CO-ORDINATED SCIENCES

Paper 0973/11
Multiple Choice (Core)

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

General comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Question 18**. **Question 20** proved most challenging for the candidates.

The physics questions that were found particularly challenging were **Questions 28**, **30**, **38** and **40**.

Comments on specific questions

Question 4

This question about food tests and enzymes had answers almost equally distributed over three distractors, most candidates choosing an incorrect answer. The question requires careful reading, to gain credit candidates needed to understand the concepts of enzyme action at different temperatures, and remember the iodine starch test. The answer most often given suggests that candidates were not reading the question carefully, rather than a lack of understanding.

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Question 7

Although more candidates chose the correct answer than any other, a substantial number got confused between temperature and humidity, incorrectly suggesting that high humidity increases transpiration.

Question 8

The majority of candidates answered this question about energy usage incorrectly. There seems to be a common misconception that respiration uses energy, rather than releasing it. In some cases, this may be a confusion between respiration and breathing.

Question 11

Only about half the candidates correctly answered this question. Candidates need to be clear about the definitions of the terms gene and allele, and also the meanings of a number of similar names as displayed here (genotype / phenotype, homozygous / heterozygous), which candidates can easily mix up.

Question 13

Many candidates found this question challenging, with slightly less than half the candidates getting it right. They needed to look carefully at the labelling on the diagram.

Question 16

Candidates are expected to be able to describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds, and hence to know the characteristic properties of covalent compounds. They chose the incorrect **A** more often than the correct answer, **D**. Some of the stronger candidates chose the incorrect **B** and incorrect **C**.

Question 17

Candidates are expected to be able to describe electroplating with copper, which includes the changes to the electrodes during this process. They chose the incorrect **C** more often than the correct answer, **B**. Some of the stronger candidates chose the incorrect **A**.

Question 18

Candidates understood very well the meaning of exothermic in terms of heat energy transfer.

Question 20

Candidates are required to know the tests and positive results for carbon dioxide, chloride ions and copper(II) ions, as well as being able to describe the reaction between carbonate ions and dilute hydrochloric acid. There is evidence that candidates guessed at the answer to this question.

Question 23

The reaction of magnesium with dilute hydrochloric acid and the properties of magnesium as a metallic element are required knowledge. Some of the stronger candidates chose the incorrect **A** rather than the correct answer, **B**.

Question 24

Candidates chose the incorrect **B** more often than the correct answer, **C**. They should know that whilst carbon dioxide is weakly acidic, carbon monoxide is not.

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Question 28

Candidates had to calculate a speed that was very low. They needed to convert the time from hours to seconds. Many either did not convert the time from hours at all (option **C**), or converted it into minutes (option **B**).

Question 29

Although many candidates chose the correct value for the weight, a number did not check the unit and therefore opted for **C**.

Question 30

There appeared to be widespread guessing in this question on electricity generation, with all four options being popular.

Question 32

A very large number of candidates knew that the image is the same size as the object, but a significant number thought it to be inverted top to bottom.

Question 34

To calculate speed, almost half the candidates correctly divided distance by time, but most of the others multiplied instead.

Question 38

In this question candidates were required to identify a mystery component as a fuse, and then recognise its symbol. Considerably more chose option **C** (a variable resistor) than the correct option **A**.

Question 39

Two thirds of candidates were unfamiliar with the magnetic field pattern around a solenoid, with option **C** being slightly more popular than the correct option **D**.

Question 40

This question on ionisation was not well answered, with many candidates believing that either infrared rays or γ-rays were the most highly ionising.

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Paper 0973/21
Multiple Choice (Extended)

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

General comments

The majority of candidates successfully selected the correct responses, and the paper was generally well answered.

Candidates performed very well on **Question 14** and **Question 27**. **Question 18** proved the most challenging for the candidates.

The physics questions that were found particularly challenging were **Questions 32**, **34**, **35** and, particularly, **Question 33**.

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Comments on specific questions

Question 4

This question about food tests and enzymes requires careful reading, students needed to understand the concepts of enzyme action at different temperatures, and to remember the iodine starch test. The question had answers almost equally distributed over two distractors, slightly more candidates choosing the correct answer. The incorrect answer most often given suggests that candidates were not reading the question carefully, rather than a lack of understanding.

