CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/11
Multiple Choice (Core)

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

General comments

Candidates performed well on **Questions 1**, **2**, **9**, **12** and **33**. **Questions 15**, **17**, **23**, **25**, **28**, **29**, **31**, **34, 36** and **40** proved the most difficult for candidates.

Comments on specific questions

Question 2

The majority of candidates had no difficulty in calculating the size of a cell from its image size and magnification.

Question 3

When asked where a fatty acid might be found, candidates were divided on whether it was in oils or glycogen, suggesting some confusion between the terms, glycogen and glycerol, and the structure of oils.

Question 4

Many candidates were unable to distinguish between amino acids and proteins, believing that an enzyme molecule is an amino acid.

Question 7

Candidates appear to have guessed which sequence of blood vessels was correct as all options were selected. Some candidates confused the order of the pulmonary artery and the pulmonary vein and others whether the aorta led to the renal artery or renal vein.

Question 9

Candidates had no difficulty stating the effects of adrenaline.

Question 11

Candidates were presented with a selection of gametes, having either one or two sex chromosomes. The majority chose the wrong gametes for the production of male and female offspring, with few correctly getting offspring with either XX or XY chromosomes.

Question 12

Most candidates realised that herbivores eat only plants.

Question 13

In this question, candidates had to interpret a graph about atmospheric carbon dioxide. Many missed that they were asked which process, if reduced, would give this trend, rather than cause it.

Question 15

Candidates chose the incorrect options **A** and **B** more often than the correct option, **C**. Candidates are expected to know that a formula including atoms of two or more elements represents a compound in which the atoms are chemically joined together.

Question 17

Candidates chose the incorrect options **B** and **C** more often than the correct option, **A**. Candidates are required to know that Group I elements form 1+ ions and that Group VII elements form 1- ions, and to use these charges to construct the formula of the compound formed from the two ions.

Question 20

Candidates chose the incorrect option **D** more often than the correct option, **B**. Candidates are expected to understand that oxygen is gained during oxidation and that there is no change in the numbers of each type of atom in a chemical reaction.

Question 21

There was evidence that many candidates had guessed at the answer. Candidates are expected to be able to describe the preparation, separation and purification of salts using techniques specified in the syllabus.

Question 23

Candidates chose the incorrect options **C** and **D** more often than the correct option, **A**. Candidates should be able to describe chemical tests for water using copper(II) sulfate and cobalt(II) chloride.

Question 25

Candidates chose the incorrect options **A**, **B** and **D** more often than the correct option, **C**. Candidates are required to describe the manufacture of calcium oxide from limestone during thermal decomposition, and the use of limestone in treating acidic soil and neutralising acidic industrial waste products.

Question 27

There was evidence that many candidates had guessed at the answer. More able candidates chose the incorrect option **B** more often than the correct option, **D**. Ethanol may be formed by fermentation and also by the reaction between ethene and steam.

Question 28

Very common errors involved candidates multiplying the maximum speed by the total time (option **D**) or halving this figure (option **B**).

Question 29

Many candidates believed the unit of weight to be kg, leading them to choose option **A** or option **B**.

Question 30

A large majority could deduce the resultant force on each object and could then identify which was not in equilibrium.

Question 31

In this question on moments, many candidates were not aware that the force should be multiplied by the perpendicular distance to the pivot, therefore selecting options **C** or **A**.

Question 33

Few could not identify condensation as the change of state described.

Question 34

Candidates were required to calculate the speed of sound from values of time and distance. Many made the mistake of omitting to double the distance to the wall, so arriving at the incorrect option **B**.

Question 36

The topic here was electrostatic charging. Many candidates selected either option **A** (thinking that proton transfer is involved) or option **B**. These candidates missed the fact that the two insulators repel each other, so must have like charges.

Question 38

Quite a common misconception about fuses is that they produce exactly their rated current in a circuit (option **C**).

Question 40

Many candidates thought that the number of atoms remaining after two half-lives is half the original value, making option **D** a popular choice. Others thought that the number would drop to zero, option **A**.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/12
Multiple Choice (Core)

There were too few candidates for a meaningful report to be produced.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/21
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 1**, **2**, **5**, **10** and **26**. **Questions 7**, **19**, **25**, **29**, **33** and **40** proved the most difficult for candidates.

Comments on specific questions

Question 7

Candidates appear to have guessed which sequence of blood vessels was correct as all options were selected. Some candidates confused the order of the pulmonary artery and the pulmonary vein and others whether the aorta led to the renal artery or renal vein.

Question 9

The function of the cornea caused some problems with candidates guessing between three of the possible four options.

Question 12

Some candidates confused consumer levels with trophic levels in this food web.

Question 14

Candidates understood how pure salt crystals are obtained from an aqueous salt solution.

Question 19

Candidates chose the incorrect option **A** more often than the correct option, **C**. Candidates should be able to describe, in terms of the frequency of collisions between reacting particles, the effect of concentration on the rate of a reaction. They should also know that temperature changes, rather than changes in concentration, affects the proportion of particles with the minimum energy to react.

Question 22

More able candidates chose the incorrect option **B** more often than the correct option, **D**. They should know that lime is used to neutralise acidic substances. They should also be able to classify sulfur dioxide as an acidic oxide based on the non-metallic character of sulfur.

Question 25

There was evidence that many candidates had guessed at the answer. More able candidates chose the incorrect option **B** rather than the correct option, **D**. Candidates are required to describe the manufacture of calcium oxide from limestone during thermal decomposition, and the use of limestone in treating acidic soil and neutralising acidic industrial waste products.

Question 26

Candidates knew the uses of the named fractions and they understood the position of their collection in the fractional distillation column.

Question 28

A common error was for candidates to multiply the maximum speed by the total time, leading to option **D**.

Question 29

In this question on moments, a large number of candidates opted for the incorrect option **C**, multiplying the force by the length of the hypotenuse of the triangle and not realising that the perpendicular to the line of action of the force should be used.

Question 33

Although most could use the wave equation, a large majority of these did not notice that the frequency was given in MHz and therefore arrived at the incorrect option, **C**. Others confused the prefix ‘mega’ with ‘kilo’ and selected option **B**.

Question 35

The topic here was electrostatic charging. Few thought that proton transfer is involved, but many selected option **B**, missing the fact that the two insulators repel each other, so must have like charges.

Question 37

A large majority of candidates could use the power equation correctly, but many of these omitted to convert the time into seconds, so arriving at the incorrect option, **C**.

Question 40

It was widely known that beta-particles are attracted towards a positively charged plate, but the use of the left-hand rule for the magnetic field caused a problem for candidates. More chose option **C** rather than the correct option **D**, probably finding difficulty with the direction of conventional current being to the left.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/22
Multiple Choice (Extended)

Question Number	Key
1	C
2	D
3	D
4	B
5	C
6	C
7	D
8	A
9	B
10	D

Question Number	Key
11	C
12	A
13	A
14	D
15	A
16	B
17	
18	D
19	B
20	C

Question Number	Key
21	C
22	B
23	A
24	D
25	C
26	A
27	B
28	B
29	C
30	A

Question Number	Key
31	C
32	A
33	C
34	B
35	A
36	C
37	A
38	B
39	A
40	A

General comments

Candidates performed well on **Questions 1**, **2**, **3**, **10**, **16**, **19** and **32**. **Question 38** proved the most difficult for candidates.

Comments on specific questions

Question 8

Candidates knew that warm blooded animals require more food in cold weather as more energy is required to maintain a constant body temperature, but they were divided on whether the rate of respiration was high or low, however, a majority opted for the correct choice of high.

Question 16

Candidates understood how to use the atomic number and nucleon number to determine the number of neutrons in an atom.

Question 17

Please note that due to an issue with question 17, this question has been discounted. Each candidate's total mark has been multiplied by a weighting factor so that the maximum mark for the question paper remains unchanged.

Question 19

Candidates understood how increasing the concentration of reactants increases the rate of a reaction.

Question 28

Many candidates appeared to be guessing in this question on speed−time graphs, with options **A**, **B** and **C** all being popular.

