

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

Biology:

This was a small cohort of twenty three candidates, and little can be read into the statistics, but the paper in general appears poorly answered, with a strong suggestion in many cases of guessing between two possible answers by the candidates. This may suggest disruption of their learning this year.

Chemistry:

No questions proved to be particularly easy for the candidates.

Question 19, **Question 24** and **Question 27** proved most difficult for the candidates.

Physics:

Physics **Questions 29**, **34** and, especially, **Question 40** caused difficulty for many candidates.

Comments on specific questions

Question 1

This question on processes occurring in plants and animals was poorly answered with the majority of candidates thinking that plants either did not move, or did not excrete, showing a lack of understanding of fundamental processes in living organisms.

Question 2

While the majority of candidates understood that a membrane is required for osmosis to take place, a considerable number of them thought that osmosis took place in only one direction. They were equally divided on whether this was in or out of the cell.

Question 3

This question on chemical composition of proteins was very well answered

Question 4

Almost half the candidates identified the correct enzyme activity graph, however, a considerable number chose one showing a plateau is activity followed by a rise.

Question 6

A significant number of candidates confused assimilation and absorption.

Question 7

While most candidates correctly stated that transpiration rate is higher at higher temperatures, they were less sure about the effects of humidity, appearing to guess between high and low humidity as giving the greater transpiration rate.

Question 8

This question on the breathing system was very well answered

Question 9

This question asked candidates to decide which skin structures helped maintain body temperature in cold conditions. Most candidates correctly identified the hair but were divided on subcutaneous fat or a sweat gland. This question was common to both papers and produced a similar set of results.

Question 15

More able candidates chose the incorrect **D** rather than the correct answer, **C**. Candidates are required to be able to balance simple symbol equations.

Question 19

Candidates chose the incorrect **B**, **C** and **D** more often than the correct answer, **A**. Candidates are required to know that the chemical test for aqueous bromide ions produces a cream precipitate with the addition of acidified aqueous silver nitrate.

Question 20

Some of the more able candidates chose the incorrect **B** rather than the correct answer, **C**. Candidates are required to know the trends in the elements descending Group I of the Periodic Table.

Question 22

Candidates chose the incorrect **C** more often than the correct answer, **A**. Candidates are expected to be able to explain, in terms of their properties, why alloys are used instead of pure metals. They should know that metallic elements exist as atoms, not as molecules.

Question 24

Candidates chose the incorrect **C** more often than the correct answer, **A**. Some of the more able candidates chose the incorrect option **B**. Candidates are expected to be able to describe the chemical test for water using cobalt(II) chloride.

Question 25

Candidates chose the incorrect **A** more often than the correct answer, **D**. Some of the more able candidates chose the incorrect **C**. Candidates are required to know that lime is calcium oxide, and that limestone is calcium carbonate, and that these, together with calcium hydroxide, are bases.

Question 26

Some of the more able candidates chose the incorrect **D** rather than the correct answer, **C**. Candidates should know that complete combustion of hydrocarbons produces carbon dioxide and water.

Question 27

Candidates chose the incorrect **A** more often than the correct answer, **D**. More able candidates chose the incorrect **A** and **B**. Candidates are expected to be able to deduce the structure of a polymer product from a given alkene, and so they should understand that poly(ethene) is represented as a saturated hydrocarbon made during addition polymerisation.

Question 29

In this question on moments, slightly more than half the candidates multiplied the force by the distance from the left-hand end of the rule, rather than using the distance to the pivot. This led them to choose the incorrect option **B**.

Question 31

Although most candidates correctly identified nuclear fission as non-renewable, almost one in three chose hydroelectric.

Question 32

Here a large majority could identify the change of state shown.

Question 34

The topic here was the frequency and wavelength of a wave. Candidates chose reasonably evenly between options **A**, **B** and the correct **C**, showing that the most common misconception was to confuse frequency with period. Surprisingly many of the more able candidates failed to deduce either the frequency or the wavelength and therefore opted for **B**.

Question 40

This question on half-life proved to challenging. Fewer candidates chose the correct option **C** than any of the other options. A large proportion of candidates thought the correct time to be 180 years (option **D**). This is obtained by multiplying the half-life by the final number of atoms.

