CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/11
Multiple Choice (Core)

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

General Comments

Candidates performed very well on **Questions 2**, **7**, and **12**. **Questions 6**, **8**, **11**, **16**, **18**, **22**, **25**, **29**, **37** and **38** proved the most challenging for candidates.

Comments on individual questions

Question 3

Candidates were asked which molecules make up larger fat molecules. While almost all chose fatty acids as one of the components, they were divided on whether the other component was glucose of glycerol.

Question 6

Candidates found this question demanding. Candidates were asked which process was taking place when saliva and starch are mixed within a partially permeable membrane suspended in water. Very few correctly answered digestion, most thinking it was assimilation or egestion.

Question 8

Very few students knew the composition of expired air, most thinking it contained very little oxygen and a high concentration of carbon dioxide.

Question 11

In this question candidates had to interpret a graph showing the variation in mass of two types of potato. There was evidence of guessing as to whether the mass of the potatoes showed continuous or discontinuous variation.

Question 15

More able candidates chose the incorrect option **A** rather than the correct answer, option **C**. Candidates are expected to understand the differences between chemical changes and physical changes.

Question 16

There was evidence that many candidates had guessed at the answer. Candidates should know that ionic substances form when a metal and a non-metal react together.

Question 18

Candidates selected the incorrect options **A** and **C** more often than the correct answer, option **D**. Candidates are expected to know that when aqueous sodium chloride is electrolysed, sodium hydroxide is formed, which turns red litmus blue.

Question 19

Stronger candidates selected the incorrect option **C** rather than the correct answer, option **B**. Candidates are required to understand and identify endothermic and exothermic changes from information given.

Question 22

Candidates selected the incorrect options **C** and **D** more often than the correct answer, option **A**. Candidates are required to know the characteristic reactions of acids with metals and other bases, including the products that are formed.

Question 24

Stronger candidates selected the incorrect option **B** rather than the correct answer, option **A**. Candidates are expected to be able to describe the noble gases in Group VIII of the Periodic Table.

Question 25

Candidates selected the incorrect options **B** and **C** more often than the correct answer, option **D**. Candidates should be able to deduce the volume remaining when specified gases are removed from a sample of clean air.

Question 26

Stronger candidates selected the incorrect option **C** rather than the correct answer, option **D**. Candidates are required to know the chemical reactions involved in the manufacturing processes listed in the syllabus.

Question 28

Most candidates could identify the correct distance–time and speed–time graphs, although all the options were popular.

Question 29

A large number of candidates selected option **D**, failing to appreciate that there was an unbalanced 10 N force acting on object Z.

Question 31

In this question on power, a significant number selected option **A**, being unaware that a power of 1500 W indicates a rate of energy transfer of 1500 J / s.

Question 33

Although most candidates knew at which positions cooling or heating were required to produce a convection current, many did not consider the arrows indicating the direction of the current, thus arriving at the incorrect option **A**.

Question 35

Candidates should be aware that sound needs a medium through which to travel. A number thought that the bell cannot vibrate in a vacuum, leading them to select option **B**.

Question 36

It was widely known that e.m.f. is measured in volts using a voltmeter, but a significant number of candidates thought that a voltmeter is connected in series with the cell, rather than in parallel.

Question 37

This question on resistor combinations proved demanding. By far the most common error was to select the option with only one resistor, option **A**, ignoring the fact that a second resistor in parallel reduces the combined resistance.

Question 38

Many candidates selected the lower values (5 A or 9 A), probably believing that either of these would provide the greatest safety, but not realising that both of them would blow at the maximum current given in the question (10 A).

Question 39

Many candidates either chose the wrong direction for the field lines (option **C**) or chose the wrong field pattern (option **B**).

Question 40

A significant number of candidates incorrectly selected option **C**, a value arrived at by multiplying the current rate of emission by the number of days.

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

General comments

Candidates performed very well on **Questions 2**, **14**, **16**, **29** and **33**. **Questions 4**, **24**, **27**, **30** and **31** proved the most challenging for candidates.

Comments on individual questions

Question 4

This question about denaturation of an enzyme caused some confusion. Some candidates knew a high pH changes the active site of an enzyme, however, some believed that a high temperature changes the active site of the substrate. This suggests that the candidates did not read the options carefully enough and did not notice the word substrate.

Question 8

Almost all candidates knew that the rate of breathing increases, but many believed that the depth decreases. For this type of question, candidates should relate the question to a real situation, and ask themselves what happens to their own breathing when running.

Question 13

Almost all candidates knew that the first stage of eutrophication is the increased growth of algae, but they were then divided as to whether the next stage was the aquatic plants dying, or a decrease in oxygen levels.

Question 14

Most candidates were able to calculate a temperature change from the readings on a thermometer.

Question 16

Most candidates were able to identify the correct dot-and-cross diagram showing all the outer-shell electrons in a molecule of ethanol.

Question 24

Candidates selected the incorrect option **A** more often than the correct answer, option **D**, with stronger candidates selecting the incorrect option **C**. Candidates are required to describe noble gases as monatomic and unreactive. They should also know the uses of named noble gases, and the approximate proportion of these gases in clean air.

Question 27

There was evidence that many candidates had guessed at the answer. Candidates are expected to understand the polymerisation processes involving alkene monomer units with a carbon-carbon double bond. They should also be able to describe the formation of simple condensation polymers, such as nylon, from monomer units containing both –COOH and $–NH_2$ groups.

Question 29

A large proportion of candidates could calculate mass from measurements taken in a displacement method for determining density.

Question 30

This question involved equating initial gravitational potential energy and final kinetic energy. Rearranging the equation caused difficulty for many, often leading to a choice of either option **A** or option **B**.

Question 31

Few candidates knew that the Sun is not the source of geothermal energy, with evidence of guessing as all incorrect options were popular choices, particularly wind.

Question 33

This question on wave terms caused little difficulty for most candidates.

Question 34

Although many candidates were aware that the movement of the object would cause the image to become smaller, many of these believed it to be an upright image rather than an inverted one, so selected the incorrect option **D**.

Question 37

A common misconception was to believe that the currents in two resistors with different resistances are equal when they are connected in parallel.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 2**, **8**, **10**, **21** and **27**. **Questions 15**, **36** and **37** proved the most challenging for candidates.

Comments on individual questions

Question 2

This question about what living organisms are made from was very well understood.

Question 8

Most candidates correctly answered this question about respiration in yeast.

Question 13

In this question, candidates had to interpret a graph of oxygen concentration in a stream at various distances downstream from fertiliser run-off. There was evidence of guessing between an increase followed by a decrease in oxygen concentration, or the reverse.

Question 15

More of the stronger candidates selected the incorrect option **C** rather than the correct answer, option **A**. These candidates understood that molten covalent compounds are not electrical conductors, but they did not appreciate that covalent compounds generally have high volatilities.

Question 16

Stronger candidates selected the incorrect option **D** rather than the correct answer, option **B**. They were able to use the stoichiometry in the reaction equation, but had not converted the volume, 30 cm^3, to dm^3 before calculating the moles of hydrogen gas produced.

