

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 15** and **24**. **Questions 6, 13, 30, 33** and **39** proved the most difficult for candidates.

Comments on specific questions

Question 2

This question asked what structure is found in some plant cells, but not animal cells. Few candidates correctly stated chloroplasts, with many stating stomata. Attention needs to be drawn to the fact that the stomata are pores, the cells associated with them are the guard cells.

Question 3

In this question, some candidates confused the results of a negative test for starch and a positive test for fats. However, the majority correctly identified a positive protein test.

Question 6

While almost all candidates realised that chemical digestion produces molecules that can be absorbed, most thought that this was done by breaking the food into smaller pieces, rather than by producing small molecules.

Question 7

Some candidates confused the pulmonary vein and the pulmonary artery. Candidates should remember that veins lead to the heart and that the word pulmonary means lungs.

Question 8

Many candidates did not read the question carefully and simply noticed the phrase 'maintenance of a constant body temperature', leading to an answer of homeostasis.

Question 9

In this question candidates had to interpret a graph in relation to the release of adrenaline. Few understood that adrenaline would cause a rapid increase in pulse rate. A significant number thought that adrenaline decreases the pulse rate.

Question 15

Candidates understood how to interpret diagrammatic representations of molecules. However, some candidates chose the incorrect option **C**, which represented two different diatomic elements, rather than the correct option, **B**.

Question 16

Candidates chose the incorrect option **C** more often than the correct option, **A**. Candidates should be able to recall the products of the reaction of potassium with water.

Question 17

Candidates chose the incorrect option **C** more often than the correct option, **A**. Candidates are expected to know the electrode products in the electrolysis of dilute sulfuric acid.

Question 18

Candidates chose the incorrect option **B** more often than the correct option, **C**. Candidates are expected to distinguish between endothermic and exothermic reactions by the direction of temperature change.

Question 21

Candidates chose the incorrect option **C** more often than the correct option, **B**. Metals form basic oxides and non-metals form acidic oxides.

Question 23

Candidates chose the incorrect option **A** more often than the correct option, **D**. Although the four options are correct descriptions of noble gases, candidates should know that they are unreactive because they have full outer shells of electrons.

Question 24

Most candidates were able to deduce the order of reactivity of the four metals using the observations of the reactions with dilute hydrochloric acid.

Question 25

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

Question 26

Candidates chose the incorrect option **C** more often than the correct option, **B**. Naphtha is a feedstock for making chemicals.

Question 28

Many candidates did not look carefully at the graph axes and selected option **C**, which represented a stationary object.

Question 29

This question concerned the forces on a parachutist falling at constant speed. It was widely believed that the weight was greater than the air resistance, rather than them being equal.

Question 32

Many candidates incorrectly believed wind energy to be non-renewable.

Question 33

The topic here was convection. There appears to have been much uncertainty over this question with all options proving popular, particularly the incorrect options **A** and **C**.

Question 37

Common mistakes in this question on resistors in series and Ohm's law were either to choose the value of resistance (option **C**) or to multiply this value by the p.d. of the battery (option **D**).

Question 38

Although many candidates were aware that a fuse protects a circuit, most of these chose a rating of 9 A, not realising that this fuse would blow in normal use.

Question 39

A large proportion of candidates knew that the number of protons and neutrons should be added to find the mass number, but many of these put the mass and atomic numbers in the wrong places in the nuclide symbol.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 1, 2, 3, 6, 15, 19, 23 and 30**. **Questions 34 and 36** proved the most difficult for candidates.

Comments on specific questions

Question 11

Almost all the candidates realised that the change in colour seen in peppered moths was due to natural selection rather than artificial selection. However, a number put this down to adaptation rather than mutation. This may be due to a confusion over cause and effect, or a misunderstanding of the terminology.

Question 13

Most candidates correctly answered this question of eutrophication. A significant number thought that increased respiration by decomposers came before the death of producers.

Question 15

Candidates understood very well how to interpret diagrammatic representations of molecules.

Question 18

Some candidates chose the incorrect option **C** rather than the correct option, **D**. The combustion of hydrogen is exothermic and the thermal decomposition of limestone is endothermic.