Question 9

This question about accommodation in the eye showed a spread of responses across all four distractors, suggesting widespread guessing.

Question 12

The majority of candidates answered this question about consumers in a food web correctly, but a substantial number did not look at the diagram carefully enough with regard to the arrows rather than the positioning of the organisms.

Question 13

The majority of candidates answered this question about eutrophication correctly, but some did not look further than the first distractor, which although it might reduce oxygen taken out of context, is not the main factor in eutrophication.

Question 14

Candidates understood very well how a soluble salt and insoluble chalk can be separated from water.

Question 15

Candidates are expected to be able to describe the differences in volatility, solubility and electrical conductivity in ionic and in covalent compounds, and hence to know the characteristic properties of covalent compounds. They chose the incorrect **A** more often than the correct answer, **D**. Stronger candidates chose the incorrect **C**.

Question 16

Candidates are expected to be able to calculate stoichiometric reacting masses from balanced equations. It appears that many of them may not have doubled the M_r of oxygen. They chose the incorrect **C** more often than the correct answer, **D**

Question 17

There was evidence that candidates guessed at the answer to this question. They are required to interpret energy level diagrams of exothermic and endothermic reactions, so they should be able to identify the relative amount of energy possessed by the reactants and by the products.

Question 18

Candidates are expected to understand the relationship between temperature and activation energy, and between temperature and the number of effective collisions between reacting particles and hence rate of reaction. They chose the incorrect **A** more often than the correct answer, **D**.

Question 20

Candidates are required to know the tests and positive results for carbon dioxide, chloride ions and copper(II) ions, as well as being able to describe the reaction between carbonate ions and dilute hydrochloric acid. They chose the incorrect **A** more often than the correct answer, **B**

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Question 27

Candidates knew very well that ethene is a monomer in the formation of poly(ethene).

Question 30

A relatively popular incorrect choice in the question on moments was option **D**. In this arrangement the force on the right-hand side was furthest from the pivot and this probably attracted candidates who found the calculations challenging.

Question 31

Slightly more candidates thought that nuclear power stations do not use steam than chose the correct answer **C**, hydroelectric.

Question 32

Sensitivity of a thermometer was not well understood, with more than half believing that this meant how quickly a thermometer shows a change in temperature.

Question 33

This was the physics question that was the most challenging. There was a considerable amount of information to process and candidates needed to consider it carefully. Options **C** and **D** were both considerably more common choices than the correct option **A**.

Question 34

There was much confusion about the nature of the wave shown, with many thinking it to be longitudinal and then correctly giving sound as an example.

Question 35

The question stated that the angle of incidence was greater than the critical angle. Candidates needed to be clear about the phenomenon of total internal reflection. Most candidates chose option **B**, the refracted ray.

Question 38

In this question candidates were required to identify a mystery component as a fuse, and then recognise its symbol. More chose option **C** (a variable resistor) than the correct option **A**.

Question 40

Although this question on ionisation was reasonably well answered, almost one in three candidates believed that γ-rays were the most highly ionising.

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Paper 0973/31
Theory (Core)

Key message

Candidates seemed to have 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 frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered most of the questions well. There was a good range of marks on every question. Candidates generally scored on all questions. Few gained no credit on any question but very few gained full credit on any question. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Some candidates only gained some of the credit 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 credit 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.

A number of candidates seemed to doubt their original answers and ended up crossing out a correct answer and replacing it with an incorrect answer.

Comments on specific questions

Question 1

(a) (i) Most candidates gained at least half the available credit for identifying two of the parts of the alimentary canal and associated organs.

(ii) Organ J was frequently identified as the liver.

(iii) Organ E was frequently identified as the pancreas.

(b) In the incorrect definition for digestion, many candidates were able to identify the two errors.

(c) In the table of food molecules and the smaller molecules they are made from, most candidates gained most of the available credit.

Question 2

(a) (i) Exothermic was well known.

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(ii) Many candidates were able to correctly balance the equation.

(b) A number of different correct physical properties of magnesium were seen. Most candidates gained at least some credit.

(c) (i) This was not well answered. The question asked for differences and similarities in the observations made. Few candidates correctly identified a difference or a similarity in the observations made.