Question 21

Most candidates knew the properties of transition elements.

Question 23

Stronger candidates selected the incorrect option **A** rather than the correct answer, option **C**. They knew that ammonia turns red litmus blue, but they did not understand that the strong base sodium hydroxide displaces ammonia from its salts.

Question 27

Many candidates correctly identified the total number of amide linkages in a molecule using its displayed formula.

Question 31

The most common misconception among candidates was to believe that wind is an energy source that is reliable at all times, option **D**.

Question 36

Few candidates selected the correct answer, option **A**. These candidates missed that the unit of resistance on the graph was kΩ rather than Ω, so arrived at the incorrect answer, option **C**.

Question 37

Some candidates did not take account of units in this question on energy in an electric circuit. These candidates did not convert the time in minutes to a value in seconds, therefore mistakenly selecting option **C**.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/31
Theory (Core)

Key messages

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 should be congratulated for their clear and accurate responses.

Calculations were often done well with working shown.

Comments on specific questions

Question 1

(a) (i) Enamel was quite well known for **A**. Pulp was less well known for **B** with many candidates giving dentine or nerves.

(ii) Chewing, eating and ingestion were all popular incorrect responses.

(b) (i) Most candidates were able to use the graph to determine the average number of cavities in 1985 and 2015 but some did not calculate the decrease as a percentage, leaving it as 3.8 rather than 83%.

(ii) Most candidates gave at least one reason for the reduction in cavities. A few candidates gave vague answers relating to healthcare or medicine, which were not sufficient.

(c) This was generally well answered. Candidates who did not score both marks usually referred to oxygen, haemoglobin or arteries/veins.

Question 2

(a) (i) Almost all candidates correctly suggested sodium.

(ii) A number of candidates suggested iron rather than aluminium as the metal extracted from bauxite.

(iii) A number of candidates suggested copper rather than iron as the main metal found in steel.

(iv) Many candidates incorrectly suggested copper, rather than platinum as the inert electrode metal.

(b) (i) Most candidates correctly deduced the correct order of reactivity.

(ii) Many candidates correctly named a Group I metal as a metal that reacts with cold water.

(iii) Many candidates were awarded both marks. A number of candidates did not state whether the changes were increases or decreases. Some candidates incorrectly referred to changes that could be made to the magnesium or the addition of a catalyst.

(iv) Almost all the candidates were able to complete the balanced symbol equation.

Question 3

(a) (i) A few candidates drew clear and accurate circuit diagrams. Some candidates did not know the correct symbols for a switch or a lamp. Some candidates drew two extra cells in the circuit.

(ii) Many candidates knew the correct symbol for a voltmeter. Fewer candidates were able to draw the voltmeter connected across the lamp.

(iii) Candidates needed to show the link between 1.5 V and 3.0 V. There were many vague answers. For example, so the lamp is brighter or so the lamp lasts longer.

(iv) Most candidates multiplied the potential difference by the current rather than dividing the potential difference by the current.

(v) Joules, ohms and amperes were often incorrectly suggested.

(b) (i) This was well answered by many candidates.

(ii) The normal was quite well known. Reflection line was a popular wrong answer.

(iii) Reflection was well known although a number of candidates suggested refraction.

Question 4

(a) (i) Most candidates included a snake in their food chain. However, many added organisms not shown in the web or chose organisms which did not follow the direction of the arrows. A few candidates simply made up their own food chain with a snake in it.

(ii) A few candidates chose to give definitions of the terms rather than examples from the food web.

(iii) A wide variety of correct responses were given by the candidates. Examples of responses not accepted were those relating to extinction of species, which had already been given in the question.

(b) Sunlight and oxygen were often suggested incorrectly.

(c) Candidates found this demanding but many managed to gain at least one mark usually for a reference to herbivores.

(d) Decomposers were well known as the type of organism that get their energy from dead organic matter.

Question 5

(a) Common pitfalls were to talk about the bulk properties or the movement of particles rather than the arrangement of the particles.

(b) Evaporation was well known.

(c) Seven was well known as the pH number of pure water.

(d) Chlorination kills microbes/bacteria. Many candidates chose vague words like remove, purify or clean.

(e) Common errors were to place the bonding pair electrons around the hydrogen electron shells and to leave too many or too few non-bonding electrons in the outer shell of the oxygen atom.

(f) There was much confusion between solvents and solutions. Generally, candidates needed to use the word dissolve in their response.

Question 6

(a) (i) This was answered correctly by most candidates.

(ii) This was answered correctly by most candidates.

(iii) Few candidates attempted to calculate the area under the graph. Most candidates multiplied the maximum speed by the time.

(b) (i) The idea that gaps are left to allow the track to expand in hot weather and avoid the track buckling was not well known. To stop overheating or melting were common incorrect ideas.

(ii) Many candidates did not calculate the mass of the rail. Consequently, they determined the volume as 1.3 m^3 rather than 0.13 m^3.

Question 7

(a) (i) Many candidates correctly identified parts **A** and **B**. However, the names of these parts were sometimes vague. For example, gland for **A** or hair erector for **B**.

(ii) Many candidates confused thicker layer of skin with thicker layer of fat. Few candidates were able to give an explanation in terms of insulation.

(b) Many candidates correctly identified two roles of the brain in the maintenance of internal body temperature. However, a number of candidates thought that the brain shivers and sweats to increase or decrease body temperature.

(c) Homeostasis was well known.

Question 8

(a) (i) Refinery gas was not well known as fraction **X**. Crude oil, petroleum and natural gas were often suggested.

(ii) Few candidates knew that the naphtha fraction is used as a feedstock for making chemicals. Fuel was the most popular response but this use had already been given in the question.

(iii) Fractional distillation was quite well known. Distillation was not accepted.

(iv) Many candidates correctly determined the mass of diesel oil as 130 kg.

(v) Few candidates were able to identify both elements present in the molecules, although many knew either carbon or hydrogen. Many other elements, compounds and oil fractions were suggested.

(b) (i) Coal and natural gas were often correctly suggested. Crude oil was sometimes given, suggesting that some candidates did not know that crude oil is also called petroleum.

(ii) Some candidates suggested carbon dioxide which was given in the question.

(iii) Many candidates were not able to answer this clearly. There were many vague ideas such as one change is able to be seen and the other is not.

Question 9

(a) (i) The weight of the submarine was mostly identified as force **C**.

(ii) Many candidates incorrectly suggested that the submarine would be stationary if forces were balanced. However, in the question, the candidates were told that the submarine was moving. Therefore, the submarine must have been travelling at constant speed.

(b) (i) What happens to an atom during nuclear fission was not well known. Few candidates mentioned the nucleus at all. A few candidates suggested that the atoms splits. This response was given partial credit.

(ii) A few candidates correctly explained that the lead would prevent the escape of ionising radiation from the reactor. Very few candidates mentioned the consequences of ionising radiation reaching the submarine crew.

(c) (i) Most candidates divided the speed by the time rather than multiplying the speed by the time.