Question 19

Candidates were easily able to interpret the graphical representation of the volume of gas being produced in a reaction over time. They understood the reason why a higher concentration of an aqueous reagent results in a higher rate of reaction.

Question 23

Many candidates knew that the elements in Group VIII of the Periodic Table are unreactive because they have full outer shells of electrons.

Question 30

Most candidates were able to identify chemical energy in a fossil fuel as being non-renewable.

Question 32

In this question on thermometers, although most candidates were aware that a small tube diameter increases sensitivity, many incorrectly opted for a small bulb as well and selected option **D**.

Question 34

The topic here was refractive index. A significant proportion of candidates chose option **B**; this value is obtained by using the two angles given in the question as the angles of incidence and refraction, rather than subtracting them from 90° .

Question 36

A large proportion of candidates knew that the length of the wire should be doubled, but some also believed that the cross-sectional area also needed to double, leading them to select the incorrect option **A**.

Question 39

This question about the force on a current-carrying wire was quite well answered. The most common mistake was to believe that the magnetic field is directed from the S pole to the N pole.

CO-ORDINATED SCIENCES

Paper 0654/32 Theory (Core)
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Key message

Candidates in general had a good understanding of what the questions were asking. Some candidates did not completely answer the questions. To access the maximum marks available, candidates should read the question carefully and complete all the instructions contained in the question.

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

General comments

There were some good responses from candidates who demonstrated a good knowledge of the syllabus. They were able to answer questions in both familiar and unfamiliar contexts.

Calculations were often done well with working shown.

Comments on specific questions

Question 1

- (a) (i) This question was not well understood. The most common suggestions were artery and capillary rather than the specific names of the vessels.
- (ii) The types of blood vessels were well known by many candidates.
- (iii) Valves were well known as the structures in the circulatory system that ensure one-way flow of blood.
- (iv) The septum was not well known.
- (b) Most candidates gained at least one mark on this question.
- (c) The function of capillaries was not well known.
- (d) Most candidates gained at least one mark on this question.

Question 2

- (a) (i) Carbon was quite well known as the element that forms diamond and graphite. Phosphorus was a common incorrect answer.
- (ii) Chlorine was well known as a halogen.
- (iii) Copper was well known as the element that is electroplated onto another metal.
- (iv) Aluminium was quite well known as the element that is extracted from bauxite. Phosphorus and carbon were common incorrect answers.
- (v) The majority of candidate gave the correct answer of sulfur.

- (vi) Chlorine was well known as the element used to sterilise drinking water. Phosphorus was a common incorrect answer.
- (b) Almost all candidates correctly determined that one molecule of phosphorus oxide contains 4 phosphorus atoms and 10 oxygen atoms.
- (c) Few candidates were able to explain why phosphorus oxide makes an acidic solution when dissolved in water. Many candidates simply repeated the question.
- (d) Nitrogen and potassium were not well known as elements commonly found in fertilisers.

Question 3

- (a) Most candidates correctly determined the speed of the ultrasound wave. Many were not able to complete the unit conversion from centimetres to metres.
- (b)(i) Cancer and mutation were well known consequences of using X-rays.
- (ii) Most candidates were able to suggest a use for X-rays in a hospital.
- (c)(i) γ -radiation was correctly placed in the electromagnetic spectrum by most candidates.
- (ii) Few candidates correctly determined the number of atoms that decayed. Few candidates were able to determine that 12 hours was 2 half-lives. Many candidates ended up with an answer that was greater than the original number of undecayed atoms and had obviously not checked their answer.

Question 4

- (a)(i) This question was quite well answered apart from the description of the genotype **Aa**, where many candidates included either recessive or dominant in their responses.
- (ii) This question was well answered.
- (b)(i) Some candidates reversed their two answers. Others suggested gametes rather than genes for the second answer.
- (ii) Many candidates suggested gametes rather than nucleus.
- (iii) Many candidates correctly suggested X and Y as the sex chromosomes found in male gametes in humans.
- (c) This question was well answered.
- (d) This question was quite well answered.