(ii) Magnesium chloride was not well known as a product of both of the reactions.

(d) (i) This was not well answered. Candidates needed to be clearer in their references to reactivity, i.e., the position of copper in the reactivity series, or the relative reactivities of copper and hydrogen.

(ii) Few candidates made the connection between transition metals and coloured compounds.

(e) (i) Water was often identified as the other substance that needed to be present for iron to rust.

(ii) Many barrier methods were suggested for rust prevention.

(iii) Many candidates continued to suggest barrier methods in this part rather than making alloys.

Question 3

(a) (i) Many candidates placed an **X** somewhere along the line where the speed was a maximum rather than where the bus was not moving.

(ii) Few candidates determined the distance correctly as 600 m. Most calculated the distance as 1200 m, because they did not determine the area under the graph but did a simple distance = speed × time calculation.

(b) (i) Most candidates were able to calculate the weight of the bus as 50 000 N.

(ii) The only response accepted was the Earth.

(c) (i) Many candidates were able to suggest that the bus would go faster.

(ii) Some candidates correctly determined the resultant force as 400 000 N, although many others suggested 600 000 N

(d) The calculation was often well done. Some candidates forgot to convert 45 cm into metres.

Question 4

(a) (i) 72 bpm was the only value accepted.

(ii) Many candidates found it challenging to determine values from the graph, usually making multiple errors.

(iii) This simple calculation was generally well done.

(iv) The question asked for changes to the pattern of breathing. Many candidates gave answers in terms of pulse rate. Answers needed to focus on breathing rate and breathing depth.

(b) (i) The only clear piece of evidence from the diagram that showed that the blood vessel was an artery was the thick wall.

(ii) The component of the blood visible on the diagram was a red blood cell. A number of candidates suggested plasma.

(c) (i) The structure that separates the right and left sides of the heart was correctly identified by many candidates as the septum. Artery, vein and aorta were common incorrect responses.

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(ii) The type of tissue that the walls of the heart are made from is muscle or muscular tissue.

Question 5

(a) (i) The chemical names for limestone and lime need to be better known by many candidates.

(ii) This idea that the limestone and carbon inside the lime kiln were in small pieces so that the reaction would be speeded up needed to be better known by many candidates.

(iii) Many candidates correctly suggested treating acidic soils or reducing or neutralising the acidity of the soil. A few candidates incorrectly suggested that it was to lower the pH of the soil. Reference to fertility of the soil without further detail did not gain credit.

(b) (i) Candidates needed to use all the information in the question to produce a word equation. Many gained partial credit.

(ii) A common error here was to suggest that the sodium hydrogencarbonate loses hydrogen gas when it decomposes into sodium carbonate.

(c) (i) Some candidates gained partial credit here. To gain full credit, responses needed to give greater detail.

(ii) The colour change from orange to colourless needs to be better known.

Question 6

(a) (i) Kinetic energy was well known.

(ii) Many candidates gave the answer fuel. They needed to read the question very carefully and think about what is being asked.

(iii) Chemical potential energy was well known.

(iv) There were a number of different correct answers seen.

(b) Almost all the candidates correctly identified the Sun for the first answer but a number of candidates incorrectly suggested either kinetic, chemical, thermal or solar rather than electrical for the second answer.

(c) Most candidates were able to state one way to increase the turning effect.

(d) (i) Many candidates omitted the switch from their diagram.

(ii) Many candidates were able to explain one advantage of connecting the lamps in parallel.

Question 7

(a) (i) Most candidates gained at least partial credit. It was usually the medium or high sugar concentration that they correctly identified.

(ii) Most candidates correctly identified plant cell **A**.

(b) Many candidates gained full credit for an answer that described the movement of water across a partially permeable membrane.

(c) (i) Light and chlorophyll were both well known as requirements needed for photosynthesis.

Oxygen was sometimes suggested incorrectly.

(ii) This was well answered by many candidates.

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(d) Producer is the term used to describe organisms that use photosynthesis to make their own nutrients.

Question 8

(a) Bauxite was not well known as the ore of aluminium. Aluminium ore or iron ore were frequently given as answers.

(b) Most candidates were able to insert one word correctly into the sentences about electrolysis.