(ii) Most candidates were able to name a region of the electromagnetic spectrum and give a use for waves in that region. The most popular was X-rays and body/bone scanning.

Question 10

(a) Most candidates gained at least one mark and some gave all four correct answers.

(b) Many candidates correctly suggested pH as a factor that changes enzyme activity. Popular incorrect responses were surface area and light.

(c) Few candidates were able to identify the four elements found in proteins. Calcium was often included with a combination of some of the other elements.

(d) Biuret was well known as the test for proteins. Benedict's solution and iodine were sometimes suggested.

(e) Protein was frequently linked to amino acids. Glycogen was linked to glucose by some candidates, but others linked it incorrectly to glycerol. Fats and oils were usually linked to either fatty acids or glycerol but not both.

Question 11

(a) This was well answered with many candidates gaining all three marks.

(b) Many candidates found this question demanding. Many did not mention electrons at all and few suggested losing two electrons or even just losing electrons.

(c) (i) Calcium oxide was not known as the chemical name for lime. Limewater and limestone were frequently suggested.

(ii) Carbon dioxide was well known as the gas produced in the thermal decomposition of calcium carbonate. Hydrogen was a common incorrect suggestion.

(iii) Few candidates were able to explain that limestone is spread on soil to neutralise acidic soil. Most answers suggested to add nutrients or as a fertiliser.

(d) (i) Three was the correct and most popular answer. A common error was two.

(ii) Five was the correct and most popular answer. Many other numbers were incorrectly suggested.

Question 12

(a) (i) Friction was not well known as the force. Electrostatic, kinetic and gravity were often suggested.

(ii) Few candidates knew that the particle transferred was an electron. Fewer knew that it had a single negative charge. Proton was frequently suggested.

(b) Few candidates referred to the most energetic molecules escaping during evaporation and even fewer were able to explain that the average energy of the remaining molecules would be lower.

(c) (i) 58 000 000 J was well known but some candidates gave seven zeros.

(ii) The idea that the warmed air particles would move faster was quite well known.

(d) (i) Increasing the current or voltage was well known as a way to increase the turning effect on the coil.

(ii) Force and pivot were quite well known.

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
Theory (Extended)

Key messages

Candidates should be reminded to read the stimulus material and each question carefully. To be awarded full marks, candidates should ensure that they complete all the instructions contained within the question and pay attention to the command word given. This was particularly true for **Questions 1(b)(iii)**, **4(a)(ii)**, **6(a)(i)**, **6(a)(ii)**, **7(c)** and **9(b)(ii)**

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, 'Formula triangles' are not given credit. Care should be taken when extracting data and units from a question. Candidates should show their working, express the value to an appropriate number of significant figures and include units where they are instructed. When writing numbers, candidates should ensure that they are clear. This was particularly relevant for **Question 3(c)(ii)**, **6(c)**, **9(a)**, **12(a)(i)** and **12(b)**.

Candidates should be reminded to always 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 2(a)(ii)**, **2(b)(iii)**, **5(a)(ii)**, **5(b)(i)**, **6(a)(i)**, **6(a)(ii)** and **8(b)(i)**.

General comments

A high standard of scientific knowledge, understanding and vocabulary was 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. It is important that candidates read all the stimulus material carefully and complete all the instructions contained within the question.

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. Similarly, formulae consisting of a mixture of words, symbols and units should be avoided. Numerical calculations often arrived at the correct value and arithmetic operations were generally error free. Candidates should be aware that such questions are marked in stages and credit can be given for correct working leading to an incorrect answer if evidence for that process is clearly shown.

Comments on specific questions

Question 1

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

(b) (i) Most candidates could state that there are 46 chromosomes in cell **Z**. A common error was to suggest that the arrangement was 23 from the mother and 23 from the father, rather than

describing the arrangement of chromosomes as being in pairs. This highlights the need to read the question carefully.

(ii) Some candidates could correctly state the sex chromosomes as XX. Egg cells was a common incorrect answer.

(iii) Some candidates were able to name the jelly coat as the adaptive feature. Many tried to describe the feature. This also highlights the need to read the question carefully.

(c) Most candidates correctly identified one function of the amniotic fluid.

(d) Most candidates were able to identify the correct statement about the function of the placenta. A common misconception was that the blood of the fetus and the mother mix at the placenta.

Question 2

(a) (i) Many candidates correctly determined the formula of magnesium sulfate as $MgSO_4$ Common errors were incorrect use of capitalisation and lower case to display the formula, or the inclusion of a + sign between the ions.

(ii) Most candidates recognised the role of electrons in conducting electricity and how their ability to move changed when magnesium become bonded to sulfur, subsequently scoring well on this question. Weaker responses contained uncreditworthy ideas about magnesium being able to conduct because it is a metal and that magnesium sulfate cannot conduct because sulfur is a non-metal with no reference to electrons.

(b) (i) Most candidates knew the correct test for hydrogen gas. The squeaky pop element was better known than the need for a lit splint. A glowing splint was commonly seen.

(ii) Most candidates could calculate the mass of magnesium chloride correctly. The most common error was to calculate the relative molecular mass of hydrochloric acid.

(iii) Most candidates correctly identified that magnesium was oxidised and/or lost electrons. Only a few candidates referred correctly to H^+ or hydrogen ions being reduced and/or gaining electrons, therefore the most common mark was 1. Some candidates confused the roles of oxidation and reduction.

Question 3

(a) (i) Successful candidates recalled a learned definition of frequency.

(ii) The majority of candidates correctly calculated the wavelength. The most common error was the incorrect rearrangement of the formula.

(iii) Those who knew how diffraction of water waves could be demonstrated in a ripple tank were most successful at communicating their ideas with the aid of a diagram, as suggested in the stem of the question.

(b) The sentences to explain how a simple d.c. motor rotates were completed correctly by the majority of candidates.

(c) (i) The circuit symbol for a filament lamp was known by almost all candidates. The most common error was to draw out a full circuit diagram.

(ii) The correct answer of 2000 was frequently seen. The most common error was incorrect rearrangement of formulae. Working was often shown, so intermediate marks could be awarded if the final answer was incorrect. Many candidates identified the correct unit of coulombs, even if they did not attempt to calculate the amount of charge.

Question 4

(a) (i) A mass of 62 was frequently correctly calculated from the graph. Kinetic energy was often correctly identified. Heat energy was insufficient. Mesophyll was frequently seen. Water vapour was very

rarely identified as the substance that was diffusing. Oxygen and water were the most common incorrect responses. Stomata were well known as the correct structure.

(ii) Many candidates correctly identified the effect that an increase in humidity would have on the transpiration and evaporation rates. However, not all applied this to the affect it would have on the experimental results, so did not gain the mark. This highlights the importance of reading the question carefully.

(b) (i) Cohesion was frequently correctly identified as the method that water molecules are held together in the xylem**.**

(ii) Support and structure were frequently identified as other functions of xylem. Some candidates thought that the xylem is used to store minerals.

(iii) Almost all candidates correctly identified the phloem as the other transport tissue.

Question 5

(a) (i) Many candidates deduced the correct formula for LiC*l*.