Question 5

- (a) Few candidates were able to determine the percentage of other gases in clean air.
- (b)(i) 2, 8, 8 was the most common and the correct answer.
- (ii) Few candidates were able to state that argon is very unreactive due to a full outer shell of electrons.
- (iii) Some candidates were able to suggest a use for argon gas. Others confused argon with helium and suggested filling balloons.
- (c)(i) Many appropriate suggestions were given for a source of the carbon dioxide found in the air.
- (ii) Some candidates correctly described one difference between an element and a compound.

- (iii) Many candidates suggested either methane or carbon monoxide as a greenhouse gas. Incorrect responses included oxygen and nitrogen.
- (d)(i) Most candidates knew that the pH of pure water is 7.
- (ii) Many candidates were able to suggest a suitable pH for the rainwater with carbon dioxide dissolved in it.

Question 6

- (a) Weight and drag were correctly identified by many candidates as forces **C** and **D** respectively.
- (b) Few candidates were able to describe two ways in which forces may change a body. Many candidates vaguely suggested motion.
- (c) Most candidates were awarded one mark for correctly suggesting two of the four energy transfers. Light was a common incorrect answer.
- (d) The idea that the power output was greater because the rate of work done increased was not well known.
- (e)(i) Few candidates correctly continued ray 1 but more candidates were able to continue ray 2.
- (ii) The focal length of the lens was not well known. Candidates needed to draw the double headed arrow as accurately as possible.
- (iii) Inverted and diminished were both suggested correctly by some candidates.

Question 7

- (a)(i) Candidates were instructed to give their answer to 1 significant figure. Consequently, the candidates who gave their answer as 0.318 were only awarded one mark.
- (ii) Some candidates were able to suggest humidity as a factor that affects the rate of transpiration.
- (iii) There were four marking points for this 3-mark question. Most candidates were only able give one relevant point and gave answers that lacked sufficient detail.
- (b)(i) Root hair cell and root cortex cell were not well known as **X** and **Y** respectively.
- (ii) Osmosis was quite well known. Diffusion was also accepted as a correct response.

Question 8

- (a) Some candidates were able to state that there were three elements in one molecule of ethanol. Some candidates counted up the number of atoms and others named the elements.
- (b) Many candidates were able to draw the structural formula of ethanol. A few candidates replaced the -OH group with an OH^- ion.
- (c) Fermentation was quite well known as one way of producing ethanol. Few candidates knew that ethanol is also made by reacting ethene with steam.
- (d) Some candidates were able to complete the word equation for the complete combustion of ethanol. Some candidates were able to name the other reactant as oxygen.
- (e) Some candidates were able to explain that ethanol is not a hydrocarbon because it contains oxygen.
- (f) Uses of ethanol were quite well known.

Question 9

- (a) Some candidates were able to explain that less pressure is exerted on the ground due to a greater surface area.
- (b)(i) Celsius was well known as the temperature scale.
- (ii) Few candidates were able to state that the physical property of alcohol that varies with temperature is volume.
- (iii) This question proved demanding. Few candidates understood the term fixed point.
- (c)(i) Many candidates correctly determined the resultant force as 350 N. Some candidates found it difficult to describe the direction of the resultant force.
- (ii) More candidates divided the force by the distance rather than multiplying the force by the distance.

Question 10

- (a)(i) Few candidates were able to define an enzyme as a protein that functions as a biological catalyst.
- (ii) Many candidates did not fully understand the question. A good description of the trend shown was that enzyme activity increases and then decreases, reaching maximum activity at pH 7.
- (b) This question was quite well answered. A common error was to think that aerobic respiration does not occur in plants.
- (c) Most candidates were awarded full marks on this question.

Question 11

- (a) Many candidates identified an alloy from the description. Incorrect answers included ionic bonding and compound.
- (b) Many candidates were able to name the collection of metals as transition elements/metals. A few candidates gave a list of transition elements, usually nickel, copper and zinc.
- (c) The test for iron(II) ions was not well known.
- (d) Most candidates knew that oxygen and water are the two substances that react with iron to make rust. Air was not accepted as an answer.
- (e)(i) Few candidates were able to deduce the number of neutrons and the number of electrons in the isotope of iron. Many deduced one of the quantities correctly.
- (ii) Very few candidates were able to state the meaning of the term isotope. Most candidates knew that it was the numbers of protons, neutrons or electrons that are either different or the same but few stated it correctly.
- (f) Many candidates correctly placed the metals in the correct order, showing good data handling skills.