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Paper 0654/22
Multiple Choice (Extended)

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

General comments

Biology:

This paper in general appears reasonably well answered, but with a strong suggestion in many cases of guessing between two possible answers by the candidates. This may suggest disruption of their learning this year.

Chemistry:

Candidates performed very well on **Question 21**.

No questions proved to be particularly difficult for the candidates.

Physics:

Physics **Questions 35** and **36** were challenging for many candidates. **Questions 31** and **33** were particularly well answered.

Comments on specific questions

Question 1

Most candidates correctly stated that plants need carbon dioxide and ions for their nutrition, however, a significant number also thought that they needed organic compounds.

Question 2

This question asked candidates to work out in which direction osmosis is occurring, and whether it is through the cell surface membrane or the cell wall. Whilst almost all got the direction correct, a slight majority believed that it occurred through the cell wall rather than the membrane.

Question 3

This question on chemical composition of proteins was very well answered.

Question 7

This question used a novel way of asking in which direction the products of transpiration are carried by the phloem sap. Almost all candidates realised that sucrose was being carried, but they then appeared to guess in which direction it was moving.

Question 8

This question on the breathing system was very well answered.

Question 9

This question asked candidates to decide which skin structures helped maintain body temperature in cold conditions. Most candidates correctly identified the hair but were divided on subcutaneous fat or a sweat gland. This question was common to both papers and produced a similar set of results.

Question 18

Candidates, including some of the more able candidates, chose the incorrect **B** more often than the correct answer, **A**. Candidates are expected to be able to suggest a method of making a given salt from suitable starting material, given appropriate information.

Question 21

Candidates knew very well that helium is used to fill airships.

Question 29

Candidates found little difficulty in answering this question on measuring density by displacement.

Question 30

Here a large majority correctly identified nuclear fission as non-renewable.

Question 31

Candidates were also confident in answering this question on thermal conduction, with a very high proportion correctly choosing option **A**.

Question 33

This question was another well answered question, with many candidates knowing that sound waves do not travel in a vacuum.

Question 34

In this question on current and electric charge, just over half of candidates did not convert milliamps to amps and therefore opted for the incorrect option **C**.

Question 35

This question was challenging for candidates; more than twice as many candidates incorrectly chose option **C** as the correct answer instead of **B**, treating the four wires as resistors in series rather than in parallel.

Question 36

Although a majority knew the properties of thermistors, many of these candidates incorrectly believed that decreased resistance led to an increase in voltmeter reading, causing them to choose option **B**.

Question 38

Only two in five candidates could determine the direction of the force on the wire, although it was widely known that this would be either into or out of the page.

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Paper 0654/32 Theory (Core)
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Key message

Candidates had a good understanding of what the questions were asking.

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.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. There was a good range of marks on every question and on the paper as a whole. Candidates generally gained marks on all questions. Performance depended on scientific knowledge and on the ability of the candidates to understand the question and express themselves clearly.

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

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.

There was no evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

- (a) (i) This was answered correctly by almost every candidate.
- (ii) Most candidates were able to determine the difference in the number of teeth between a human and an elephant.
- (b) Enamel was the correct and most popular response. Dentine or cement were common incorrect responses.
- (c) Molar or premolar was the correct response. Some candidates tried to describe the teeth in terms of strong, sharp, etc.
- (d) Brushing teeth was well known.

- (e) (i) Most candidates correctly described identified D as the place where egestion occurs. Some candidates were able to identify E as the place where most absorption occurs. Some candidates were able to identify H as the place where ingestion occurs. There were no common incorrect responses.
- (ii) The pancreas was well known.
- (f) Most candidates gained both marks.
- (g) Plasma was identified by some candidates as the part of the blood that transports soluble nutrients. Many candidates incorrectly suggested red blood cells or haemoglobin.

Question 2

- (a) (i) The term hydrocarbon was not well known. Few candidates were able to describe a hydrocarbon as a compound containing carbon and hydrogen atoms only.
- (ii) Natural gas was not well known as the fossil fuel whose main constituent is methane. Coal was often suggested.
- (b) Some candidates were able to complete the dot-and-cross diagram for methane. Many forgot to include the symbols for the chemical elements.
- (c) (i) Some candidates confused exothermic and endothermic reactions.
- (ii) Carbon dioxide was well known as a product of the complete combustion of methane. Only one candidate suggested water. Carbon monoxide and hydrogen were often suggested.
- (iii) Causing breathing problems was accepted as an adverse effect of carbon monoxide on the health of humans.
- (d) (i) Few candidates were able to explain that an alkene contains a carbon – carbon double bond but an alkane only has single bonds. Many candidates confused alkanes with alkenes.
- (ii) Very few candidates knew the chemical test that distinguishes between an alkane and an alkene. Some candidates did not attempt this question.