(ii) Some candidates misunderstood the type of bonding in lithium chloride. Many responses incorrectly referred to covalent or intermolecular bonds. The idea that the bonds or forces in lithium chloride required lots of energy to overcome was better understood.

(b) (i) Many candidates correctly described the structure as having layers. There was again confusion about the type of bonding, with some referring to giant ionic structures or ionic bonding.

(ii) The idea that layers can slide over each other was well known. Far fewer candidates were able to explain this in terms of forces between the layers. Incorrect ideas about covalent bonds were common.

(c) (i) Most candidates correctly deduced the melting and boiling points of mercury.

(ii) The majority of candidates were able to correctly calculate the number of neutrons and electrons for mercury. The most common misconception was that the nucleon number and the number of neutrons were equal.

Question 6

(a) (i) This question asked candidates to describe the arrangement and separation of molecules in a liquid and in a gas. Candidates struggled to separate their knowledge about particles into these two categories. There were often conflicting statements in the sections. There was some confusion with the term separation, with candidates trying to describe which process would be used to separate a liquid and a gas, rather than how the molecules were separated in the substance.

(ii) This question asked candidates to compare the motion of molecules in a liquid and in a gas. The most commonly seen correct responses compared the speed of motion of molecules in each state.

(b) (i) The majority of candidates correctly described the similarity and differences of the composition of the nucleus between the two isotopes. The most common error was to confuse protons and neutrons.

(ii) Many candidates correctly determined the half-life from the graph.

(iii) Nuclide notation was well understood by many candidates. Occasionally a few candidates suggested an alpha particle was produced rather than a beta particle. A common error was to write the charge of a beta particle as 1.

(c) The method for calculating mass was well understood. The most common error was to calculate the mass of liquid chlorine, but not subtract this from the total mass to obtain the mass of the canister.

Question 7

(a) (i) Most candidates understood the role of cilia in preventing lung infections. Some candidates did not describe how cilia in smokers changed, while others just explained the role of cilia rather than the consequences of them not working properly.

(ii) The majority of candidates correctly identified cell **X** as being a goblet cell. Ciliated cell was the most commonly seen incorrect response.

(b) (i) COPD and coronary heart disease were well known as diseases caused by smoking. Diabetes was an incorrect response that was seen fairly often.

(ii) Most candidates correctly named tar as the component of tobacco smoke that causes cancer.

(iii) The majority of candidates were able to give a definition of a mutation, although some responses lacked enough detail to be awarded a mark.

(c) Most candidates found it difficult to explain why alveoli being thin and well ventilated are advantages in terms of diffusion. Most responses simply suggested it made diffusion quicker or more efficient.

(d) The parts of the gaseous exchange system were well known.

Question 8

(a) Most candidates correctly placed the metals in the order of reactivity. The most common error was to invert the order of the middle two metals.

(b) (i) Most candidate incorrectly suggested ideas involving electrolysis. Many candidates understood that carbon was used as it was more reactive and would displace copper from the ore.

(ii) Many responses stated that calcium is below magnesium in Group 2 of the Periodic Table but did not explain in terms of atomic radius and attractive forces why this would make it more reactive.

(iii) Sacrificial protection was poorly understood. Most candidates described the idea of forming an outer protective oxide layer, despite understanding that zinc was more reactive than iron. Many candidates did not state what the iron and zinc would react with, or suggested that zinc would rust.

(c) (i) The equation for the reaction between iron and copper chloride was sometimes correct. The most common errors were to include ions in the equation and incorrect balancing.

(ii) Displacement was commonly seen as the correct response.

(d) Some candidates were able to explain that the outer aluminium layer reacts with oxygen to form an oxide layer and that this is protective. Only a very few candidates went on to explain how it was protective. Commonly seen misconceptions were that aluminium is a non-metal or that it is unreactive.

Question 9

(a) (i) The most common answer was gravity, which was insufficient. A common error was to name an energy rather than a force**.**

(ii) The size of the force was almost always correctly calculated at 840 N.

(iii) There were some good answers to the calculation of the acceleration of the skydiver. The most common error was to not use the figure calculated in **(a)(ii)** for the first stage of the calculation.

(b) The shape of the graph was well explained by most candidates in terms of changes of speed. Fewer candidates correctly explained how the forces changed during the descent. Many candidates only commented on air resistance.

(c) The majority of candidates were able to show the proof that the loss in gravitational potential energy when the sky diver reached the ground was equivalent to 6.3 MJ.

Question 10

(a) (i) Most candidates did not know the name of the process, fossilisation, that turns carbon compounds in plants into compounds in fossil fuel. The most commonly seen response was decomposing.

(ii) The chemical process shown by arrow **B** was commonly mistaken as photosynthesis rather than respiration. Therefore, few correct equations were seen.

(iii) The majority of candidates correctly annotated the diagram to show the process of feeding.

(iv) Candidates infrequently named the cell structure as a chloroplast. Palisade mesophyll cells and mitochondria were frequently seen incorrect responses.

(b) The majority of candidates correctly identified the factors that cause an increase in carbon dioxide.

(c) The majority of candidates correctly identified at least one way that deforestation causes extinction of animal species. Non-creditworthy responses included those that mention loss of homes or disruption of food chains, without adding more detail.

Question 11

(a) There was good understanding of the products of electrolysis. The most common error was that non-metals form at the cathode.

(b) (i) Many found this demanding. The products of electrolysis of aqueous copper(II) sulfate using different electrodes at the anode were not well understood. Some candidates did recognise that copper would be produced if a copper electrode was used, but failed to recognise this would be in the form of copper ions. The most commonly seen correct response was that oxygen would be evolved if a carbon electrode was used.

(ii) The most common incorrect response was 0.10 g. Most candidates correctly read the graph and realised that the change in mass at the anode would have the same magnitude as the change of mass at the cathode but did not consider that a gain in mass at the cathode would result in a corresponding loss of mass at the anode.

(iii) Many candidates found it difficult to write an ionic half-equation. The main issue was determining that copper would be produced at the cathode if carbon electrodes were used. For those candidates that deduced this, the ionic half-equation for the formation of copper was quite well known.

Question 12

(a) (i) Not all candidates started by calculating the voltage going through the variable resistor. The calculation of $R = V/I$ was well known and the majority of candidates gained at least two marks from this part of the calculation.

(ii) Some candidates correctly suggested that increasing the resistance of the variable resistor in the circuit would limit current and prevent resistor **R** from overheating. The most common error was not reading the question carefully and not realising they needed to use the circuit given, or that there was already a variable resistor in the circuit.

(b) Many candidates correctly calculated the correct power input into the solar cell. The most common error was to invert the formula when rearranging.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/42
Theory (Extended)

Key messages

Candidates would benefit from practising mathematical skills. When completing any mathematical calculation, the workings should be laid out clearly, any unit conversions completed as required, rounded appropriately, displayed to the correct degree of significance requested with the units stated. These were useful skills required in answering **Question 3(c)(iii)**, **8(f)** and **12(a)(iii).**

Candidates should read all stimulus material carefully and follow all the instructions. There were instances when candidates would have benefitted from more careful reading to enable them to give the desired responses. **Question 1(b)** and **12(a)(ii)** are examples of this.