(c) (i) Hydrochloric acid was the most popular answer.

(ii) Few candidates were able to explain that the liquid was not an electrolyte.

(iii) Few candidates suggested sulfuric acid.

(d) (i) A number of candidates referred to neutrons.

(ii) Neutrons were also referred to in the responses of some candidates.

Question 9

(a) (i) Many candidates were able to identify the three states of matter shown on the diagram.

(ii) Very few candidates were able to explain that the liquid expands when heated.

(iii) Candidates found this part challenging. The clearest answers referred to placing the thermometer in melting ice and in boiling water and marking 0 °C and 100 °C on the scale.

(b) Few candidates located the correct position for infrared. Many placed infrared in the position of either ultraviolet or visible light.

(c) Many candidates referred to the penetrative properties of alpha particles. Some did not choose paper as the correct material to use.

(d) Few candidates got both of the numbers correct. 40 was a common suggestion for both the number of neutrons and the number of protons.

Question 10

(a) Most candidates scored at least some credit but very few gained full credit.

(b) Relay neurone was a common incorrect response.

(c) (i) Many candidates referred to gravitropism. This was often accompanied by a very weak explanation of what happens to the root and shoot.

(ii) Many candidates suggested light as the correct answer here.

Question 11

(a) (i) Diamond and graphite were the commonest answers but many candidates placed them the wrong way round.

(ii) Some candidates knew that it was covalent bonding. Other candidates knew that it was a giant structure. Few candidates knew both.

(b) (i) Few candidates identified methane as gas **Q**. Hydrogen, oxygen or nitrogen were frequently suggested.

(ii) Few candidates realised that it was the test for ammonia gas that was needed.

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Question 12

(a) (i) The term normal needs to be better known. Mirror line was the most common answer.

(ii) Most candidates correctly drew the reflected ray. A few candidates stopped the reflected ray halfway to the boy rather than continue it on to reach the boy.

(iii) The angle of incidence was well known. A few candidates confused it with the angle of reflection.

(iv) Same size and laterally inverted were frequently given as the descriptions of the image in the mirror.

(b) (i) Candidates found this challenging. Few candidates drew clear and accurate ray diagrams.

(ii) Few candidates located the focal length of the lens.

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

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Paper 0973/41
Theory (Extended)

Key messages

Successful candidates gained marks by:
- reading questions carefully
- recalling syllabus definitions
- showing working in calculations
- checking units.

General comments

The presentation of responses by candidates was generally of a high standard. Written answers were legible, with good use of English, enabling efficient communication of ideas. This was evident in the strongest answers to **4(a)** explaining osmosis, and in **7(a)(iv)** suggesting reasons for the small population of the desert fox. Full credit was obtained when candidates were aware of all the data supplied and the requirements of each question, as in **8(a)(i)** where the names of the reactants and products, and the formula of methanol facilitated the writing of the balanced equation. Where definitions and meanings were required, full credit was more likely when the syllabus wording was recalled. This was useful to candidates finding the concept of e.m.f. challenging in **3(c)** and in completing the definition of adaptation in **7(b)(i)**.

Where numerical answers were required, showing formulae, substitution and manipulation for each stage of the calculation often gained credit even when there was an error in the result on the answer line. Those making a mathematical error in **6(b)**, the acceleration calculation, often gained some credit for showing the correct formula. Candidates should be aware that the system of units are based on the metre, kilogram and second and that they gain credit for making conversions from the data supplied, as in the energy calculation in **12(b)**. They should also check whether the question or answer line specifies the unit to be used in the reported answer as done by successful candidates in calculating the moment in **12(c)**.

Comments on specific questions

Question 1

(a) (i) Several candidates noticed that the circulatory systems of fish and mammals differ in the number of atria and ventricles. Some mentioned that blood flows through the heart once, being careful to refer to one circuit of the body.

(ii) Good explanations of the advantages of a double circulatory system mentioned higher blood pressure or greater blood flow and the idea of more efficient delivery of oxygen, rather than just more blood.

(b) (i) Most calculations of the difference in thickness of the blood vessels were correct.