Question 3

- (a) (i) Some candidates correctly identified gamma rays as the waves in the electromagnetic spectrum with the highest frequency. Many more suggested X-rays and radio waves.
- (ii) A few candidates correctly identified infrared as the waves emitted by a remote control for a television. Many candidates suggested radio waves.
- (b) (i) Refraction was well known. Reflection was often suggested. Some candidates attempted to describe refraction in terms of the bending of light.
- (ii) The normal was well known.
- (iii) Most candidates stated the value of the angle as 45°. Several candidates suggested 26°.
- (iv) Few candidates knew both variables.
- (v) Most candidates gained full marks for the calculation.
- (c) (i) Some candidates gave the correct order as alpha, beta and gamma. An equal number of candidates reversed the order.
- (ii) Some candidates correctly identified beta particles as negatively charged particles. An equal number of candidates suggested alpha particles.

- (iii) Some candidates correctly identified gamma rays as the most penetrating. An equal number of candidates suggested alpha particles.

Question 4

- (a) (i) There was a lot of confusion between the stigma and the anthers. Very few candidates gained full marks. The only part correctly identified by most candidates was A which was the petals which attract pollinators.
- (ii) Few candidates identified the filament as part B. Many suggested the stigma.
- (b) The ovule was often confused with the ovary.
- (c) Some candidates gained one mark but few gained both marks. There were some very vague descriptions offered.
- (d) Drinking, eating and breathing were all common incorrect responses.

Question 5

- (a) (i) Many candidates knew that the number of protons equalled the number of electrons. So 26 was a popular and correct response.
- (ii) Fewer candidates were able to subtract the proton number from the nucleon number to determine the number of neutrons.
- (iii) Few candidates appreciated that the proton number of all atoms of iron would be the same
- (b) No candidates knew the chemical test for aqueous iron(III) ions. Many candidates did not attempt this question.
- (c) (i) Some candidates were able to define the term alloy.
- (ii) Uses of stainless steel were well known.
- (iii) The presence of both oxygen and water were well known as the two conditions needed for the rusting of iron.
- (iv) Many candidates were able to describe coating the iron with a suitable material (e.g. paint / oil) to prevent the iron coming into contact with either water or oxygen.

Question 6

- (a) (i) Many candidates knew the human audible frequency range but few were able to apply this information to fully answer the question.
- (ii) Most candidates were able to relate frequency to pitch.
- (iii) Some candidates were able to rearrange the usual formula ($\text{speed} = \text{distance} / \text{time}$) to determine the time taken.
- (b) (i) Some candidates contradicted themselves in their description. (e.g. the dolphin is moving at constant speed, acceleration.)
- Candidates should refer to the speed of the dolphin increasing rather than the motion of the dolphin increasing.
- (ii) Nearly all the candidates were able to use the graph to determine the maximum speed of the dolphin.
- (iii) Few candidates were able to answer this question. Few attempted to use the area under the graph.

- (c) Few candidates were able to explain that the faster (more energetic) particles escape from the surface of the liquid. Instead there were often descriptions of density changes

Question 7

- (a) (i) Few candidates drew an arrow between dead organisms and carbon dioxide in the atmosphere to represent the process of decomposition. Some candidates drew arrows to or from dead organisms. Many candidates did not attempt this question.
- (ii) Many candidates described the path of oxygen through the body rather than the process of respiration. Some candidates confused respiration and photosynthesis. Few candidates were able to identify either the reactants or products in this reaction.
- (b) Water and carbon dioxide were well known as two of the requirements for photosynthesis.
- Chlorophyll and light or sunlight were also correctly suggested by some candidates. The Sun was not accepted as a requirement.
- (c) (i) Many candidates correctly circled consumer and herbivore as the two words used to describe the sheep in food chain. Some candidates only circled one word.
- (ii) The wolf was frequently identified as the tertiary consumer in the food chain. The fox was sometimes suggested.