Candidates should be reminded to take care when drawing and annotating diagrams. Credit was occasionally missed through careless drawings and labelling. Straight lines should be drawn with a ruler. Questions where these skills are useful included **6(b)(i)** and **11(b)(ii)**.

General comments

There was a high standard of scientific knowledge and understanding seen with many candidates providing detailed and accurate responses.

Whilst many candidates had a broad knowledge of the syllabus, it was evident that some areas of the syllabus were better known than others. 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) (i) Many candidates were able to identify the parts of a flower where fertilisation and pollen production occurs. Occasionally the stigma was identified as the site of fertilisation and the site of pollen production.

(ii) The question specified visible pieces of evidence, so it was important that candidates referred to the stimulus material provided to enable them to answer the question. Some candidates referred to petal colour, which cannot be seen in the diagram.

(b) Careful reading of the question was required as candidates should have described the pollen from a wind-pollinated flower. It was evident there was some confusion between pollen and seeds in plants with some candidates referring to seed dispersal techniques.

(c) (i) There were some very good responses that detailed the benefits of sexual reproduction in terms of increased genetic diversity and the resulting benefits this brings to a plant species. Occasionally candidates described sexual reproduction, without referring to the benefits of reproducing sexually. Responses such as these, whilst correct, were ignored.

(ii) This question required for some context to be applied to a candidate's scientific knowledge. A common incomplete response was that asexual reproduction requires only one parent. The

candidate needed to apply this knowledge to a situation as to when this ability would be useful for their response to be creditworthy. The best responses referred to physically isolated plants being still able to reproduce.

(d) Most candidates were able to state two characteristics of living organisms. Very occasionally candidates gave one of the characteristics as reproduction, which was already given.

Question 2

(a) The majority of candidates were able to identify the particles in a solid and in a liquid.

(b) Describing the movement of particles in a solid and in a liquid proved a little more demanding. The idea of particle vibration in a solid was well known, however, candidates also needed to state that the vibration was by particles held in fixed positions. The movement of particles in a liquid by flowing or moving over each other was more successfully described.

(c) Several candidates simply reworded the information in the stimulus material, describing the changes of state. Candidates were required to analyse this information and provide explanations based on these observations. The best responses referred to the lack of new products and the identification of a reversible process.

(d) There were some excellent diagrams of sodium and chloride ions drawn. Very occasionally candidates tried to show covalent bonding. Some candidates tried to show the process of the loss and gain of an electron. This was acceptable if the resulting ions were shown correctly.

(e) This question proved demanding for all but the most able candidates. The products at the anode and cathode were frequently reversed. The product given at the bottom of the electrolysis apparatus was the most challenging with incorrect responses of sodium, sodium oxide and water frequently seen.

Question 3

(a) (i) The majority of candidates were able to correctly identify the direction of the weight force of the turtle.

(ii) Most candidates were able to describe weight. Occasionally weight was described as a magnetic force or described as acting on a surface. These responses were ignored.

(b) Most candidates were able to use the correct formula to calculate speed. A common omission was to not convert 20 days into 480 hours, giving an incorrect calculation of 60 km / h.

(c) (i) Candidates were generally able to compare radio waves with visible light. It was important that responses were comparative so describing radio waves as having a lower frequency and a longer wavelength, rather than just a low frequency and a long wavelength. Occasionally the speed of sound was given rather than the speed of light.

(ii) Occasionally the incorrect formula was used to calculate the wavelength. Credit was given if they applied the incorrect speed of light from their response in part **(i)** correctly.

(iii) This was a demanding multistep calculation. Candidates should be reminded to lay out their working clearly and logically so they can gain some credit for their working, despite giving an incorrect final value. The most common omission was to not convert 22 mW into 0.022 W leading to a power of 10 error.

Question 4

(a) The correct response of homeostasis was commonly seen. Negative feedback was accepted as an alternative correct response.

(b) This question was very well answered. Some candidates confused the name of the enzyme that is used to digest starch and gave the name of incorrect enzymes such as protease or lipase. Almost all candidates were able to identify the maximum glucose concentration. The most common

misconception was that insulin is released from the liver and that glycogen is stored in the pancreas.

(c) Candidates could generally identify adrenaline as one of the hormones that increase the concentration of blood glucose. Glucagon was less well known, and the incorrect hormone of insulin was sometimes given in its place. Candidates should be reminded to take care when spelling scientific names. The names glycogen, glucagon, and glucose are very similar but are very different substances.

(d) Almost all candidates were able to give the correct component of blood as plasma. The most common incorrect response was red blood cells.

(e) The speed and longevity of action of nervous and hormonal control were generally well known. There was some imprecision when describing the form of transmission for nervous control. References to impulses were not precise enough and candidates should refer to electrical impulses as the form of transmission.

Question 5

(a) (i) The correct line from the graph identifying the smallest marble chips was frequently seen. Very occasionally the incorrect letter of **C** was given.

(ii) The majority of candidates were able to identify the steepest section of the graph as being between 0–30 seconds.

(b) There were some excellent responses seen with candidates able to detail an increase in the rate of reaction and explain why this happens in terms of kinetic energy and an increased frequency of successful collisions.

(c) Candidates were generally able to calculate the relative formula mass of carbon dioxide as 44. A common error was to calculate the number of moles by dividing 44 by 1.1 before multiplying by 24 to give a value of 960. Another common error was to divide the number of moles by 24 rather than multiplying.

(d) Candidates were able to give several consequences of the increase in concentration of greenhouse gases in the atmosphere. References to the ozone layer and acid rain were ignored.

Question 6

(a) Most candidates were able to use the correct formula to calculate the force supplied.

(b) (i) The question asked for the direction of the force at **X**. Any arrows showing the force from other areas in the figure were ignored. A variety of responses were seen, with arrows pointing in random directions.

(ii) Some responses lacked detail. Occasionally candidates recognised that the split-ring commutator provided current that changed directions but needed to specify that this changed every half turn or that the current was an alternating current and this enabled the coil to keep turning.

(c) (i) The name of the process of evaporation was well known.

(ii) The process of evaporation was not well explained by candidates. The best responses referred to the most energetic particles leaving the surface. Many candidates simply described particles with energy leaving the surface or repeated that particles evaporate, which was already provided in the stem of the question.

Question 7

(a) Most candidates were able to identify antibiotic **B** as the most effective antibiotic as it had the largest area clear of bacterial growth surrounding the disc.

(b) (i) Most candidates could state that mutation occurred in the genetic material or were able to provide the location of the genetic material as being the nucleus or chromosome.

(ii) The term ionising radiation was frequently given. Examples of ionising radiation such as X-rays were also acceptable.

(c) This question was very demanding. Candidates needed to relate the development of antibiotic resistance to evidence that it is an example of evolution. Knowledge of the syllabus terms and definitions would aid candidates in answering this question. The best responses were able to correctly use the scientific terms of natural selection and adaptive features and apply them to this context.