(ii) Correct explanations for the difference in thickness of the aorta and vena cava involved the prevention of bursting due to higher pressure, rather than suggesting the effect of higher blood flow or oxygen content. Some candidates were under the misapprehensions that the aorta exerts pressure on the blood or pumps the blood.

(c) (i) The adaptations of red blood cells were well known.

(ii) Statements of the components of blood were usually correct.

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Question 2

(a) Most candidates realised that pencil is used to draw the chromatography start line because it is insoluble.

(b) Those who knew that chromatography shows that the fruit drink contains more than one substance could explain why it is a mixture.

(c) Correct explanations of whether the drink contains **X** depended on the ability to compare the chromatograms of **D** and **X**.

(d) Those who knew the formula for R_f were generally able to calculate its value. Many just measured the distance travelled by the substance.

(e) Successful candidates identified the task as converting a mass in grams to a mass in moles. Others tried to use the formula for calculating concentration: mass ÷ volume.

Question 3

(a) Many knew that the difference between speed and velocity is that velocity has direction. Some confused velocity with acceleration.

(b) Some responses did state that stronger wind increases the rate of evaporation. The strongest candidates explained that this is due to more air molecules escaping into the moving air, rather than suggesting that the wind provides molecules in the surface with the energy required to escape. Many candidates needed to describe the effect of increasing wind strength rather than focussing on a comparison between evaporation with and without wind.

(c) The meaning of electromotive force as the energy supplied by a source per unit charge was recalled by just a few candidates.

(d) (i) A minority of candidates realised that the current through the fuse is shared between the two lamps.

(ii) Those who knew that if one lamp fails in a parallel circuit, the other lamp will stay lit, seldom explained this in terms of the maintenance of a complete circuit.

(e) (i) Explanations why the light stays inside the fibre usually cited total internal reflection or an accurate diagram. The importance of critical angle was less commonly mentioned.

(ii) The clearest diagrams showed accurate representations of transverse and longitudinal waves, correctly labelled. They indicated the correct relationships between direction of oscillation and direction of wave travel.

Question 4

(a) There were some good explanations for the increased mass of the grape in terms of the movement of water by osmosis down a water potential gradient. The use of the concept of water concentration was not accepted.

(b) The best explanations for there being no change in mass of the grape placed in grape juice identified zero potential gradient. It was rarely stated that movement occurs in both directions causing there to be no net movement of water.

(c) The descriptions of the immersed cells were often chosen correctly.

(d) The structural differences between plant cells and animal cells were well known.

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Question 5

(a) (i) Most candidates used the graph to find the correct mass of carbon dioxide.

(ii) Many responses included the correct explanation that the same amounts of reactants would produce the same amounts of carbon dioxide. Others attempted to explain that temperature does not affect yield while omitting the observation that reactant quantities were kept constant.

(iii) The relative molecular mass of carbon dioxide was usually correct and good use of the molar gas volume was made. Those who did not obtain the correct volume had often used an incorrect formula for calculating the number of moles.

(b) Explanations of the dependence of reaction rate on temperature usually referred correctly to the kinetic energy of particles and the rate of collision. Full credit was obtained by recognising the important fact that, at higher temperature, more colliding particles possess the minimum energy or activation energy to react, rather than making vague reference to the number of successful collisions.

(c) Respiration, or a process involving respiration, was often correctly suggested as a process producing carbon dioxide. Where combustion was suggested, reference had to be made to a carbon containing substance or a named example.

Question 6

(a) (i) The gravitational force was usually correctly identified.

(ii) Many candidates gave the correct value of the force resisting motion, knowing that it equalled the driving force. Others were under the misconception that a resultant force is required to maintain constant speed.

(b) Those who realised that the mass of the tractor had to be found before application of the formula $a = F / m$ usually calculated the correct acceleration.

(c) It was usually recognised that the area of contact between the tyres and the ground is increased by using wider tyres. The strongest candidates were able to express the fact that the weight is spread over a larger area rather than repeating the reduced pressure information in the question.

(d) Most candidates correctly calculated the work done in lifting the bucket.

Question 7

(a) (i)(ii) The correct food chain and the number of trophic levels were usually obtained from the information in the food web.

(iii) The best explanations for desert foxes feeding at two trophic levels named their possible prey and identified their trophic levels, rather than restating the question.