Question 29

In this question on moments, slightly more candidates opted for the incorrect option **D** than the correct option, **C**. Possibly they thought that the value of *F* is double the weight of the beam as it is twice as far from the pivot as the centre of gravity.

Question 30

Some candidates rearranged the pressure equation incorrectly, dividing the pressure by the weight to arrive at option **B**.

Question 32

This question on kinetic theory of gases presented few problems.

Question 37

A very large majority recognised the shape of the magnetic field around a current-carrying conductor, although a fair proportion of them could not identify the correct direction of the field lines and therefore selected the incorrect option, **B**.

Question 38

It was not widely known that, of the factors given, only the resistance of the conductor has no effect on the induced e.m.f.. Many chose the length of the conductor or the speed of movement.

Question 39

Although many were aware that increasing the voltage decreases the power loss, there was some confusion over its effect on the current. Candidates may have believed that 'decreases' in the left-hand column must imply 'increases' in the right.

Question 40

Candidates were well aware that the force must be either downwards or upwards, but using the left-hand rule correctly was a problem for some of them, causing them to select option **D**.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/31
Theory (Core)

Key message

Some candidates missed available marks due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question.

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

General comments

A good standard of scientific knowledge was displayed by many candidates. Some candidates gave clear and accurate responses.

Calculations were often done well with working shown.

Comments on specific questions

Question 1

(a) (i) This question was well answered with many candidates being awarded three or four marks.

(ii) Most candidates correctly named the pancreas and the liver although a few candidates mixed them up.

(iii) Many candidates correctly defined digestion.

(b) A few candidates did not follow the instructions in the question and drew more than one line from each nutrient.

(c) The dietary importance of iron was not well known. Few candidates mentioned making haemoglobin or preventing anaemia. Many candidates incorrectly suggested that iron strengthens bones.

Question 2

(a) (i) Some candidates knew that oxidation involves a gain of oxygen.

(ii) Covering the nail with paint was a common correct response. Other correct methods were also credited.

(b) Recycled was not well known. Re-used was also accepted.

(c) The properties of transition elements were not known by many candidates. Few candidates scored both marks.

(d) (i) Steel is used for making cars instead of pure iron because steel is stronger.

(ii) This question proved challenging. Some candidates correctly determined that 65% of stainless steel was iron but most were unable to calculate the mass of iron in 80 kg of stainless steel.

(e) Many candidates correctly stated the meaning of malleable.

Question 3

(a) (i) Many candidates referred to the greater surface area of the skis but fewer were able to explain that this reduced the pressure. Many candidates vaguely referred to spreading the weight.

(ii) Reflection was the idea required. The idea that the sound wave bounced off the wall was also accepted.

(b) (i) The weight was usually correctly identified as **L**. **M** was a popular incorrect response.

(ii) The friction force was usually correctly identified as **K**. **M** was a popular incorrect response.

(c) (i) Most candidates correctly stated the maximum speed as 5 m / s.

(ii) Some candidates correctly explained that a line with a gradient on the graph showed acceleration.

(iii) Some candidates realised that the average speed was 2.5 m / s rather than the speed being 5 m / s and used this to calculate the distance travelled.

(d) Skin cancer was well known as a consequence of being exposed to large quantities of ultraviolet radiation.

Question 4

(a) (i) Most candidates gained all three marks.

(ii) There were many vague answers given. Stronger responses stated that untreated sewage spreads disease.

(b) (i) Almost all candidates correctly calculated the difference in height as 18 cm.

(ii) Some candidates knew that oxygen was required for germination. Some also knew that warmth or a suitable temperature was also needed. Temperature, on its own, was not accepted.

Question 5

(a) Many candidates showed a good understanding of separation techniques and scored full marks.

(b) Few candidates referred to poisoning or the presence of harmful substances in their responses.

(c) (i) Many correct answers were seen. Some candidates vaguely referred to elements and compounds containing molecules. Candidates should avoid describing a compound as a mixture of elements.

(ii) Most candidates knew that the negative electrode is the cathode. Bromide was not accepted as an alternative to bromine.

(d) Most candidates correctly determined the order as calcium, magnesium, lead and copper. A few candidates replaced one of the four metals with the word metal.

Question 6

(a) (i) Many candidates scored one or two marks. Some candidates seemed confused about the energy present in the turning turbine and the generator and suggested wind energy.

(ii) Splitting was the most popular and correct answer. Exploding was frequently suggested.

(b) (i) Few candidates correctly stated the charge on an α-particle and just wrote down a number, usually 4.

(ii) Most candidates did not read the question carefully and simply suggested that the numbers decreased rather than that they decreased by two.

(iii) This calculation was not well answered. A few candidates determined that 72 000 years was 3 half-lives but were unable to do anything with the 3 apart from divide it into 6.0.

Question 7

(a) Few candidates scored all three marks. Identifying **C** as the stoma/stomata was known by most candidates although a number suggested guard cells.

(b) Well answered by many candidates.

(c) Some candidates were able to identify the reactants and/or products, but few mentioned using light energy. Some candidates gave a description of respiration rather than photosynthesis.

(d) Few candidates suggested that plants make amino acids from nitrate ions. All five options were equally popular.

(e) Root hair cell was not well known as the plant cell that absorbs mineral ions.

(f) Xylem was quite well known as the vessels that transport mineral ions in the stem of a plant.

Question 8

(a) (i) Many candidates were awarded full marks for this question.

(ii) Many candidates correctly determined that it was covalent bonding and most were able to explain why. A few candidates confused covalent and ionic bonding and a few referred to single and double bonding.

(b) This equation was not well known. A number of candidates correctly suggested oxygen as the other reactant but few suggested carbon dioxide and water as the products.

(c) (i) Some candidates correctly suggested carbon monoxide.

(ii) Many candidates gave very vague answers suggesting that carbon monoxide can make it difficult to breathe, rather than that carbon monoxide is poisonous.

Question 9

(a) (i) Many candidates omitted the switches or drew the heater and motor in series rather than in parallel.

(ii) Few candidates suggested 16 Ω and even fewer could explain why. 50 Ω (average value) and 100 Ω (addition of values) were common incorrect answers.

(iii) Electrons were well known as the particles that flow in wires in an electric circuit. Current was a frequently suggested incorrect response.

(iv) Few candidates knew either of the correct answers – increase the current (or voltage) or increase the strength of the magnetic field.

(b) (i) Most diagrams were low quality with molecules of varying size being used on both diagrams. The liquid diagram should have shown many molecules in random arrangement with most molecules touching. The gas diagram should have shown a few molecules (not more than 7) in a random arrangement.

(ii) Most candidates correctly stated 100 °C as the boiling point of water but incorrect answers ranged from 0 °C to 110 °C.

Question 10

(a) (i) Few candidates were able to suggest a change in temperature as the stimulus or a muscle as the effector.

(ii) The motor neurone was not well known as neurone **X**.

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

(b) Many candidates did not realise that it was necessary to perform a unit conversion before completing the calculation.

(c) This part was well answered with many candidates gaining full marks.

(d) A wide range of effects of adrenaline on the body were suggested with many gaining full marks.

Question 11

(a) (i) Candidates who described where the limestone and the water were found after the filtration were awarded one mark. The second mark was for explaining why the water passes through the filter paper but the limestone does not.

(ii) Few candidates suggested the use of universal indicator and even fewer explained the correct use of a pH colour chart.

(b) (i) Deforestation and burning carbon-containing fuels in cars were common correct responses.

(ii) Few candidates suggested climate change or global warming as consequences of an increase in carbon dioxide in the atmosphere. Many candidates incorrectly referred to ozone depletion.

(c) (i) $45\,cm^3$ was the correct answer given by most candidates.

(ii) 190 s was the correct answer given by many candidates. 280 s was a common error.

(iii) Most correctly drew an initial steeper line but many did not show the line levelling off at $45\,cm^3$.

(iv) This question was well answered. Some candidates were confused about changing the surface area and suggested decreasing the surface area.

Question 12

(a) As many candidates used volume = mass × density as used volume = mass ÷ density. Many were also confused by the powers of ten involved in the calculation.

(b) (i) Convection was not well known.

(ii) Radiation was known by many candidates.