Question 8

(a) Candidates were able to identify the presence of a double bond in unsaturated hydrocarbons. Most candidates were able to identify that hydrocarbons consist of hydrogen and carbon atoms. Very occasionally candidates omitted to include those hydrocarbons only consist of hydrogen and carbon atoms.

(b) Common errors when writing the equation included the addition of oxygen, forgetting that hydrogen exists as diatomic molecules and errors in balancing the equation.

(c) Candidates were generally able to show some of the shared electrons. Common misconceptions included that only one pair of electrons were shared between the carbon atoms and that additional electrons existed on the hydrogen atoms.

(d) The conditions required for fermentation were generally well known with many candidates identifying anaerobic conditions or the necessity for the presence of yeast, glucose or a suitable temperature.

(e) Most candidates were able to identify the missing reactant as H_2O.

(f) There were a variety of places that candidates introduced errors into their calculations. Some candidates struggled with calculating the relative formula mass of ethanol whilst others struggled with the conversion of cm^3 to dm^3. Candidates should note the units that are given in the question are the units that are required by the answer. It would be beneficial for candidates to practise the skill of conversion of units.

Question 9

(a) (i) Most candidates were able to identify the correct isotope of strontium using the graph provided.

(ii) Candidates needed to provide the correct isotope and give a reasonable explanation for their choice. The best responses identified strontium-90, the time required by the experiment and that this isotope was required as its activity would not decrease significantly during this time period.

(b) Most candidates identified that a beta particle has a negative charge. Fewer candidates were able to identify that beta particles were affected by magnetic fields and electric fields, instead only choosing one type of field.

(c) The majority of candidates were able to calculate the correct volume.

Question 10

(a) The structural adaptations were well known by most candidates, with many referring to the biconcave shape, the lack of nucleus and the presence of haemoglobin.

(b) (i) Almost all candidates were able to identify the correct concentration.

(ii) There were some excellent responses seen. The most common misconception was to confuse the use of the terms concentration and water potential. Candidates that recognised that the change observed in the cell was due to movement of water through osmosis generally scored highly.

(c) (i) Many candidates recognised the structure of the cell wall as preventing a plant cell from bursting. Fewer went onto to explain that the cell wall provided rigidity or strengthens the cell.

(ii) Candidates were able to give several uses of water in plants, the most commonly seen response being photosynthesis. There were some vague answers given such as growth, which were ignored. Transpiration is the movement of water through a plant, but this is not a use of water and is simply a consequence of other processes in the plant.

(iii) The correct response of root hair cell was commonly seen. Common incorrect responses included palisade cell and xylem.

Question 11

(a) Conditions required for the Contact process were often given. A common error was to give the atmospheric pressure required as 200 atmospheres instead of 1–2 atmospheres.

(b) (i) Candidates found this calculation demanding. The relative formula mass of both sulfur dioxide and sulfur trioxide were generally calculated correctly. Many candidates did not seem to know what to do with these values and various calculations were seen. Some candidates used alternative methods to calculate the correct value, which was accepted.

(ii) The activation energy was shown correctly in many of the responses using a double-headed arrow. The energy change in the reaction needed to be shown by a straight arrow pointing downwards from the level of the reactants to the level of the products. Double-headed arrows or arrows pointing upwards were not acceptable to show the energy change. Candidates should be reminded to take care with accuracy when drawing. Some candidates drew lines that were too short to be acceptable.

Question 12

(a) (i) Candidates that recognised that the most widely used fuels produced carbon dioxide or sulfur dioxide generally scored highly, being able to relate this to global warming or acid rain. Some candidates misinterpreted the question and instead talked about the energy efficiency of the fuels, which was irrelevant.

(ii) Careful reading of the question was required. Some candidates gave the advantages of using nuclear rather than wind turbines.

(iii) A common omission was to not calculate the percentage of energy transfer for each energy type before calculating the mass leading to candidates to gain an incorrect value of 11111.1 which gained candidates' partial credit.

(b) (i) This question was well answered and many candidates successfully calculated the number of turns on the secondary coil.

(ii) Many responses described the need to reduce energy loss or the reduction of current. Fewer were able to link these ideas together.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/61
Alternative to Practical

Key messages

Candidates need to read 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 e.g. **1(b)(ii)** where a line was needed to be drawn as well as measured.

Qualitative analysis tests were not well known. Candidates should be familiar with the qualitative analysis tests.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. 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.

Undertaking practical work helps the candidates to interpret and evaluate experimental methods e.g. **3(c)(i)** and results and also to describe methods such as those required by the planning question and choose apparatus of suitable precision for specified tasks.

Comments on specific questions

Question 1

(a) The standard of drawing was generally high and almost all candidates gained at least some credit. The outline was sometimes feathery or had gaps in it. The size was usually greater than half the box, although some drew the slice too large so that it did not fit in the box. Sometimes the skin was missing as the segments went right to the outer line or the segments stopped very close to the centre. Diagrams of this type should not be shaded.

(b) (i) Most candidates measured the length correctly. The most common error was to give the value in cm rather than mm and some gave the value either 10 or 100 times too large.

(ii) The majority of candidates drew a line and measured it correctly. A significant number of candidates did not draw the line and so any measurement given could not gain credit.

(iii) The majority of candidates calculated the magnification correctly. A small number inverted the division. Many did not give their answer to two significant figures, often giving two decimal places. Rounding was an issue for some candidates.

(c) Many candidates described one visible difference and the more successful described two. Some did not make it clear whether they were discussing the orange or the kiwi. Non-creditworthy responses included colour and hairy skin as these were not visible in the photographs.

(d) Candidates found this demanding. Many knew that the diameter needed to be measured in several places but usually either omitted to add these together before dividing by the number of measurements taken or simply said calculate the average.

Question 2

(a) (i) The majority of candidates chose a suitable piece of apparatus. When choosing a pipette candidates need to specify the type of pipette, in this case a teat pipette or a dropping pipette. Non-creditworthy responses included burette, volumetric pipette, syringe and measuring cylinder.

(ii) Candidates found this demanding with a wide variety of colours seen, most trying to make a contrast with the initial colour of the DCPIP. More successful candidates appreciated that the colour chosen should be white so the colour change of the DCPIP would be seen.

(iii) The vast majority of candidates drew a suitable table and entered the results appropriately. Common errors included omitting at least one of the headings and not converting the tally into numbers.

(iv) The majority of candidates gave a correct order. The most common error was to reverse the order.

(b) (i) The reason for repeating a procedure was not well known. Incorrect responses included accuracy, checking results, precision, to reduce errors and to calculate an average.

(ii) Many candidates appreciated that the drop size would vary and the most successful gave the improvement of measuring the volume. Many repeated the question stem and improved by repetition. Other non-creditworthy responses included accuracy, precision and removing errors.

(c) Many candidates appreciated that there is vitamin C in other parts of the diet not just in juices or in vitamin C supplements. The most common non-creditworthy response was just to get it from another source without specifying what that source might be.