(iv) The best reasons for the lower population of desert foxes identified how energy is lost between trophic levels so that the energy available is only sufficient to support a small population of predator. Comparison between foxes and rats based on predation and litter size were less successful suggestions. Most candidates found this question challenging.

(b) (i) Most definitions of adaptation included the fact that populations become more suited to their *environment*. A few correctly specified the time scale as *many generations* rather than *many years*, which was too vague.

(ii) Most candidates were challenged when asked to describe how selective breeding is different from natural selection. A few knew that selective breeding takes place over a shorter time scale. The best suggestions highlighted the fact that humans select desirable features rather than stating that humans select individual animals to mate. Less variation and more inbreeding were not included in candidates' answers.

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Question 8

(a) (i) Those who included all the reactants and products given in the question were generally able to write the correct balanced equation.

(ii) The meaning of the word *exothermic* was quite well known.

(iii) The most successful responses showed the energy level diagram as a continuous energy-time graph, with the product energy level lower than that of the reactants, and labelled the activation energy and energy change with vertical arrows drawn from the reactant energy level.

(b) Candidates who drew the correct bonding diagram for methanol had checked that each shell had a share in the maximum number of electrons.

(c) Many candidates wrote a correct definition to explain why methanol is not a hydrocarbon.

Question 9

(a) (i) To identify the maximum acceleration, the **X** had to placed unambiguously on the line between 15.0 s and 16.8 s on the speed-time graph, rather than at the ends of the line.

(ii) The correct value for the acceleration was usually calculated from a formula or the gradient of the graph. Some candidates measured the area under the graph.

(b) Some candidates could identify a suitable instrument for measuring a very small distance.

(c) (i) Those who knew the notation for a β-particle and the rules of conservation of mass and charge could complete the nuclear equation.

(ii) Those candidates who were aware that moving charged particles are deflected by an electric field could state the difference in the behaviour of β-particles and γ-rays.

Question 10

(a) Many candidates could identify the stigma and anther.

(b) Most comparisons of size and mass of pollen of insect-pollinated and wind-pollinated flowers were correct. The spikey appearance of pollen in insect-pollinated flowers was less well known.

(c) Those who could distinguish the features of petals from those of whole flowers usually compared the petals of insect-pollinated and wind-pollinated flowers correctly.

(d) (i)(ii) The function of the ovary in plants was less well known than that in humans.

(e) Many candidates could name the zygote cell from its description.

Question 11

(a) (i) Those candidates who correctly explained why chlorine gas is made at the anode knew that chloride ions are attracted to the anode due to their negative charge and give up electrons there. Some also stated that chlorine atoms combine to form chlorine molecules.

(ii) Some knew that hydrogen was liberated at the cathode. Sodium was a popular choice.

(iii) Correct explanations of why *inert* electrodes must be used involved the lack of reaction with the electrolyte or products, rather than giving a general definition of the word *inert*.

(b) There were a few correct ionic half-equations seen. Not all included state symbols, as required by the question.

(c) There were some good 2- and 3-dimensional diagrams of the lattice structure of sodium chloride, with the ions and their charges labelled.

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Question 12

(a) (i) The majority of candidates knew that a step-down transformer lowers voltage.

(ii) There were many successful calculations of the number of turns on the secondary coil. Errors commonly occurred in rearranging the formula.

(b) The formula for electrical energy transferred was well known. The correct result was obtained by candidates who successfully converted the unit of time into seconds.

(c) The formula for moment of a force was well known. The correct result was obtained by candidates who successfully converted the unit of distance into metres**.**

(d) A small number of candidates explained the ways in which the design of the heat sink allowed it to remove thermal energy efficiently. They knew that a black surface is a good emitter of heat radiation, and that a large surface area enables efficient convection and radiation. Most responses were more concerned with ways in which heat is transferred from the microprocessor to the heat sink, discussing the absorption and conduction of thermal energy, which did not answer the question.

Question 13

(a) A minority of candidates knew that nitrogen-containing fertilisers are important for plant growth.

(b) (i) A correct balanced equation for the formation of ammonia was sometimes provided. Many candidates used formulae such as H or H_3.