Question 8

- (a) (i) Many candidates identified molecules that were compounds rather than elements.
- (ii) Many candidates correctly identified hydrogen, chlorine or hydrogen chloride as diatomic molecules.
- (iii) Carbon dioxide was well known as a greenhouse gas.
- (b) (i) The two elements present in a molecule of ammonia were frequently identified as nitrogen and hydrogen.
- (ii) Few candidates could determine the total number of atoms in a molecule of ammonia, NH_3 . Three was a common incorrect response.
- (c) The meaning of the term solvent was not well known.
- (d) (i) Some candidates were able to determine that the salt produced is calcium chloride.
- (ii) Evaporation and crystallisation were well known as possible methods for obtaining a sample of the dry salt from solution.
- (iii) A wide variety of correct ways to increase the rate of reaction were given. Candidates needed to be clear about whether the quantities mentioned were increasing or decreasing.

Question 9

- (a) Most candidates drew a vertical arrow but some drew it moving upwards rather than downwards.
- (b) Many candidates found it difficult to clearly describe two differences and gave very vague responses.
- (c) (i) There were many clear responses to this question.
- (ii) Few candidates were able to state the correct value for the combined resistance and less were able to explain their answer. Candidates needed to recall that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

- (d) Many candidates gained one mark here either for suggesting an increased current or an increase in the number of turns.

Question 10

- (a) (i) The only common error was to link the part A with the cell membrane rather than cell wall.
- (ii) Few candidates identified three parts of a plant cell that are also found in an animal cell.
- (iii) Some candidates described one difference in structure. This was frequently the absence of chloroplasts in a root hair cell
- (iv) Most candidates gave a correct function of root hair cells.
- (b) Some candidates correctly calculated the magnification as 2.5. A common wrong response was 0.03.
- (c) Red blood cells were commonly known as the type of animal cell that transports oxygen. A number of candidates suggested haemoglobin.

Question 11

- (a) (i) Lithium, sodium and potassium were often suggested as the three metals that have only one electron in their outer shell. Magnesium was a common incorrect response.
- (ii) Calcium and magnesium were well known as two metals that are Group II metals.
- (b) A wide variety of correct physical properties was given by the candidates. Some candidates suggested chemical properties.
- (c) This was well answered by most candidates.

Question 12

- (a) (i) Force R was frequently identified as the weight of the bus.
- (ii) The size of force S was correctly stated as 500 000 by some candidates who used the information in the question about the bus travelling at constant speed.
- (b) Gravitational potential energy and kinetic energy were usually identified as the two forms of energy transferred to the bus as it accelerates up the hill.
- (c) Radiation was frequently identified as the method of thermal energy transfer between the Sun and the Earth.
- (d) No candidates were able to answer this question with a clear correct response.
- (e) Diesel and petrol were sometimes incorrectly suggested as a non-renewable energy source. Water was not accepted as a renewable energy source on its own.
- (f) Many candidates described why the pressure increased in the tyre rather than how the speed of the molecules inside the tyre increased.

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Paper 0654/42 Theory (Extended)
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Key messages

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.

- Calculations were generally well done. An important skill that students should practise is the conversion of units and the rearrangement of formulae. 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 units where they are instructed. This was particularly evident in questions **3(a)**, **3(b)(i)**, **3(c)(i)** and **12(b)**.
- Candidates should be reminded to always using correct scientific terminology when describing phenomena. It is important that candidates are able to express themselves 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 extended prose type questions. Using and understanding scientific terms was particularly relevant for questions **5(e)**, **6(b)**, **7(a)** and **10(a)(ii)**.

General comments

It is important for candidates to read all the stimulus material carefully and complete all the instructions contained within the question. There were occasions where candidates could not access the full marks available or gave irrelevant responses due to not reading the question thoroughly or answering a question of their own devising.

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 encourage candidates to go through the syllabus ensuring that they have covered each learning objective in their revision.