(iii) Sound not being able to travel through a vacuum was well known. Common errors were to suggest that the sound waves had a frequency outside the range of audible frequencies for a human or that the Sun was too far away.

(c) (i) Infrared was often misplaced to the other side of visible light.

(ii) Gamma was well known as the electromagnetic radiation which has the highest frequency.

(iii) A few candidates realised that the infrared and visible light both travel at the same speed.

(d) (i) (ii) The double headed arrows were frequently drawn inaccurately. A common error was to indicate twice the amplitude. A few candidates failed to label either of their arrows and so could not be awarded credit.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/32
Theory (Core)

There were too few candidates for a meaningful report to be produced.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/41
Extended Theory

Key messages

Candidates should read the stimulus material carefully and follow the guidance given. Marks are often missed as candidates do not answer all aspects of the question using the required terminology. This was particularly evident in the longer answer responses to **Questions 1(a)(ii)**, **3(c)**, **6(c)** and **11(b)**.

Candidates should try to match the answers they give with the number of marks available for each part of a question. A two-mark question will require two separate points to be made.

When completing calculations, candidates should remember to state the formula used, show the working, express their answer to an appropriate number of significant figures and include units. This was particularly evident in **Questions 2(b)(iv)**, **3(a)(ii)**, **3(b)(ii)**, **3(b)(iii)**, **6(d)(i)** and **8(d)**.

Candidates should be reminded to use correct scientific terminology when describing phenomena. It is important that candidates are able to express their ideas using scientific language, have a good understanding of what the specific scientific terms used in the syllabus mean and be able to apply these when giving responses. This is particularly relevant for **Questions 1(a)(i)**, **2(b)(iii)**, **3(c)**, **5(b)(ii)**, **6(d)(ii)**, **7(a)(ii)**, **11(b)** and **12(a)(i)**.

General comments

A high standard of scientific knowledge, understanding and vocabulary were displayed by many of the candidates. There were some examples of vague responses which prevented some candidates from accessing the available marks. Candidates should be encouraged to be specific in their responses. Clear and concise scientific language should be used to express ideas in sufficient depth.

Calculations were frequently done well with all working shown. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Formulae consisting of a mixture of words, symbols and units should also be avoided. Numerical calculations often arrived at the correct value and arithmetic operations were generally error fre
e. Candidates should be aware that such questions are marked in stages and credit can be given for a correct operation leading to an incorrect answer if evidence for that process is clearly shown.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to correctly identify at least one of the structures.

(ii) There were some good descriptions of vasodilation, including the widening of the arterioles to enable more blood to flow to the capillaries. Many candidates used the generic term blood vessels throughout. Not many referenced the increased blood flow, specifically to the surface of the skin. Some candidates appeared to be under the misapprehension that capillaries widen or move closer to the surface.

(iii) Negative feedback was correctly identified by some candidates. Homeostasis was a very common incorrect response.

(b) (i) Insulin was correctly identified by the majority of candidates as the hormone that reduces the concentration of glucose in the blood.

(ii) Glands were not well known. A large range of incorrect responses were seen, including pancreas, brain, liver and reproductive organs.

(c) (i) Few candidates were able to identify the brain as the organ that detects the change in temperature of the blood. The most common incorrect answer was skin.

(ii) Sensitivity was correctly identified by almost all candidates.

Question 2

(a) (i) The changes of state were almost always correctly identified.

(ii) Almost all candidates recognised that kinetic energy increased when the gas was heated.

(b) (i) Most candidates knew that pencil is used on the chromatography paper due to it being insoluble. Some candidates thought that it would react with the solvent, rather than being dissolved.

(ii) Almost all candidates where able to correctly identify at least one of the dyes present in food colouring **X**. Correct identification of 1, 2 or 3 dyes were regularly seen. Very rarely was the incorrect answer of **C** seen.

(iii) Some candidates understood that substance **D** was insoluble. Incorrect ideas included suggestions about purity and reactiveness.

(iv) Most candidates could recall and use the formula for R_f. A range of values for the R_f were allowed as there was not consistency in how to measure the distance travelled in the diagram. Some subtracted the distances and a minority inverted the formula.

(c) Most candidates identified that the pure substances had a fixed melting point, or that mixtures melt over a range. A good proportion were able to explain both. A few answers referred to boiling points, or the idea that pure substance have high melting points and that mixtures have low melting points.

Question 3

(a) (i) Not all candidates recognised that as the speed was constant, force **A** = force **B**. The most common incorrect answer was that force **B** must be bigger as the swimmer is moving forwards.

(ii) A speed of $0.6\,m/s^2$ was the most commonly seen answer. Some candidates did not convert the weight in newtons to kilograms before performing the calculation. Occasionally there were some difficulties in rearranging the formula.

(b) (i) Many candidates were able to show that 45 km/h was equivalent to 12.5 m/s. It would be beneficial for candidates to practice converting units and recognising when units require conversion.

(ii) The majority of the candidates correctly calculated the acceleration of the athlete as $0.5\,m/s^2$. The most common error was to use the speed in km/h taken from the graph, rather than the given value in m/s.

(iii) Some candidates correctly calculated the distance travelled from the graph. The most common error was to not add together the calculations of the area under the graph for the first 25 s and the next 10 s.

(iv) A force of 210 N was correctly calculated by almost all candidates.

(c) This question was not well answered. Many candidates did not follow the instruction in the stem to answer in terms of motion and energy of water molecules. Many answers were very generalised and only answered in terms of sweat. Only a few candidates identified that energy was transferred from the skin to the water molecules. Evaporation was mentioned in many responses, but not often linked to the most energetic water molecules escaping the surface.

Question 4

(a) The correct equation for photosynthesis was commonly seen.

(b) Light and chemical energy were correctly identified in the majority of responses. Solar, heat and food were common incorrect answers.

(c) Almost all candidates correctly identified palisade mesophyll cells as the cells that contained the most chlorophyll. A few gave the incorrect response of spongy mesophyll cells. Chloroplast was the most frequently seen incorrect answer.

(d) (i) Almost all candidates were able to correctly calculate the mean. Only a handful failed to round to the nearest whole number.

(ii) The relationship between light intensity and the rate of photosynthesis was almost universally identified. Fewer candidates, however, identified that the rate of photosynthesis became constant after a distance of 40 cm was reached.

(iii) Some candidates did not realise that the plant used some of the oxygen for respiration. Some suggested that it was used by the plant but did not state the process.

Question 5

(a) (i) Almost all candidates correctly identified the parts of the atom. A few misidentified neutrons as either nucleons or neurones.

(ii) Some candidates misunderstood the term electron structure. Where it was understood, this question was answered well.

(b) (i) Many candidates answered this question well, gaining both marks. However, there was some confusion about the number of orbits to draw, consistency between the atom and the ion, and whether to draw just the atom or the ion. A few showed the bonding between lithium and chlorine.

(ii) While there were some really good attempts at drawing 3D structures, and some good descriptions, the type of bonding that should be represented was often confused. Metallic bonding with ions in a sea of electrons, bonding in giant covalent structures like diamond which are regular but do not consist of ions, or regular layers sliding as in graphite, were often described instead.

(c) (i) Most candidates gained full marks for this question.

(ii) Most candidates were aware that the similar chemical properties were due to the electron numbers being the same. Only the strongest candidates realised that it was the outer shell electrons that were relevant.

Question 6

(a) The majority of candidates identified carbon dioxide as a product, however, this was not always linked to climate change, enhanced greenhouse effect or global warming. Answers were often in more general terms, such as simply stating pollution.

(b) Efficiency was calculated correctly in the majority of cases. The most common error was to multiply by 90 rather than 0.9 resulting in a power of 10 error.

(c) The strongest candidates were able to describe how heating water lowers it density, so the warm water rises. Some responses were confused and talked about thermal energy being convected or had the idea that hot water was denser. A few candidates answered in terms of air or gas, rather than water.

(d) (i) Many candidates were able to correctly calculate the frequency of the light. Those not able to complete the calculation were often able to correctly state the speed of light in a vacuum. Common errors included inverting the formula, using the incorrect speed of light and incorrect mathematical processing of the correct numbers to give a final answer with the wrong power of 10.