(ii)(iii) A suitable pressure for use in the Haber reaction chamber was suggested sometimes. Correct units needed to be included. The purpose of the catalyst was generally explained well. While most knew that a higher temperature increases the rate of reaction, few appreciated that a moderately high temperature is employed so as not to sacrifice yield too much.

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CO-ORDINATED SCIENCES

Paper 0973/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental technique and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. The bullet points in the planning question are there to help candidates structure their plan into the sections required. Candidates should be able to draw clear and labelled diagrams of assembled apparatus. Candidates should have performed identification tests on the range of substances detailed in the syllabus.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was good, the expected accuracy can often be gleaned from the data already present in a table. The standard of graph drawing was generally high although candidates need to remember that axes need to be large enough that the plotted points cover at least half of the grid. Candidates must read the questions carefully so that they answer what is being asked by the question. Explaining safety precautions is improving with more candidates addressing all three aspects. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results. Knowledge of identification tests for ions and gases was very limited.

Comments on specific questions

Question 1 Glucose test.

(a) (i) Most candidates chose the correct final colour. Yellow was a common incorrect response.

(ii) Candidates found this very challenging with few referring to colour in their answer. Discussion of possible errors, the decimal nature of the concentrations, it is an unknown substance and change in the conditions e.g. temperature were common incorrect responses.

(b) The majority of candidates chose a suitable piece of apparatus. Beaker, ruler and dropping pipette were common incorrect responses.

(c) Few candidates gave a correct temperature range for the hot water bath; 37 °C was the most common incorrect response. Room temperature and 100 °C were also quite common.

(d) Many candidates chose the correct reagent and its initial colour. Biuret and red were common incorrect responses.

(e) Almost all candidates chose a suitable safety precaution and some explained its use. A significant number omitted what the precaution is protecting and / or what it is protecting against.

(f) Stronger candidates looked at both sets of results to identify the differences and then explained them. Stating what the results should have been, incorrect calculation of percentage and using a different testing solution were common incorrect responses.

(g) (i) Many candidates knew ethanol is part of the test but of these, many did not appreciate the need for water. All testing solutions were seen.

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(ii) Many candidates gave a correct observation. Precipitate was a common incorrect response.

(iii) Although many candidates appreciated a fire risk, many did not name the chemical posing the hazard. Fat is flammable and there is no need to heat the experiment were common incorrect responses.

(iv) Candidates found this quite challenging. Not coloured, liquid, not liquid, soluble and not soluble were among a large range of incorrect responses.

Question 2 Growth of germinated seeds plan.

A small number of candidates omitted the question and the vast majority gained at least some credit.

The whole range of credit was seen and stronger candidates gave quite detailed answers with a significant number gaining full or almost full credit.

A small number of candidates discussed the germination of seeds rather than the growth of the shoots of seeds already germinated or varied the light conditions rather than the temperature.

Most listed some apparatus, usually soil or cotton wool. Few considered the need for the shoots to have light or described how the temperature would be changed.

The methods usually had at least two temperatures of hot and cold and had water given to the shoots at the start but few appreciated that the shoots would need to be watered regularly.

Measurements needed to be more specific, they were often vague such as see how much they've grown or measure the growth without specifying how this could be achieved and with what apparatus. Few appreciated that several seeds for each temperature or repeats are needed in order to make the results as valid as possible. Many measured after a few hours rather than after several days.

Most candidates could identify at least one control variable and many identified several.

If candidates decide to draw a graph, then they need to state what will be on each axis and then state how the pattern shown can be used to draw a conclusion.

Stronger candidates were able to link readings and temperatures to state how a conclusion could be made. Citing an expected conclusion e.g. seeds grow more quickly in the warm is not creditworthy.

Question 3 Identification of an unknown substance.

(a) (i) The test for carbon dioxide was well known. The tests for hydrogen and oxygen were amongst the incorrect responses.

(ii) Stronger candidates identified the anion. All common anions, cations and elements were seen as well as carbon, and a significant number omitted the question.

(b) (i) Stronger candidates knew the test for ammonia. Of those that used litmus, many described ammonia bleaching the litmus. All common ion tests were seen and a significant number omitted the question.

(ii) Stronger candidates identified the anion. All common anions, cations and elements were seen and a significant number omitted the question. Ammonia was also a common response.