Question 3

(a) Most candidates recorded at least one temperature correctly. The question asked for the temperatures to the nearest 0.5 °C and so the readings needed to end in either .0 or .5. The data already in the table gave further information on the precision required. Common incorrect responses included 70, 38.0, 39. and 48.5.

(b) (i) Candidates found this demanding**.** The answer needed to use the observations of the student. That there is solid left or there is magnesium left at the end of the reaction were both insufficient. The most common incorrect responses were grey and pink solid or colourless solution.

(ii) Most candidates appreciated that the solid was copper. Many incorrect substances were given including magnesium sulfate, magnesium nitrate, sulfate, salt, polystyrene, zinc and iron.

(c) (i) Candidates found this demanding. Incorrect responses included prevention of leaks, stopping spills and overheating or melting the polystyrene cup.

(ii) Most candidates named a more accurate piece of apparatus. Non-creditworthy responses included dropping pipette and syringe.

(d) (i) Almost all candidates calculated the value correctly. A small number added the values or omitted the .5.

(ii) The standard of graph drawing was generally good. Some candidates reversed the axes, and a significant number omitted the label and/or the unit on the axes. A small number gave non-linear axes, and some gave the values in the table as their scale. A small number did not use at least half of the grid. Plotting of the points was good except where scales were awkward and required the use of a calculator.

(iii) Many candidates drew a straight line of best ft. Some drew multiple lines, non-continuous lines, did not use a ruler or did not include the origin.

(iv) Proportionality was not understood, and very few candidates gained credit. Most candidates thought that if one variable increased as the other increased then this shows proportionality. The two ways of showing proportionality are by the variables giving a straight line which passes through the origin or the ratio of the two variables being constant.

(v) Many candidates used their graph to determine the estimate correctly. Most errors were caused by candidates either misreading the value of a small square or from reading very difficult scales which required a calculator.

(e) Candidates found this very demanding. Most successful candidates appreciated the use of a lid or more insulation for decreased heat loss. A few gave the same starting temperature but did not explain that the cooling rates would be the same. The most common non-creditworthy responses included to make better measurements or use more accurate equipment. Some repeated the procedure.

Question 4

(a) Qualitative analysis was not well known. Chloride and flame tests were better known than the other tests. The other three tests usually had a precipitate of assorted colours.

(b) Most candidates appreciated that the yellow of the flame would mask the colour of the flame test or that a blue flame would allow the colour of the flame test to be seen easily. The most common response stated that sodium gives a yellow flame, this was non-creditworthy.

Question 5

(a) (i) Many knew the symbol for the voltmeter although some had a wire going through the symbol. The meter was often placed in series, particularly between the terminals of the cell, or was in parallel but in an incorrect location.

(ii) Most candidates read both meters correctly. Errors seen were 0.195 V, 0.2 V and more commonly 1.6 A.

(b) Candidates found this demanding with the two most common incorrect responses being to reset the meters and to not get electrocuted.

(c) (i) Almost all candidates calculated the value correctly. A very small number added or subtracted the values.

(ii) The vast majority of candidates chose the correct value and described the error. Incorrect responses included choosing the incorrect current or voltage, not changing the length and miscalculating.

(d) (i) The majority of candidates gave a correct relationship. Incorrect responses included *R* increases as l increases, it decreases, directly proportional and inversely proportional.

(ii) Many candidates gave a correct relationship. Incorrect responses included *R* increases as I decreases, it increases, directly proportional and inversely proportional.

(e) Candidates found this very demanding. If *R* is proportional to *V*, then the ratio of the values (either *R*/*V* or *V*/*R*) should be a constant.

(f) Candidates found this demanding mainly because they omitted the fact that they needed to show the lamp was not broken. Incorrect responses stated increase the voltage, feel if the bulb is hot and use another bulb.

Question 6

Candidates were generally well prepared for the planning question. Many addressed the bullet points and gave a logical description of the investigation. Almost all candidates gained some credit.

Listing the apparatus may be useful but the apparatus is not creditworthy until it is used in the method. A significant number did not name the apparatus they were using. Scale is insufficient for ruler.

In order to gain a mark for the method, it needs to be workable and in such detail that another person would be able to perform the same method. To be able to answer the question, several different thicknesses of

cardboard needed to be used, candidates often only used one thickness.

Few measured the thickness of the cardboard used but counting the number of sheets was also creditworthy. Many took measurements during the experiment but did not specify that the measurements were of temperature or when the measurements should be taken, such as at the beginning of the experiment and after a given number of minutes. More successful candidates repeated for five different thicknesses of cardboard and also repeated each thickness more than once. Where repeats had been undertaken, averaging was insufficient – the reason for averaging needed to be explained.

Many candidates gave a suitable table with headings and units.

Control variables were well known. Controlling the temperature is insufficient without specifying which temperature i.e. initial hot water temperature or room temperature.

The question asked about rate of cooling, few showed how to calculate the rate. However, measuring the time for the same temperature decrease or measuring the temperature decrease for the same time would each give a comparable measurement of rate.

Candidates found processing the results and drawing conclusions demanding. Giving a conclusion or prediction from previous knowledge, or simply looking for a pattern in the results, is not creditworthy. The use of the results to formulate a conclusion is required. For example, look to see when the thickness of the cardboard is increased does the rate of cooling increase, decrease or stay the same which means there is no relationship. If a graph is drawn, then the quantities on each axis need to be specified and the relationship can then be determined from the shape of the graph. For example, a straight line though the origin means the rate of cooling is directly proportional to the thickness of the cardboard.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0973/62
Alternative to Practical

Key messages

Candidates need to read 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 tended to give generic answers rather than those specific to the experiment being discussed.

Interpreting and evaluating experiments proved demanding.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The standard of graph drawing was high although candidates need to remember that axes need to be labelled with quantity and unit and a curve of best fit needs to be a single curve.

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

Comments on specific questions

Question 1

(a) (i) Most candidates gave an appropriate value and explained it. Incorrect responses included 2% or above or a correct value with the non-creditworthy explanation of low glucose concentration.

(ii) The colour of Benedict's solution was very well known. The small number of incorrect responses included brown and green.

(iii) Many candidates gave a correct temperature. Incorrect responses were often between 30 °C and 40 °C or 100 °C.

(iv) Safety issues need three aspects, the protection worn, what part of the body it is protecting and what it is protecting against. Non-creditworthy responses either addressed two of these three factors or gave generic hazards such as dangerous chemicals rather than citing Benedict's solution, the hot water or the hot apparatus.

(v) Candidates found this demanding. The generic answer to avoid contamination was common and insufficient, answers need to relate to the experiment in question. Other non-creditworthy responses included to get the correct volume or to get accurate or precise results.

(vi) Candidates found this very demanding with few correct responses seen. The most common non-creditworthy response was repeat and average. Some suggested different concentrations without specifying that they needed to be in the range between 0% and 5%.

(b) (i) The standard of graph drawing was generally very good. Some candidates reversed the axes, and a significant number omitted the quantity and/or the unit on the axes. A small number gave non-

linear axes, and some gave the values in the table as their scale. A small number did not use at least half of the grid. Plotting of the points was good except where scales were awkward and required the use of a calculator.