(ii) Some of the terms used to describe perpendicular and parallel were very vague. Candidates should be encouraged to use the correct scientific terms. Sound was correctly identified as an example of a longitudinal wave by the majority of candidates.

Question 7

(a) (i) Most candidates understood that the antibiotic killed some of the bacteria. Most were able to state that the non-resistant bacteria died, or that only the resistant bacteria survived. A few thought that the bacteria that survived acquired resistance as it was the last one left.

(ii) Although many candidates understood that the resistant bacteria reproduced, the idea of passing on the resistant gene/allele/DNA was not well expressed. A relatively common misconception was that the dead bacteria became resistant or got infected by the resistant bacteria.

(iii) Natural selection was correctly stated by some candidates. The most common incorrect answer was mutation.

(b) (i) Many candidates were able to define a mutation, although some responses lacked enough detail to be awarded a mark.

(ii) Almost all candidates were able to correctly state a form of radiation that increases the rate of mutations.

(c) Most candidates scored full marks on this question, correctly identifying white blood cells and platelets.

Question 8

(a) Most candidates were able to provide a balanced symbol equation for the reaction.

(b) (i) Most candidate correctly stated the relationship between temperature and time. A few just quoted data without describing the relationship.

(ii) Almost all candidate correctly identified why reactions get faster when the temperature increases.

(c) There were some good energy level diagrams. Those who drew the correct profile for an exothermic reaction normally correctly labelled the reactants, products and activation energy. A few candidates drew the energy level diagram for an endothermic reaction. A frequent error was to see the energy change arrow going the full height of the curve. Candidates should be encouraged to be more accurate when drawing the arrows.

(d) Almost all candidates attempted to calculate the volume occupied by the gas. Many candidates incorrectly calculated the formula mass M_r of H_2 as 1, resulting in an error carried forward and a final answer of 2.4. Some candidates used alternative methods to calculate the mass by first calculating the moles of zinc used as they recognised there was a 1:1 ratio. This was acceptable.

Question 9

(a) Many candidates explained the correct relationship between resistance and current and were able to explain why the ammeter reading decreased.

(b) (i) Most candidates identified the component as a resistor, but not all stated that it was a variable resistor.

(ii) The resistance of the wire calculation was carried out very well by almost all candidates. Occasionally the equation was inverted.

(c) Only a handful of candidates were able to give a correct meaning for the term electromotive force (e.m.f.). This is a term that is poorly understood.

(d) The magnetic field was sometimes correctly drawn as concentric circles around the wire with an arrow pointing anticlockwise. Lines of force were not always drawn as complete circles. The majority of answers had the correct direction of the magnetic field.

Question 10

(a) Most candidates correctly identified the membrane. Some correctly stated water potential. Many got dilute and concentrated the wrong way round.

(b) Most candidates demonstrated an understanding that red blood cells have an increased surface area. However, not all applied this knowledge to explain how the change of shape would affect its function.

(c) The majority of candidates correctly identified at least one factor that affects the rate of osmosis. The most common incorrect response was concentration, which was given in the stem of the question.

(d) (i) The majority of candidates could correctly state two correct cell structures found in plant cells only, with a minority including chlorophyll or cell membrane.

(ii) Root hair cell was almost always correctly stated.

Question 11

(a) (i) Compound **B** was almost always correctly identified.

(ii) Compound **C** was almost always correctly identified. Compound **E** was the most frequent incorrect response.

(iii) Compound **A** was commonly correctly identified. Compound **E** was the most frequent incorrect response.

(iv) Compound **A** was almost always correctly identified. All other options were seen as incorrect responses.

(b) Many found this challenging. Candidates often answered in generalised terms about condensation polymerisation reactions, rather than referring to the monomers shown. The most commonly awarded mark was for recognising that water was produced. The strongest candidates recognised that an amide link was formed. Some candidates incorrectly referred to ions.

Question 12

(a) (i) Very few candidates gained full marks. The most common answer was the incorrect identification of the type of ionising radiation as gamma rather than beta. The rational seemed to be that as the count did not drop to zero the radiation had not been stopped. Many did not quote the first material in the experiment that shielded the radiation effectively, instead quoting materials more generally such as ‘metals’.

(ii) Many found this calculation demanding, with few getting the correct answer of 87 years. The methodology was poorly understood.

(b) Most candidates correctly stated that the forces decreased. The most common misconception was that the force became zero as the bonds between particles broke.

(c) The vast majority of responses stated the correct formula for density and were able to calculate the value correctly.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/42
Theory (Extended)

Key messages

An important skill that candidates should practice is the conversion of units in calculation questions. **Questions 3(c)(i)** and **5(c)** are examples where this skill was particularly beneficial.

Learning the definitions of keywords outlined in the syllabus is a useful tool for answering questions. This can be used to answer questions directly and also form part of a longer answer response. **Questions 1(b)**, **2(a)**, **8(b)**, **10(b)** and **11(d)(i)** are examples, where recall of the meaning and definitions of keywords would be helpful.

It is important to understand the difference between the command words in terms of response required. The terms 'describe', 'explain' and 'state' require different responses. Candidates should know the difference between these terms and the requirements of each. The difference in the responses required by the command words 'describe' and 'explain' were particularly important for **Questions 4(a)(i)**, **4(a)(ii)**, **4(d)**, **5(b)(iii)**, **7(b)(i)**, **7(b)(ii)**, **8(e)**, **11(d)(ii)** and **12(c)(iii).**

General comments

A high standard of scientific knowledge and understanding was displayed by many of the candidates. Many candidates should be congratulated for their articulate and accurate responses.

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 tool is to use the syllabus as a revision guide and candidates should go through the syllabus ensuring that they have covered each learning objective in their revision.

When completing calculations, candidates should remember to state the formula used, show the working, express the value to an appropriate number of significant figures and include the appropriate units.

It is particularly important for candidates to read questions carefully and use their knowledge to give a response to the context of the question. Candidates often give scientifically accurate answers but do not answer the question posed. The stimulus material provides essential information that should be used when answering the question.

Comments on specific questions

Question 1

(a) (i) Only some of the candidates could identify the iris as containing the radial and circular muscles. Many candidates misidentified the ciliary body. The location of the receptor cells in the retina and the neurones in the optic nerve were generally well known.

(ii) Most candidates were able to identify the location of the blind spot. The common misconception was that the fovea was the location of the blind spot.

(iii) There was some confusion between the suspensory ligaments and the ciliary muscle. Candidates should be reminded that ligaments do not contain muscle cells and so cannot contract. The correct term to describe the action on ligaments when placed under tension is tighten.

(iv) Many candidates were able to name the correct hormone of adrenaline. Very occasionally, incorrect hormones such as insulin were given.

(b) Many candidates were able to complete the sentence to describe the meaning of the term sensitivity.

Question 2

(a) Very occasionally candidates confused alkanes with alkenes. Many candidates recognised that alkanes contained carbon and hydrogen atoms and single bonds but did not specify that alkanes contained only carbon and hydrogen atoms and only single bonds.

(b) Candidates generally followed the correct naming convention, recognising that the prefix for the first alkene was eth- and the last alkene was but-. The most common error was to try and include an additional hydrogen in the structure of propene.

(c) Many candidates could describe the use of aqueous bromine to differentiate between an alkane and an alkene. Very few confused the expected observations. Occasionally other incorrect tests were given, such as the use of limewater or flame tests. Very occasionally candidates were imprecise and described the result with propene as a clear colour rather than colourless.

(d) Candidates found this question challenging. Most candidates recognised that the polymer would contain single bonds. Fewer were able to draw the $–C_2H_5$ group.

Question 3

(a) (i) A number of candidates used the correct value but the incorrect unit for weight of the pond skater, using kilograms rather than newtons. Some candidates gave the upwards acting force of 0 N resulting in an incorrect resultant force.

(ii) Most candidates were able to use the correct formula of force divided by the area to give pressure. The principle of error carried forward was applied if an incorrect weight for the pond skater was given in part **(a)(i)**.

(b) (i) Almost all candidates were able to identify the horizontal section on the graph as the time when the pond skater was travelling at a constant speed.