Comments on specific questions

Question 1

- (a) Some candidates were able to give the precise definition of sensitivity as stated in the syllabus. However, there were a number of vague responses referring to one or more particular senses such as touch and taste. Some candidates only gave the second half of the definition, stating that sensitivity was a response to a change in the surroundings or stimulus. Fewer candidates included mention of detection of a change in surroundings.
- (b)(i) A number of candidates omitted this question altogether. The biggest misconception was that the fovea was the blind spot.
- (ii) The cornea (**C**) and the optic nerve (**G**) were frequently given in place of the retina (**H**). The pupil (**D**) was frequently given in place of the iris (**B**). The part of the eye that refracts light was the most commonly correct answer.

- (iii) This question proved challenging for some candidates, who were confused on some of the parts. A common misconception is that ligaments are capable of contraction. Only muscles contract and relax, whereas ligaments are stretched or slacken.
- (c) This question was generally well answered. Brain was commonly seen. Some candidates referred to the spine or backbone instead of the correct term of the spinal cord. Nerves was the most common incorrect response seen.

Question 2

- (a) (i) The meaning of the term isotope was well known with most candidates able to describe isotopes in terms of having the same number of protons and different number of neutrons. Rarely candidates confused protons and neutrons. Any references to electrons were ignored.
- (ii) The number of protons, neutrons and electrons in an atom of potassium was often stated correctly. The number of particles in a potassium ion proved more problematic. A small number of candidates attempted to include the nucleon number.
- (b) Most candidates were able to provide a balanced symbol equation for the reaction. The most common misconception was that hydrogen exists as a single atom rather than as a diatomic molecule. A minority of candidates did not know the formula for water or gave water instead of hydrogen as a product.
- (c) Many candidates were able to give the correct number of electrons in both ions and include the charge. There were a small number of candidates that either omitted the charges or gave the number of electrons for atoms of sodium and fluorine rather than their ions. Very occasionally candidates attempted to show the mechanism of electron transfer. These responses were not creditworthy.
- (d) (i) The flame test result for sodium was not well known. A wide variety of incorrect metal ions were stated including potassium and copper, in addition to non-metals such as hydroxide, hydrogen and chloride.
- (ii) The majority of candidates stated the correct halide ion of chloride.

Question 3

- (a) (i) Candidates were generally able to show how speed was calculated using the information provided in the stimulus material. A number of candidates omitted the conversion of kilometres to metres and hours to seconds. It would be beneficial for candidates to practice converting units and recognising when units require conversion.
- (ii) The majority of candidates were able to calculate the kinetic energy. Common errors included omitting to square the velocity or using the incorrect formula of mv^2 .
- (b) (i) The majority of candidates were able to calculate the speed of sound in air. Occasionally there were some difficulties in rearranging the formula.
- (ii) Surprisingly few candidates referred to vibration of the air particles, instead referring to the wave vibrating. Many candidates accurately described the movement as a series of compressions and rarefactions.
- (c) (i) Many candidates were able to calculate the volume. However, a significant number rearranged the formula incorrectly to give a value of 25.
- (ii) Candidates generally understood the significance of the small gaps between the tracks, relating this to thermal expansion. Fewer were able to describe the consequences if the gaps were absent.

Question 4

- (a) (i) This question proved challenging to all but the most able candidates. In order to answer this question successfully, candidates needed to first recall the function of the lipase enzyme and the effect of extreme temperatures on enzyme action. Some candidates stated that test-tube 2 did not contain lipase, hence the lack of breakdown of fats, rather than recognising the relevance of the inclusion of boiled lipase. The best responses explained the effect of boiling on enzyme action as the reasoning for the lack of fat digestion.
- (ii) Nearly all candidates were able to calculate the difference in time taken.
- (iii) The best responses were able to explain the action of bile in terms of emulsification and relate this to faster digestion of fats. A common misconception evident was that bile is an enzyme.
- (b) Liver was commonly stated as being responsible for the production of bile. Incorrect responses of gall bladder and pancreas were commonly seen.
- (c) (i) The majority of candidates recognised the importance of the villi as increasing the surface area for absorption.
- (ii) The small intestine was commonly stated as the location of the villi. Very occasionally the vague response of intestine was given, which was not creditworthy.