(iii) Almost all candidates chose a suitable safety precaution and some explained its use. A significant number omitted what the precaution is protecting and / or what it is protecting against.

(c) (i) Stronger candidates identified the cation. Calcium, aluminium and chloride were common responses but most common anions and cations were seen. A significant number omitted the question.

(ii) Many candidates appreciated the role of the distilled water. Common incorrect responses included: to dissolve, neutralise or react with the residue or non-distilled water reacts with the residue.

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(iii) Good diagrams were often drawn with a ruler and had clear labels to the filter paper and the filter funnel. Non-creditworthy responses included holes in the filter paper, a filter paper with no funnel, a filter funnel with no filter paper, a flat filter paper or labelling filter rather than filter funnel or funnel.

Question 4 Effect of length of magnesium on temperature rise of a reaction.

(a) The majority of candidates recorded all three temperatures correctly. The most common error was omitting the .0 in the first two readings. A small number gave 30.05.

(b) Most candidates subtracted the values correctly. A small number subtracted successive values in column 3.

(c) (i) Candidates found this challenging and a significant number omitted the question. Common incorrect responses included acid, ammonia, silver nitrate and bleached.

(ii) Candidates found this a little challenging. The results for 10 mm because the temperature rise is the smallest, and 50 mm because the temperature rise is the largest or draw a graph and see if it is a straight line were common incorrect responses and a significant number omitted the question.

(d) Many candidates described the relationship correctly. The most common error was to describe the temperature rather than the temperature rise.

(e) Many candidates could cite at least one control variable. Length of ribbon, time and temperature were common incorrect responses.

(f) (i) Candidates found this very challenging. Parallax error, misreading the thermometer, not stirring, acid dilute or incorrect room temperature were all common incorrect responses.

(ii) Candidates found this very challenging. Incorrect responses included: use stronger acid, repeat and calculate average, more volume, less volume and warmer laboratory temperature.

Question 5 Measuring the spring constant of a spring.

(a) Candidates found this a little challenging with many measuring at 4.3 cm or measuring to the end of the loops.

(b) Many candidates measured the length and subtracted the values correctly. Common incorrect lengths included 11.46 and 11.

(c) Most calculated the value correctly, many as an error carried forward from an earlier incorrect value.

(d) A large number of candidates transcribed the stop-watch reading rather than recording the value to one decimal place.

(e) (i) Many candidates calculated the value correctly, often as an error carried forward from an earlier incorrect value.

(ii) Many candidates calculated the value correctly. Some doubled rather than squaring.

(f) The majority of candidates calculated the value correctly.

(g) Candidates found this more challenging and a significant number omitted the question. Some stated agreement or disagreement but did not explain their answer and many did not appreciate that values can be numerically different but close enough to be within the limits of experimental error.

(h) Candidates found this more challenging than usual. Look directly at the ruler, look parallel to the ruler, measure on a flat surface or lay it flat were common non-creditworthy responses.

(i) Many candidates repeated the question stem and said to make the value more accurate. Other incorrect responses included removing the reaction time error and the period of oscillation changing with time.

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Question 6 Cooling hot water.

(a) The majority of candidates drew a correct reading but a significant number omitted the question. 85.0 was a common response.

(b) The units were well known. The most common incorrect response was min.

(c) (i) Although most candidates labelled the axes with the quantity, units were often omitted. The axes were quite often reversed. Some candidates ignored the values at the bottom left-hand side of the graph and started from the origin; as a consequence the plotted points did not cover at least half of the grid. The points were usually plotted correctly although 85.5 was often plotted at 80.5 or 87.5.

(ii) The majority of candidates drew a reasonable curve close to all of the points. However, incomplete erasing of earlier attempts makes lines appear disjointed or feathery. Some did not include 85.5 in their curve.

(d) Candidates found this a little challenging and a significant number omitted the question. **M** was frequently at the incorrect end of the line.

(e) Whilst many candidates calculated the value correctly, many did not round their answer correctly.

(f) (i) Almost all candidates chose a suitable safety precaution and some explained its use. A significant number omitted what the precaution is protecting and / or what it is protecting against.

(ii) Candidates found this challenging. Heating the laboratory or heating the water were common incorrect responses.

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