(ii) A common misconception was that the formula to calculate acceleration was velocity divided by time rather than change in velocity. However, many correct answers were seen.

(c) (i) There were two common errors made in the responses to this question. Firstly, some candidates did not convert centimetres to metres, giving a value of 1.6. Secondly, misreading the wavelength. A value of 0.032 cm was commonly seen.

(ii) The frequency had to be calculated before the answer could be attempted. Many candidates missed this crucial step. Those that calculated the frequency were generally able to calculate the speed with the principle of error carried forward if an incorrect wavelength was provided in part **(c)(i)**.

Question 4

(a) (i) Only the more able candidates were able to explain why increasing temperature increased the rate of reaction in terms of increased kinetic energy of the particles leading to increased collision frequency. A common misconception was to describe there being more collisions without reference to an increased collision frequency.

(ii) This part of the question was answered much better by candidates. The correct terminology of enzymes being denatured was commonly seen as was reference to the altering of the shape of the active site preventing the successful binding of the substrate. On occasion, there was some confusion as to whether the active site was part of the enzyme or the substrate.

(b) Chlorophyll was the correct answer. The most common incorrect answer given was chloroplasts, although these structures contain chlorophyll, it was the name of the substance rather than the cell structure that was required.

(c) This question was very well answered. Very occasionally light and chlorophyll were given.

(d) Some candidates gave vague responses that were not specific to the cells in the palisade layer. Responses such as large surface area and contains chloroplasts were examples of this. The best responses were able to describe the position of the cells near the surface of the leaf or how the cells are arranged in a tightly packed arrangement. Other correct responses included reference to there being many chloroplasts and a large vacuole that pushes the chloroplasts to the edge of the cell.

Question 5

(a) The source of nitrogen was well known. The source of hydrogen proved more problematic. Candidates often simply gave the source as methane or natural gas without specifying their reaction with steam.

(b) (i) The energy change was generally labelled successfully. A common error included drawing an arrow from the peak to the lower dotted line. Occasional inaccuracies were seen with labelling by candidates drawing arrows that were too short.

(ii) The activation energy was generally labelled successfully. As with part **(b)(i)**, some imprecise arrows were seen.

(iii) There were some excellent responses seen to this question, with many candidates identifying the correct energy changes that occur during bond making and bond breaking. Several candidates correctly identified the reaction as exothermic but incorrectly reasoned that it was because more bonds were made than broken or that the reaction only involved the making of bonds.

(c) There was an error in Question 5(c) where the mass of nitrogen should have been 117.6 kg and not 58.8 kg. This has been corrected in the published version of the paper. Due to this error, careful consideration was given to its treatment in marking in order to ensure that no candidates were disadvantaged. This question required a conversion from kilograms to grams, which was missed by some candidates. However, many candidates were able to use correct formulae to calculate the number of moles and the volume.

Question 6

(a) (i) Almost every candidate identified the correct time.

(ii) There were many correct suggestions seen, with the best responses referring to the Sun being at an angle directly above the solar panel.

(b) It appeared that some candidates thought that each letter could only be used once, leading to the incorrect inclusion of natural gas, despite the instruction that each letter could be used more than once being given in the stem.

(c) (i) The correct answer was core, which was provided by many of the candidates. Any reference to the type of metal used were ignored.

(ii) This question proved challenging for some of candidates. Many candidates tried to explain in terms of number of coils or the passage of electrons. The most common omission was to not describe the initial alternating current in the primary coil. There were also some excellent responses that gained full credit.

(iii) Most candidates were able to calculate the correct output voltage.

Question 7

(a) (i) Many candidates were able to interpret the food chain. Occasionally the quaternary consumer was misidentified as a frog. The organism that occupies the first trophic level was occasionally misidentified as a primary consumer.

(ii) Candidates could state several ways that energy is lost between the trophic levels.

(iii) The Sun was commonly given. Very occasionally the incorrect response of producers was seen.

(b) (i) Responses to this question were often vague. This question required knowledge from different areas of the syllabus and candidates needed to combine their knowledge of the use of nitrate ions to produce amino acids required for growth and the composition of fertilisers. The best responses were able to link these ideas.

(ii) Some candidates did not answer this question in terms of the context of eutrophication. Candidates should be reminded to read all the stimulus material provided and tailor their responses to the context in which the question is placed. Candidates that recognised that the decomposition of producers by aerobic bacteria would increase the removal of dissolved oxygen generally scored full marks.

Question 8

(a) Most candidates were able to deduce the correct number of protons, electrons and neutrons for the isotopes given. The number of neutrons proved the most difficult for candidates to deduce.

(b) Candidates were generally able to describe the meaning of the term isotope using the words provided. The nucleon number was sometimes given as the nucleus number.

(c) The correct electronic structure was generally identified.

(d) Some candidates did not appreciate that a molecule of nitrogen contains a triple bond. Occasionally candidates did not complete the electrons on the inner shells of the nitrogen atoms.

(e) This question proved more difficult for some of the candidates. Often candidates got confused between the covalent bonding between the atoms and the intermolecular forces between covalently bonded molecules. Some candidates were not precise enough in their responses, simply describing strong bonds between ions in an ionic compound without reference to oppositely charged ions. Many candidates were able to link the ideas of the stronger forces requiring more energy to break resulting in a higher melting point.

Question 9

(a) (i) The incorrect value of 6.0 V was often seen.

(ii) Most candidates recognised that the current is the same at any point in a series circuit.

(b) The most common error was to not divide the current of 0.9 A by three to give the current for one of the lamps. Candidates were generally able to use the correct formula to calculate the resistance and the principle of error carried forward was applied if the incorrect value for the current was used.

(c) This question was generally answered well. Some gave the correct speed of infrared radiation but omitted the unit.

Question 10

(a) (i) Some candidates misidentified the nucleus as the acrosome. A few candidates were able to identify the nucleus but did not specify the haploid nature of the nucleus.

(ii) This question was very well answered, with most candidates able to state the correct number of chromosomes as 23.

(iii) Most candidates were able to explain that mitochondria are the cell structures responsible for the release of the energy, which enables the sperm to swim.

(b) On a very few occasions, candidates only ticked one box for each feature. Both asexual and sexual reproduction involve the production of offspring and so both boxes should have been ticked for this feature.

(c) There were some excellent responses seen with many descriptions of the increased likelihood of failure for fertilisation to occur and an increase in time and energy required.

Question 11

(a) The product at the anode was often identified. Occasionally the response of chloride was given, which was not accepted. The product at the cathode was less successfully identified with the incorrect product of magnesium often given.

(b) Many candidates were able to explain this in terms of relative reactivities of hydrogen and sodium.

(c) The half-equation was generally done well. Occasionally candidates got this the wrong way round showing the production of copper ions. A minority of candidates gave the charge of electrons as positive.

(d) (i) This question was very well answered with many candidates linking oxidation to the loss of electrons.

(ii) A description of the events occurring at the cathode were generally more successful than the events occurring at the anode. Careful attention should be drawn to the command word, which in this case was describe. A statement of the products found at each of the electrodes was insufficient. It was important that candidates recognised that copper electrodes were used rather than carbon electrodes.

Question 12

(a) (i) The nature of alpha radiation was often imprecisely described as helium rather than a helium nucleus. The relative penetrating ability was generally accurate.

(ii) The majority of candidates were able to draw the correct paths for the different types of radiation.

(b) The correct nuclide notation was commonly seen. Very occasionally the value of 5 was given for the atomic number of nitrogen.

(c) (i) Candidates needed to refer to particles in order to answer this question successfully. Several candidates simply stated that solids have a fixed mass and volume, which was insufficient. The best responses described the difference between solids and gases in terms of relative space between the particles.

(ii) Similar to part **(c)(i)**, the best responses referred to the lack of space between the particles, preventing water from being compressed.

(iii) There were many detailed and precise answers seen. Many candidates were able to explain why an increase in pressure occurred when temperature increased. Occasionally candidates referred to particle collisions but did not make it clear that an increased collision frequency with the wall of the container was responsible for the increase in pressure.