Question 5

- (a) The correct formula for propene was commonly given. Occasionally the incorrect answers of the formula for propane and the general formula for alkenes were given.
- (b) The correct group of alkenes was given by the majority of candidates. A small minority of candidates gave the incorrect group of alkanes.
- (c) Most candidates were successful in describing unsaturated hydrocarbons in terms of presence of at least one double bond. There was some confusion evident, whereby some candidates tried to explain this in terms of solubility.
- (d) The most common incorrect answer given was polymerisation. Correct responses of addition or hydrogenation were commonly seen.
- (e) This question was well answered with most candidates giving the correct observations. Some candidates should be reminded to use the correct scientific terminology for observations. References to a transparent or clear colour did not gain credit. The correct term is colourless.
- (f) (i) Only the most able candidates accessed both marks available. Candidates generally drew a monomer consisting of single bonding but found drawing the correct structure challenging. A significant number of candidates drew a monomer consisting of three central carbons. Many candidates omitted a bond between the two carbons given.
- (ii) Candidates had difficulty expressing their responses. There were many vague responses referring to variations of addition of monomers. The best responses recognised that condensation polymerisation resulted in more than one product, one of which is usually water.

Question 6

- (a) This calculation was generally well done, with most candidates scoring full credit. A common error was to not take gravity into account. Occasionally the incorrect units of newtons were given.
- (b) There was some confusion evident amongst some candidates between speed and acceleration. Some described the speed as increasing and then decreasing. Most candidates gained credit for referring to acceleration. Only the most able candidates were able to describe the non-uniform nature of the acceleration.

- (c) All but the weakest candidates gained partial credit. Most candidates described friction. Some candidates incorrectly referred to the movement of protons or positive charges. Some candidates tried unsuccessfully to explain this in terms of ionic bonding rather than static electricity.
- (d) This question was well answered with most candidates scoring the mark.

Question 7

- (a) Most candidates could interpret the food web to identify arctic cod as a carnivore and phytoplankton as a producer. Fewer candidates were able to identify the orca as a carnivore **and** a quaternary consumer. Candidates should be reminded to read the information carefully as they were instructed to tick **all** the terms that could be used for each organism. Only the most able candidates were able to recognise that more than one term applied to the orca.
- (b) There were many accurate and detailed responses. Most candidates were able to describe the production of carbohydrates fully, giving reference to the reactants, use of light energy and the name of the process as photosynthesis.
- (c) A minority of candidates misinterpreted the question and gave types of energy. However, most candidates were able to gain at least one or two of the marks allocated by correct description of how energy is lost between the trophic levels, with respiration and references to movement seen most commonly.
- (d)(i) This question was well answered with most candidates able to describe the process of natural selection. The last response of generations proved the most difficult for candidates.
 - (ii) The features of gas exchange surfaces were generally well known. Vague responses of near a transport system were not credited and candidates should specifically refer to a good blood supply.

Question 8

- (a) A wide variety of different colour predictions were seen. There were some references to clear, transparent or white instead of the correct term of colourless.
- (b) The balanced equation was generally given. However, a few candidates omitted the state symbols or used (l) in place of (aq).
- (c) A few candidates struggled to complete the ionic equation. Some wrote the equation in reverse and some tried to include the sulfate group.
- (d)(i) Most candidates were able to calculate the mass. A few candidates incorrectly calculated the formula mass of magnesium chloride as 59.5. Some candidates used alternative methods to calculate the mass by first calculating the moles of magnesium used as 0.02 and then multiplying by the formula mass. This was acceptable.
 - (ii) This question was generally well answered. Some candidates muddled the test for oxygen gas with the test for hydrogen gas. Some candidates referred to the sound made as pop up rather than a pop or a squeaky pop.

Question 9

- (a)(i) There was some confusion evident between the extension and the extended length, with some candidates using the extended length of 3.4 cm in their calculations rather than the extension of 1.2 cm. Candidates that did calculate the extension were generally able to calculate the weight correctly.
 - (ii) Many candidates gave the correct spring of B. Fewer were able to explain this in terms of having the smallest extension, instead referring to the longest extended length. Fewer still referred to the extension as being inversely proportional to the spring constant. A small number of candidates calculated the spring constant of all the springs, which was acceptable.

- (b)(i) Only the most able candidates correctly calculated the resistance. Most candidates were able to state the correct formula. The step that caused issues for some candidates was calculating the potential difference across the spring, which was omitted by many.
- (ii) This question proved problematic for many of the candidates, with few able to give the correct direction of the magnetic field. There was much confusion over the shape of the magnetic field, particularly what happens to the magnetic field inside the coil.