(ii) Many candidates drew an acceptable curve of best fit. Some drew multiple or feathery lines, lines which were very thick or lines which were far away from the points and so were not best fit. A small number drew a straight line. It is important that candidates fully erase lines which they replace.

(iii) Most candidates read the value from the graph correctly. Many lost marks by not marking the graph to show their working. It was expected that a line be drawn from 0.72 on the *y*-axis to the curve and then from that point on the curve to the *x*-axis. A point on the curve or a small mark on the axis is not an acceptable means of showing working and will not gain credit.

(iv) Many candidates described the quantitative data or precision of the data from the calorimeter or the subjective data from the Benedict's solution. Non-creditwothy responses included to give more values, more accurate and does not give a colour.

(c) (i) Most candidates measured the length correctly. The most common incorrect response was 40.

(ii) Candidates found this very demanding. Some candidates gave a correct value but could not explain why they had chosen it. Incorrect responses included values between 5% and 10% and many repeated the question as their explanation.

Question 2

(a) The vast majority of candidates gave correct initial and final colours. An incorrect initial colour for iodine was red and incorrect final colours for biuret were colourless or purple and for iodine blue.

(b) The conclusions were well known. Some candidates stated the nutrient but did not say whether it was present or not or wrote just negative and positive. A small number of candidates thought biuret or iodine was a test for fats.

Question 3

(a) (i) Most candidates gave the values to two decimal places. A small number recorded the values to three, one or no decimal places. A very small number did not round the second value.

(ii) Many candidates recorded the volume correctly. The easiest way to read inverted measuring cylinders on paper is to turn the paper upside down. Incorrect responses included: 85, 80.4, 80.5 and 8.5.

(b) (i) The wording of the question meant that an observation needed to be given and so no more hydrogen produced was not creditworthy. No more magnesium left, and only copper remaining were also popular non-creditworthy responses.

(ii) Candidates found this very demanding and almost no candidates gained credit. Most thought a syringe or a lid would solve the problem.

(iii) Almost all candidates subtracted the values correctly.

(iv) Most candidates calculated the mass correctly. Some gave their answer to one significant figure, which was not creditworthy.

(v) Most candidates calculated the percentage correctly. The most common error was to omit multiplying by 100.

(c) (i) Most candidates recorded the mass to 2 decimal places. The most common error was to give three decimal places.

(ii) Candidates found this very demanding. Non-creditworthy responses included remove the filter paper, use a different filter paper, tare the balance, use a more accurate balance, repeat the experiment and wash the copper.

(iii) Most candidates calculated the mass correctly.

(iv) Many candidates calculated the percentage correctly. the most common error was to omit the '100 – ' at the start of the calculation and so give a value of around 94%.

(d) Candidates found the diagram demanding. The most successful candidates drew a diagram using a pencil and ruler, had a distinct filter funnel and filter paper, had a closed lower end to the filter paper and had a collecting vessel, all labelled. Common errors included a gap at the base of the filter paper, using a dashed line for the filter paper, laying the filter paper flat over a beaker, not including a filter funnel and omitting labels. Diagrams of apparatus should not be 3-dimensional.

Question 4

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

A results table and diagram were not required but more successful candidates included one or both, which often addressed some of the marking points.

Listing the apparatus may be useful but the apparatus is not creditworthy until it is used in the method. A significant number did not name the apparatus they were using. Scale is insufficient for balance since most measuring instruments include a scale.

Safety issues need three aspects to be addressed, the protection worn, what part of the body it is protecting and what it is protecting against. Some response only addressed two of these three factors.

In order to gain a mark for the method, it needs to be workable and in such detail that another person would be able to perform the same experiment. To be able to answer the question, several different masses of salt needed to be used, candidates often only used one mass. The most common errors included timing how long the solutions took to reach boiling point rather than measuring the boiling points, using concentrations of solutions rather than masses of salt and using a water-bath to heat the solutions, not appreciating that the solution could not boil since the boiling point would be higher than 100 °C (this was given in the stem of the question).

Measurements were well deduced. Amount of salt is not creditworthy, this needed to be specified as mass. More successful candidates repeated for five different masses of salt and also repeated each mass more than once. Some only considered no salt and with added salt. Where repeats had been undertaken, averaging was insufficient – the reason for averaging needed to be explained.

Control variables were well known. Common errors included controlling the mass of salt or the temperature of the Bunsen burner flame.

Candidates found processing the results and drawing conclusions demanding. Giving a conclusion or prediction from previous knowledge, or simply looking for a pattern in the results, is not creditworthy. The use of the results to formulate a conclusion is required. For example, look to see if adding increasing masses of salt to water increases the boiling point further or makes no difference which means there is no relationship. If a graph is drawn, then the quantities on each axis need to be specified and the relationship can then be determined from the shape of the graph. For example, a straight line though the origin means the variables are proportional.

Question 5

(a) (i) Almost all candidates recorded the reading correctly.

(ii) Most candidates calculated the distance correctly. The most common errors were 1.5 and 20.

(iii) Most candidates calculated the distance correctly. The most common errors were again 1.5 and 20.

(b) Almost all candidates recorded the mass correctly. The most common error was 82.8.

(c) Most candidates calculated the mass correctly. The most common errors were to not give the answer to the requested two significant figures, often two decimal places, or incorrectly round their final answer.

(d) (i) Most candidates calculated the volume correctly. Incorrect responses included 16 and 64.

(ii) Most candidates gained credit. The scale needs to be viewed at eye level to the reading or perpendicular to the reading not just at eye level or perpendicular. Another common error was to view the scale parallel to the reading. Ensuring the measuring cylinder was flat or reading to the bottom of the meniscus were not creditworthy.

(e) Almost all candidates calculated the mass correctly.

(f) The most successful candidates calculated 10% of one of the values, then added and subtracted the 10% from the value in order to determine the 10% range and then showed that the other value either was, or was not, in that range. Some calculated the percentage difference between the two values. Unsupported answers of yes or no were not creditworthy.

Question 6

(a) Most candidates recorded the temperature correctly. Where a value needs to be recorded to the nearest 0.5 then the answer needs to end in .0 or .5.

(b) (i) Candidates found this demanding. Many discussed the water rather than the thermometer. Incorrect responses included the water reaching its highest temperature, the water cooling, to allow even distribution of temperature or for accuracy.

(ii) Safety precautions were well known.

(c) Many candidates recorded the temperature correctly. The most common error was 79 instead of 79.0.

(d) (i) The majority of candidates calculated the temperature decrease correctly.

(ii) Candidates found this a little demanding. The most common incorrect response was 3 which is the temperature decreases for the last 2 minutes.

(e) Most candidates related the rate of cooling to the time or duration of the experiment instead of to the temperature of the water.

(f) (i) Many candidates used their earlier answer to correctly predict a temperature at 9 minutes. There was no pattern to incorrect responses.

(ii) More successful candidates appreciated that the temperature would cool to room temperature. Incorrect responses ranged from large negative values to temperatures between 40 and 50 °C.