CO-ORDINATED SCIENCES

Paper 0973/51
Practical Test

Key messages

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

Candidates should avoid generic answers and give only those specific to the experiment being discussed.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques and were quite careful in their experimenting. The standard of graph drawing was generally quite high although candidates need to remember that axes need to be labelled with quantity and unit and a line of best fit needs to be a single line. Interpreting and evaluating experiments proved challenging.

Undertaking practical work helps candidates to interpret and evaluate experimental methods and results and describe methods such as those required by the planning question.

Comments on specific questions

Question 1

(a) (i) and **(ii)** Almost all candidates recorded results for measuring cylinder **A** and **B**.

(b) (i) Stronger candidates answered the question with reference to the experiment and avoiding contamination with the enzyme. Many gave a generic response about avoiding contamination, which was insufficient.

(ii) Candidates found this very demanding. Mix was in the question and so the popular answer of mixing the contents was not creditworthy. Other incorrect responses included fair test and accuracy. Stronger candidates described mixing to enable an even concentration through the mixture.

(iii) Stronger candidates answered the question with reference to the experiment and discussed a comparison, or effect with or without the enzyme. Common non-creditworthy responses included fair test, accuracy and to get valid results.

(c) Many candidates appreciated that the enzyme would allow the larger or faster production of juice. The generic answer of faster reaction was insufficient.

(d) (i) The standard of graph drawing was generally good. Some candidates reversed the axis and a significant number omitted the label and/or the unit on the axis. The unit for minutes was frequently given as ‘m’ which is incorrect. Many did not start their axis at the origin (0,0) and so the point at the origin could not be plotted. Some candidates did not use a linear scale. Plotting of the points was good except where scales were awkward and required the use of a calculator.

(ii) Some candidates drew a smooth curve close to all of the points. Some drew dot-to-dot lines, used a ruler between points or drew multiple or feathery lines.

(iii) Many candidates read the value from their graph correctly with many showing the working on the graph. Two lines, one from 5 minutes to the graph and then from this intersection to the volume is the best way of showing the value.

Question 2

(a) (i) The final colours of the solutions were generally correct. A small number gave unexpected colours, possibly due to cross contamination of the testing solutions. Brown for Benedict's solution is not creditworthy.

(ii) Many candidates knew the nutrients being tested for. Some candidates referred to just sugar for the Benedict's test. Carbohydrate and starch were also common incorrect responses. Positive and negative were popular non-creditworthy responses as were just reducing sugar and protein without stating whether they were present or absent.

(b) Candidates found this question demanding. Some knew that ethanol was required but thought the other reagent was alcohol, iodine, limewater, fats or lipids. The result of the test was not well known, both white and emulsion were required. Solution, suspension, precipitate and a variety of colours were common incorrect responses.

Question 3

(a) (i) All candidates recorded a time for experiment **1**. A small number did not record the time to the nearest second.

(ii) All candidates recorded a time for Experiment **2**. Many did not have a time which was within 10 seconds of Experiment **1**, possibly due to inaccuracies when measuring volumes or time.

(iii) Candidates found this demanding. It was expected that there would be a 10% calculation of either of their values for Experiment **1** or Experiment **2** and that this 10% value would be either added to or subtracted from the value they had used and then compared to the other value so that they could ascertain whether the two values were indeed within 10%. Most did not do a calculation but simply stated that the values either were, or were not, within 10% which was not creditworthy. It was also common for candidates to erroneously subtract the values and consider that their answer was a percentage value.

(iv) Candidates found this demanding with stronger candidates appreciating that using different syringes would ensure that there was no cross-contamination so that the reaction would not begin in the syringe.

(v) Stronger candidates recalled that iodine is used to test for starch. Common incorrect responses included starch, glucose and Benedict's solution.

(b) Almost all candidates obtained a full set of results with most recording the times to the nearest second. Stronger candidates obtained a time for sodium chloride which was similar to those for water and the strongest had much shorter times for the three catalysts.

(c) (i) Candidates found this very demanding. Many only chose some of the catalysts and almost no candidates referred to the data in Table 3.1. Most said they were either faster or that they took less time.

(ii) Candidates found this very demanding. Common incorrect responses included fair test, accuracy, reliability, to see the effect of **H** and **K**, to get more results and to see if the additional solutions contain starch.

Question 4

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

A diagram and a results table were not required, stronger candidates included both to illustrate their answer, and these often contained several of the marking points.

There were three possible methods for this plan, collecting and measuring the volume of gas evolved with time, timing the reaction until bubbles are no longer seen, (i.e. to the end of the reaction) or measuring the decrease in mass of the reactants with time.

Some candidates described a basic method which would work although some forgot the time element since the question was about rate of reaction. Many candidates attempted to count bubbles despite the question saying that this would be impossible. Most successful candidates repeated for five different masses of catalyst and then repeated each mass more than once. Some measured the time for a glowing splint to relight, heated the reactants with a Bunsen burner or timed water to be produced, none of which was creditworthy. A significant number did not name the apparatus they were using, scale is insufficient for balance.

Those that discussed safety usually named goggles or gloves but many did not name the hazardous chemicals in the experiment or the part of the body they were protecting.

Measuring the amount of something is too vague, the quantity being measured needs to be specified, in this experiment it was volume of gas, mass of catalyst, mass of reactants, time or time for the reaction to end. Writing the results down is too vague to be creditworthy.

Control variables were well known.

Candidates find processing results and drawing conclusions challenging. Where repeats have been undertaken, averaging is insufficient – the reason for averaging needs to be explained. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is insufficient. The use of the results to formulate a conclusion for their investigation is required. For example, look to see when the mass of catalyst is increased, does the volume of oxygen released in five minutes increase, decrease, or stay the same, which means there is no relationship. If a graph is to be drawn, the quantities on each axis need to be specified and the relationship can be determined from the shape of the graph. For example, a straight line though the origin would mean the rate is directly proportional to the mass.

Question 5

(a) (i) Most candidates recorded readings for both the top and the bottom of the spring. Many did not record to the nearest 0.1 cm and a significant number had the readings reversed.

(ii) Almost all candidates subtracted the values correctly.

(iii) Many candidates drew the arrow carefully to show the top and bottom of the spring, not including the loops. Some drew the arrow including either one or both loops which was not creditworthy.

(b) Almost all candidates recorded all values of l which increased in value as the load increased.

(c) Candidates found this demanding. Non-creditworthy responses included: repeat and average, use a straight ruler, measure to the nearest 0.1 cm, get someone else to check the reading, put the ruler at zero and the most popular; wait until the spring stops moving.

(d) Many candidates did not know the meaning of the term proportional. Most thought they were proportional because as the load increases the length of the spring increases or because there was a constant increase as the load was increased. However, to show proportionality the ratio of the load to the length (or the length to the load) must be constant.

(e) Candidates found this demanding. Many multiplied l_0 by 3 and gave this as their answer rather than using this value and Table 5.1 to deduce the load required.

Question 6

(a) (i) Almost all candidates recorded a value of T at t = 0 s.

(ii) Almost all candidates recorded a full set of values for T which decreased with time. Some did not record their values to the nearest 0.5 °C.

(b) Candidates found this demanding. Incorrect responses included: allowing the water temperature to settle or stabilise, for the water to start cooling or for accuracy.

(c) (i) Many candidates calculated the rate correctly with some giving the value to two significant figures. Some added all of the values between 0 and 180 and then divided by 180. Some showed no working out and so incorrect answers could not gain an error carried forward mark.

(ii) Many candidates calculated the rate correctly or made the same error as in **(c)(i)**. A small number rounded their value incorrectly.

(d) Candidates found this very demanding and many tended to discuss rate of cooling at the beginning compared to the end, to time rather than to the temperature of the water.

(e) Changes to reduce the rate of cooling were quite well known. Common non-creditworthy responses included to wait longer between readings, use a colder room or just lower or higher temperatures without specifying any other details.

CO-ORDINATED SCIENCES

Paper 0973/61
Alternative to Practical

Key messages

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

Candidates should avoid generic answers and give those specific to the experiment being discussed.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques and were quite careful in their experimenting. The standard of graph drawing was generally high although candidates need to remember that axes need to be labelled with quantity and unit and a line of best fit needs to be a single line. Candidates found interpreting and evaluating experiments difficult.