Question 10

- (a)(i) This question asked for the name of the effect rather than the process. Few candidates stated plasmolysis, with a large number giving osmosis.
- (ii) There were some excellent, detailed and accurate responses seen describing the process in terms of water potential. Some candidates should be reminded to use the correct scientific terminology. The term water potential should be in reference to osmosis rather than water concentration.
- (b) Many correct responses were seen. Common incorrect responses included water and glucose.

Question 11

- (a) Many candidates gave the correct property of hard. The weaker candidates referred to strong bonds, which was already given in the stimulus material.
- (b) The vast majority of candidates were able to give a correct use of graphite.
- (c) Many candidates were able to refer to delocalised electrons. The second mark proved more difficult for candidates to achieve, with few referring the movement of charge.
- (d) The vast majority of candidates stated covalent bonding. A very small minority referred to ionic bonding or tetrahedral bonding.
- (e) The most common error was to only have one shared pair of electrons between the carbon and oxygen atoms rather than two. Occasionally candidates depicted ten electrons in the outer shell of carbon.

Question 12

- (a) Microwaves were commonly given in the correct place. Occasionally infrared waves and ultraviolet waves were muddled. Some candidates tried to include visible light.
- (b) Many candidates correctly calculated the refractive index. However, a few candidates simply divided the value of 30 by 15, which was not creditworthy.
- (c)(i) This question was generally well answered, with many candidates scoring both available marks.
- (ii) The main misconception seen was incorrect notation given to the beta particle. However, most candidates accessed both marks available.
- (iii) Candidates should be reminded to show all their working. There were some cases where credit could not be given as no working was shown on the graph. A few candidates were able to determine the correct half-life. The most common incorrect answers seen being 20 and 21.

CO-ORDINATED SCIENCES

Paper 0654/62 Alternative to Practical

Key messages

Candidates were clearly well prepared for this Alternative to Practical paper and were familiar with several experimental techniques. Where the science is unfamiliar to candidates, for example **Question 3**, all the information to be interpreted in order to answer the questions is provided within the question. Candidates found interpreting and evaluating experiments difficult. Candidates are becoming more prepared for the planning question, describing their investigation in a logical sequence taking heed of the bullet points in the question.

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 line of best fit needs to be a single line. Candidates must read the questions carefully so that they answer what is being asked by the question, for example, omitting the line in **1(b)(ii)**. Candidates need to take care when rounding their calculated values and quoting their values to an appropriate number of significant figures. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1 – Flower

- (a) (i) The majority of candidates drew a large, detailed diagram of the flower. Weaker candidates drew a feathery outline or used less than half of the box. A small number drew a flower from memory rather than the flower in the question.
- (ii) Candidates found this difficult with a significant number omitting the question. Many labelled the ovaries, the anthers or the filaments. A label line needs to touch the part being labelled.
- (b) (i) A small number confused the unit giving an answer either ten times too large or ten times too small.
- (ii) A significant number did not draw the line asked for in the question.
- (iii) The majority of candidates calculated their value correctly. A small number inverted the division and a significant number rounded their value incorrectly.
- (c) (i) Almost all candidates knew the starch test, a very small number gave either biuret or Benedict's.

Question 2 – Exercise and pulse rate

- (a) (i) Almost all candidates recorded the readings correctly, a very small number reversed them.
- (ii) Almost all candidates calculated the pulse rate correctly.
- (iii) Whilst most candidates calculated the value correctly many did not appreciate the need to record the value as an integer.

- (iv) Candidates found this challenging, incorrect responses included palm, jaw, thumb, chest and heart or unqualified pulse meter or stethoscope.
- (b)(i) A significant number omitted the labels. Those that did label the axes often omitted the unit on each axis.
- (ii) Many candidates drew a good best-fit line. Some drew feathery or multiple lines. A significant number didn't label either line.
- (iii) Most candidates plotted the points correctly.
- (iv) Most candidates drew a good best-fit line.
- (v) Most candidates extended their lines and read the values from the graph correctly. Some read to 70 rather than 75.
- (vi) The majority of candidates understood this concept of fitness, a significant number discussed the heart rate slowing faster with no reference to the 75 / starting heart rate.

