correct order. Common errors were to invert the order, reverse sodium and zinc and omit zinc by adding distilled water.

(d) Calculation of 10% of one of the values was well known. A significant number used time rather than rate or didn't include whether the ions were or were not a catalyst for the reaction.

(e) (i) Stronger candidates used the data in the question and appreciated that the rate was too fast to be measured. The number of drops being a control variable for all of the metal ions, was also accepted. Non-creditworthy responses included, to compare, unfair but without any qualification, and more accurate.

(ii) Many candidates appreciated that the time would be shorter. Many candidates repeated the stem of the question and discussed rate.

(iii) Candidates found this very demanding. The time in the question is much larger than the result in the table and very similar to distilled water and sodium ions. Few appreciated that the student could have added the incorrect solution to the flask. Many thought that less copper ions were added, this was not creditworthy as getting less than one drop would be very difficult and also the results did not compare the amount of the ions added. Not swirling the flask would not account for such a large increase and misreading the stopwatch is not creditworthy.

Question 4

(a) Many candidates drew a suitable results table and entered the observations correctly. Some did not separate the tests from the observations and did not use columns and rows. For aqueous ammonia, there was frequently no distinction between adding a few drops and excess. A blank box or a dash are not acceptable to indicate no reaction.

(b) (i) (ii) Some candidate had clearly learned the tests for anions and cations.

(c) Candidates found this demanding. A blue flame is used so that the colour of the metal ion can be easily seen. A yellow flame masks the flame colour of the metal ion. Incorrect responses included: hotter, faster reaction, complete combustion, no incomplete combustion, quicker results and that a yellow flame is poisonous.

Question 5

(a) (i) Most candidates measured the distance correctly. Incorrect responses included 60 and 11.5 cm.

(ii) Many candidates multiplied their answer to **(a)(i)** correctly although many of these did not follow the data in the question and gave 60 rather than 60.0 cm. A significant number reversed **(a)(i)** and **(a)(ii)** hence 11.9 and 12.0 cm were popular responses.

(b) (i) The majority of candidates calculated the value correctly but some did not record their value to one decimal place, hence 3 was a popular response, as was 5.

(ii) Most candidates drew the image correctly. Inverting the diagram proved difficult for some.

(c) The majority of candidates appreciated that the values decreased. Some had one or both increasing.

(d) (i) The standard of graph drawing was quite good. Many did not label the axes either with the quantity or more often with the unit. Some reversed the axes. Some gave scales which were too small so that the plotted points did not cover at least half of the grid. A significant number gave non-linear axes. The plotting of points was good. Where the scales were linear, but awkward, the points were often plotted incorrectly. The scale on the *x*-axis was sometimes reversed.

(ii) Many candidates drew a line of best-fit. Many joined the points dot-to dot and so did not draw one line.

(e) Many candidates did not show on the graph the chosen values. The best way to do this is to draw a triangle between the points chosen for the gradient calculation. The points chosen must cover at least half of the line between the plotted points. Many candidates did not use at least half of the line or inverted the calculation.

(f) Candidates found this demanding with many repeating the question. Some defined dark or gave accuracy or easier to see, with no explanation.

Question 6

(a) (i) Candidates found this very demanding. Many could not recall what a set square looked like or did not know how to use it. Many drew a diagram with either no spring or no ruler.

(ii) Candidates found this demanding with few describing parallax. Incorrect responses included, the use of dim light, the use of a ruler and taking an average.

(b) Many candidates read the ruler correctly. Common incorrect responses included: 48.4, 46.5, 46.4, 46.3, 45.8 and 47.6 cm.

(c) (i) Candidates found this very demanding. Non-creditworthy responses included, repeat, use more masses and extend the range.

(ii) Candidates found this exceptionally demanding. Most candidates gave yes and stated that as the mass increases the reading on the ruler increases, or no as the difference between the readings is not the same. However, these variables are not proportional because the division of the variables is not a constant or because as the mass doubles, the reading on the ruler does not double.

(d) Many candidates predicted a mass in the range acceptable. Common incorrect responses included 103, 105, 350 and 370 g.

(e) Candidates found this very demanding. Of those that knew goggles should be worn, many did not say why the spring was an issue. Quite a few candidates thought gloves would be needed to protect the hands from the spring.