Undertaking practical work helps candidates to interpret and evaluate experimental methods and results and also describe methods such as those required by the planning question.

Comments on specific questions

Question 1

(a) (i) Most candidates read the temperature correctly. Many omitted the '.0'. The most common incorrect response was 30.5 °C.

(ii) Stronger candidates answered the question with reference to the experiment and described avoiding contamination with the enzyme. Many gave a generic response about avoiding contamination, which was insufficient.

(iii) Candidates found this very demanding. Mix was in the question and so the popular answer of mixing the contents was not creditworthy. Other incorrect responses included fair test and accuracy. Stronger candidates described mixing to enable an even concentration through the mixture.

(b) (i) Stronger candidates answered with reference to the experiment and discussed a comparison, or effect, either with or without the enzyme. Common non-creditworthy responses included fair test, accuracy and to get valid results.

(ii) Many candidates appreciated that the enzyme would allow the larger or faster production of juice. The generic answer of faster reaction was insufficient.

(c) (i) The standard of graph drawing was generally very good. Some candidates reversed the axes and a significant number omitted the label and/or the unit on the axes, the unit for minutes was frequently given as 'm' which is incorrect. Many did not start their axes at the origin (0,0) and so the point at the origin could not be plotted. Some candidates did not use a linear scale. Plotting of the points was good except where scales were awkward and required the use of a calculator.

(ii) Many candidates drew a smooth curve close to all of the points. Some drew dot-to-dot lines, used a ruler between points or drew multiple or feathery lines.

(iii) Many candidates read the value from their graph correctly with many showing the working on the graph. Two lines, one from 5 minutes to the graph and then from this intersection to the volume is the best way of showing their value. Some did not show their working on the graph.

(iv) Many candidates drew a steeper line. Common incorrect responses included the line not continuing to 8 minutes, beginning steeper but crossing the original line at higher volumes to give a lower final volume or the line being less steep.

(v) Many candidates drew a line that was less steep than the original and ended at a lower volume. Fewer candidates appreciated that if the enzyme is denatured and inactive, then the results will be similar to the results for measuring cylinder **B** which contained no enzyme. Therefore, the line should be similar to the plotted points for measuring cylinder **B**. A small number drew a steeper line. Most lines were correctly labelled.

Question 2

(a) (i) The final colours of the solutions were generally well known. Incorrect responses included brown, blue-black, no change and stays the same for biuret solution and purple for Benedict's solution.

(ii) Stronger candidates stated that reducing sugars were present for the Benedict's test. Carbohydrate and starch were common incorrect responses. Positive and negative were popular non-creditworthy responses as were just reducing sugar and protein without stating whether they were present or absent.

(b) Candidates found this more demanding. Many knew that ethanol was required but thought the other reagent was alcohol, iodine, limewater, fats or lipids. The result of the test was not well known. Both white and emulsion are required. Solution, suspension and precipitate were common incorrect responses.

Question 3

(a) (i) The majority of candidates chose a suitable piece of measuring apparatus. Incorrect responses included beaker, cylinder, flask and conical flask.

(ii) Candidates found this demanding. It was expected that there would be a 10% calculation of either 9.2 or 8.6 and that this 10% value would be either added to or subtracted from the value they had used and then compared to the other value so that they could ascertain that the two values were indeed within 10%. Many did not do a calculation but simply stated that the values either were, or were not, within 10% which was not creditworthy. It was also common for candidates to erroneously subtract the values and consider that their answer was 6%.

(iii) Stronger candidates recalled that iodine is used to test for starch. Common incorrect responses included starch, glucose and Benedict's solution.

(iv) Candidates found this demanding with stronger candidates appreciating that the concentrations need to be kept the same. Common incorrect responses included fair test, accuracy and for a repeat.

(b) (i) Almost all candidates read the stop-watches correctly. Some candidates just copied the readings into the table or rounded the second stop-watch reading to 4.

(ii) Candidates found this very demanding. Common incorrect responses included fair test, accuracy, reliability, to see the effect of **H** and **K**, to get more results and to see if the additional solutions contain starch.

(iii) Many candidates appreciated that the volume was 9.9 cm^3. Very few used the term meniscus. Discussing a straight line or the curvy bits at the side were not creditworthy. A small number thought that the volume was 10 cm^3.

(c) Candidates found this very demanding. Many only chose one or two of the solutions, rather than all three of the catalysts, and almost no candidates referenced the data in Table 3.1, Most said they were faster or that they took less time.

(d) Candidates found this demanding. The most popular incorrect choice was litmus. Those that chose universal indicator discussed colours and pH rather than comparing the colour obtained to the pH colour chart.

Question 4

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

A diagram and a results table were not required. Stronger candidates included both to illustrate their answer, and these often contained several of the marking points.

There were three possible methods for this plan, collecting and measuring the volume of gas evolved with time, timing the reaction until bubbles are no longer seen, (i.e. to the end of the reaction) or measuring the decrease in mass of the reactants with time.

Some candidates described a basic method which would work, although some forgot the time element since the question was about rate of reaction. Many candidates attempted to count bubbles despite the question saying that this would be impossible. Most successful candidates repeated for five different masses of catalyst and then repeated each mass more than once. Some measured the time for a glowing splint to relight, heated the reactants with a Bunsen burner or timed water to be produced, none of which was creditworthy. A significant number did not name the apparatus they were using. Scale is insufficient for balance.

Those that discussed safety usually named goggles or gloves but many did not name the hazardous chemicals in the experiment or the part of the body they were protecting.

Measuring the amount of something is too vague. The quantity being measured needs to be specified. In this experiment, it was volume of gas, mass of catalyst, mass of reactants, time or time for the reaction to end. Writing the results down is too vague to be creditworthy.

Control variables were well known.

Candidates find processing results and drawing conclusions challenging. Where repeats have been undertaken, averaging is insufficient – the reason for averaging needs to be explained. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is insufficient. The use of the results to formulate a conclusion for their investigation is required. For example, look to see when the mass of catalyst is increased, does the volume of oxygen released in five minutes increase, decrease, or stay the same, which means there is no relationship. If a graph is to be drawn, the quantities on each axis need to be specified and the relationship can be determined from the shape of the graph. For example, a straight line though the origin would mean the rate is directly proportional to the mass.

Question 5

(a) (i) Many candidates recorded the bottom reading correctly with a small number giving 36.5 cm. Many candidates gave the reading of the top of the spring as 32 rather than 32.0 cm.

(ii) Most candidates subtracted the values correctly.

(b) Most candidates identified the incorrect result and many deduced 9.1 cm. Incorrect responses included 7.1 and 9.5 cm.

(c) Candidates found this demanding. Non-creditworthy responses included: repeat and average, use a straight ruler, measure to the nearest 0.1 cm, get someone else to check the reading, put the ruler at zero and the most popular; wait until the spring stops moving.

(d) Many candidates did not know the meaning of the term proportional. Most thought they were proportional because as the load increases the length of the spring increases or because there was a constant increase as the load was increased. However, to show proportionality the ratio of the load to the length (or the length to the load) must be constant.

(e) Candidates found this challenging. Many multiplied l_0 by 4 and gave this as their answer rather than using this value and Table 5.1 to deduce the load required.

(f) Candidates found this demanding. Many chose goggles but said to protect the eyes from the spring without saying what might happen to cause the spring to reach the eyes. Gloves to protect the hands, taking the weight off carefully and standing away from the apparatus were common non-creditworthy responses.

Question 6

(a) The majority of candidates measured the reading on the thermometer correctly. Common incorrect values included 70.8, 80.0 and 78 °C.

(b) (i) Candidates found this demanding. Incorrect responses included: allowing the water temperature to settle or stabilise, for the water to start cooling or for accuracy.

(ii) Stronger candidates appreciated that the temperature needed to be the same throughout the water. Many discussed heat or accuracy.

(c) (i) Many candidates calculated the rate correctly with some giving the value to two significant figures. Some added all of the values between 0 and 180 and then divided by 180. Some showed no working out and so incorrect answers could not gain an error carried forward mark.