Question 3 – Hardness in Water

- (a)(i) Candidates found this a little difficult with many suggesting a measuring cylinder which was not acceptable. If a pipette is to be used then it needs to be a volumetric or graduated pipette.
- (ii) Most candidates counted the tally correctly.
- (iii) The majority of candidates ordered the three hardest waters correctly; most placed the remaining three in an order rather than placing them together on the same hardness.
- (iv) Candidates found this challenging. Many repeated the experiments but few averaged the repeats. Common incorrect responses included digital thermometer, more water types, increased concentration of soap solution and adding more soap.
- (b)(i) Candidates needed to use the information given in the question and found this challenging. Add less soap was the most common incorrect response.
- (ii) Again, candidates needed to use the information given in the question and found this even more challenging. Most able candidates appreciated that the temporary hardness was removed or that the water contained permanent hardness. Common incorrect responses included evaporate the impurities and use less soap.
- (c)(i) More able candidates evaluated the information in the table and could name at least two of the three substances with explanations. Incorrect responses included lithium, chloride, carbonate and potassium sulfate. Some candidates gave 'same reactions as' rather than giving the results of the tests.
- (ii) The test for carbon dioxide was well known. A small number gave the test for oxygen, hydrogen or fats or thought that an emulsion was formed.

Question 4 – Planning question

Candidates were quite prepared for the style of answer required of a planning question and some addressed the bullet points in the question, which are included as a guide to the areas needing to be addressed in the plan.

A very small number omitted the question and almost all of those who answered gained some credit. There were five aspects which needed to be included in the plan and candidates needed to address at least one point from each aspect and then any two others to gain full credit.

The whole range of marks was seen and more able candidates gave detailed answers gaining full or almost full credit.

Whilst many candidates measured mass and volume few included the apparatus needed to do this.

Many candidates appreciated that the solids were dissolved and so boiled the solutions to dryness. Some filtered the solutions, added solid to the water, measured the boiling points or measured the time taken for the water to boil.

Many measured the mass of the solid in the container at the end of the heating without appreciating the need to measure the mass of the empty container.

The control variable was well known. A small number kept the mass of solid or the concentration of the water constant.

Candidates continue to find processing results and drawing conclusion difficult, many guessing a conclusion rather than explaining how the results could be used to find a pattern. If a graph is to be drawn then the quantities on each axis need to be given.

Question 5 – Determining mass of a load

- (a) (i) Many candidates recorded the position correctly. Common incorrect responses included 69.0 and 68.9.
- (ii) Many candidates recorded the position correctly. Common incorrect responses included 71, 70.6 and 70.7.
- (iii) Almost all candidates calculated the position correctly.
- (iv) Almost all candidates calculated the distance correctly.
- (b) (i) More able candidates described reading perpendicular to the scale. Non-creditworthy responses included directly, straight above and above.
- (ii) Candidates found this very difficult and few gained credit. Many discussed the weights on each side being the same, the moments on each side being equal and putting the load on the other side.
- (c) The majority of candidates calculated the distance correctly. Incorrect responses included 5.6 and 22.5.
- (d) Many candidates calculated the value correctly. Incorrect responses included not multiplying by 0.25, reversing the 4 and the 5 and not giving the answer to 2 significant figures.
- (e) Candidates found this quite difficult. Many knew the length would be longer but did not appreciate that the ruler would be too short. A significant number thought the distance would be too small so the weight would be too close to the pivot.

Question 6 – Cooling water

- (a) (i) The majority of candidates recorded the temperature correctly. 80.15 was a common incorrect response.
- (ii) The units were well known. Some candidates gave C°, min or just °.
- (iii) Almost all candidates completed the time column correctly.
- (b) (i) The majority of candidates estimated the missing temperature. Incorrect responses included 77.5 and 75.
- (ii) Most candidates subtracted correctly. A small number gave the final temperatures for each column.
- (iii) Many candidates appreciated that the temperature decreased more at the bottom of the beaker but few appreciated that this needed to be quoted for the same time. A small number thought the temperature decreased more at the top due to evaporation.
- (c) Candidates found this very difficult. Many thought the thermometer must be placed at the top or the bottom.

- (d) Whilst the control variable was well known some candidates gave temperature unqualified or time.
- (e) Many candidates gave a suitable modification to the apparatus. Some discussed changing the thermometer to a more accurate one or discussed how the method could be changed.