(ii) Many candidates calculated the rate correctly or made the same error as in **(c)(i)**. A small number rounded their value incorrectly.

(d) Candidates found this very demanding and many tended to discuss rate of cooling at the beginning compared to the end, or to time rather than to the temperature of the water.

(e) Stronger candidates chose the initial room temperature. Incorrect responses ranged from –130 to +500 °C, often accompanied by calculations.

(f) Changes to reduce the rate of cooling were quite well known. Common non-creditworthy responses included to wait longer between readings, use a colder room or just lower or higher temperatures without specifying any other details.

CO-ORDINATED SCIENCES

Paper 0973/62
Alternative to Practical

Key messages

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

Candidates should avoid generic answers and give those specific to the experiment being discussed.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques and were quite careful in their experimenting. The standard of graph drawing was generally high although candidates need to remember that axes need to be labelled with quantity and unit and a line of best fit needs to be a single line. Candidates found interpreting and evaluating experiments difficult.

Undertaking practical work helps candidates to interpret and evaluate experimental methods and results and also describe methods such as those required by the planning question.

Comments on specific questions

Question 1

(a) Most candidates interpreted the information correctly to determine the final colour of the indicator and the associated change in carbon dioxide concentration. Some used high, low and intermediate instead of the requested colours and thought that **C** showed either an increase or a decrease despite the colour of the indicator not changing.

(b) (i) Many appreciated that the increase in carbon dioxide concentration was due to the fish respiring. Some only referred to the increase in carbon dioxide concentration which was insufficient.

(ii) Some candidates appreciated that plants both respire and photosynthesise and that the decrease in carbon dioxide concentration must be due to the rate of photosynthesis being greater than the rate of respiration. Others just stated that the plants were photosynthesising. Some only referred to the decrease in carbon dioxide concentration, which was insufficient.

(iii) Candidates found this very demanding and tended to give the generic answer to compare, which was insufficient. Other common non-creditworthy responses included fair test and accuracy.

(c) More successful candidates appreciated that the indicator would remain red because the rate of photosynthesis would be the same as the rate of respiration and so there would be no change in the concentration of carbon dioxide. However, candidates who chose yellow or purple could still access the mark if they correctly identified whether the rate of photosynthesis was higher or lower than the rate of respiration in justification of their chosen colour.

Question 2

(a) The colours of the testing regents were generally well known. Brown is not acceptable as a Benedict's solution colour. There was some confusion with orange and blue showing a low concentration of reducing sugar and purple and blue-black being the result for non-reducing sugar.

(b) Biuret was generally well known. Incorrect colours included red and blue.

Question 3

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

Most named a ruler or tape and a fan. The most common incorrect responses were meter and air conditioning.

Many candidates used various heights on a tree, with many contravening safety rules with precariously balanced ladders. Other candidates transferred the concept to a laboratory or outside space where the variables could be controlled more easily. Both methods were creditworthy. The most common incorrect method included timing the fall of the seeds.

More successful candidates used five different heights and repeated each one. Some compared only two heights. Measurement of the height was usually seen but the distance was often given as the distance the seed fell rather than the distance from the base of the tree.

Control variables were quite well known, speed of the fan was the most common. Size of seed was insufficient.

Candidates find processing results and drawing conclusions challenging. Where repeats have been undertaken, averaging is insufficient – the reason for averaging needs to be explained. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is insufficient. The use of the results to formulate a conclusion for their investigation is required. For example, if the height of the seed increases and the distance the seed travels increases, the conclusion is that the higher the height the further it travels. Or, if the distance the seed travels decreases as the height of the seed increases, then there is no relationship between the height and the distance. If a graph is to be drawn, then the quantities on each axis need to be specified and the relationship can be described from the type of graph produced. For example, a straight line passing through the origin would mean the variables were proportional.

Question 4

(a) (i) Candidates found this demanding. Non-creditworthy responses included to mix, to fully react and to speed up the reaction.

(ii) Most candidates named a suitable piece of apparatus. Incorrect responses included beaker, cylinder and conical flask.

(iii) Stronger candidates recalled that iodine is used to test for starch. Common incorrect responses included starch, glucose and Benedict's solution.

(iv) Candidates found this demanding. Many thought the average would be more accurate or would stop anomalies happening.

(b) (i) Most candidates recorded the times correctly. Some did not record to the nearest second or incorrectly rounded 21.17 to 21.1 s.

(ii) Most candidates calculated the rate correctly. Some did not give their values to the required three significant figures.

(iii) Many candidates gave a correct relationship. Some did not use the variables in the question and discussed time. Proportional was a frequent incorrect response. To be proportional, the ratio of volume to rate (or rate to volume) must be constant.

(iv) Stronger candidates appreciated that the two volumes added together should be constant. 6, 3 and 0 cm^3 were the most common correct answers. Some candidates gave these incorrectly in the reverse order, gave all three numbers the same or repeated the numbers in the left-hand column.

(c) The test for oxygen was quite well known. Incorrect responses included relighting a lit splint, using a blown-out splint, or describing the test for hydrogen or the test for carbon dioxide.

Question 5

(a) (i) The flame test colour for Li^+ was quite well known. Ca^{2+} was the most common incorrect response, Zn^{2+} and NH_4^+ were also common.

(ii) The flame test colour for K^+ was quite well known. Common incorrect response included Fe^{2+}, Cu^{2+} and NH_4^+.

(iii) Candidates found this demanding. Methods using wires and soaked splints to get the ions into the flame were both acceptable. It is never advisable to spray solutions into a flame in a laboratory. Incorrect vectors for the solution included tweezers, tongs, spoons and rods. Many omitted the flame being blue or roaring. Some candidates put the solution into a beaker or bowl and heated it.

(b) (i) The test for chloride ions was quite well known. Incorrect responses included sulfate, bromide and carbonate.

(ii) The test for sulfate ions was quite well known. Incorrect responses included chloride and nitrate.

(c) Candidates found this demanding. The most popular incorrect choice was litmus. Those that chose universal indicator discussed colours and pH rather than comparing the colour obtained to the pH colour chart.

Question 6

(a) (i) Some candidates found reading the ruler demanding. 66 and 69 cm were common. However, many candidates showed both their readings and working out and so gained an error carried forward mark.

(ii) Most candidates subtracted the values correctly.

(b) (i) Almost all candidates multiplied the values correctly.

(ii) Many candidates described the relationship correctly. Some had the distance increasing as the mass increased.

(c) Candidates found this demanding. A 10% calculation of at least one value was expected so that it could be seen that the others fell within the 10% range. Many merely stated yes because they are close, or no because they are too far away, neither of which was creditworthy.

(d) (i) Most candidates multiplied the values correctly.

(ii) Most candidates evaluated the expression correctly. A small number of candidates rounded their answer incorrectly.

(e) Candidate found this very demanding. Non-creditworthy responses included: cannot find an accurate distance, parallax error and no repeats.

(f) Stronger candidates appreciated that the ruler was not long enough. The mass being too light was insufficient. The consequence of this was needed. Non-creditworthy responses included the ruler not balancing and the mass falling off the ruler.

Question 7

(a) The distance was usually measured correctly. Incorrect responses included 6, 12.5 and 60 cm.

(b) Candidates found this quite demanding. Many calculated correctly but did not follow the pattern in Table 7.1 and gave their answer as 60 cm. Common incorrect answers included 40 and 48 cm.

(c) (i) Most candidates appreciated that one was larger but omitted to say which one was larger. Size alone was insufficient. Many appreciated that the image was upside down. Non-creditworthy responses included different orientation, direction and rotation. Flipped alone was insufficient.

(ii) Most candidates calculated the magnification correctly.

(d) (i) Some candidates omitted to label the axes either with the quantity, the unit or both. Plotting of the points was well done.

(ii) Many candidates drew a smooth curve close to all of the points. Some drew a dot-to-dot line, used a ruled line between points or drew multiple or feathery lines.

(e) Most candidates read the value from their graph correctly with many showing the working on the graph.

(f) Candidates found this demanding. Parallel was often confused with perpendicular. Non-creditworthy responses included: repeats and look directly or straight on**.**