Question 12

- (a) Few candidates knew the symbol for a fuse.
- (b)(i) Most candidates correctly determined the resistance as 80. Few knew that unit of resistance is the ohm (Ω). A common incorrect suggestion was V/A.
- (ii) Few candidates were able to explain that a 5 A fuse is used because the fuse rating needs to be slightly greater than the maximum current.

- (c) (i) Conduction was the most popular answer. A number of candidates incorrectly suggested either convection or radiation.
- (ii) Convection was the most popular answer. A number of candidates incorrectly suggested either conduction or radiation.
- (d) Few candidates were able to describe evaporation as the most energetic molecules leaving the surface of a liquid.
- (e) Most candidate gave very vague answers which did not clearly state either an advantage or a disadvantage.

CO-ORDINATED SCIENCES

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.

A skill that it would be beneficial for candidates to practise is analysing data in graphical form. There were occasions in questions **4(c)(i)**, **8(d)(i)** and **11(e)(i)** for example, where candidates either misinterpreted the data or did not use the data to answer the questions fully. Examining the axes labels, units and scales gives a lot of information that is required if candidates are to interpret the graphical data successfully.

Conversion of units is an important skill. Candidates should be able to convert joules to kilojoules and vice versa. This skill was important in question **9(b)**.

General comments

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 go through the syllabus ensuring that each learning objective has been covered.

It is particularly important for candidates to read questions carefully and use their knowledge to give a response to the context of the question. Frequently candidates repeated information in the stem of the question but did not answer the question asked.

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 when appropriate.

Comments on specific questions

Question 1

- (a) (i) The majority of candidates correctly named and labelled an anther. Occasionally candidates identified the correct structure but labelled it incorrectly. Examples of incorrect labels include pollen grains and stigma. Candidates should ensure that the end of the label line touches the structure that it is meant to label.
- (ii) The majority of candidates identified the ovary with an **X**.
- (iii) Several candidates gave general features of wind-pollinated flowers, such as lots of pollen. These responses were not relevant. The question specifies the adaptations of part **Y** for wind-pollination. Candidates that recognised this question was about the stigmas generally answered well, often referring to its position as hanging outside the petals or it being feathery.
- (iv) This question required careful reading. Candidates were required to give the difference between pollen grains from insect-pollinated and wind-pollinated flowers. Any references to the number of pollen grains were not credited. However, most candidates were able to give suitable differences, including reference to size and shape. Very occasionally candidates confused pollen from a wind-pollinated flower and pollen from an insect-pollinated flower.

- (b) There were some very good responses with many candidates expanding on points relating to lack of genetic diversity. The best responses also identified the inability to adapt to a changing environment and the increased risk from genetic and infectious diseases.

Question 2

- (a) Most candidates were able to correctly calculate the gravitational potential energy. Very occasionally candidates omitted the gravitational field strength or used an incorrectly arranged formula.
- (b)(i) The majority of candidates were able to correctly calculate the average current. The most common error was to multiply the charge by the time giving a value of 1200 A.
- (ii) Almost all candidates were able to state that the speed of light is faster than the speed of sound. Far fewer were able to link this idea to the distance being the same.
- (c)(i) This question was answered well with electrons being a commonly seen answer, followed by beta particles.
- (ii) The description of an electric field was not well known. Several candidates referred to the area around positive and negative ions or charges. Candidates should be reminded to learn the meaning of keywords given in the syllabus.
- (d) The most common misconception was that visible light and X-rays travel at different speeds. Most candidates could state that gamma radiation has a shorter wavelength than visible light and that X-rays have a smaller frequency than gamma radiation.
- (e) This question was answered well with most candidates explaining that the volume of air would increase due to the increase in kinetic energy of the molecules. Occasionally candidates stated that the volume of air would decrease but gave the correct effect of an increase of temperature on the energy of the molecules.

Question 3

- (a) Nearly all candidates were able to state the correct volume of 100 cm^3 .
- (b)(i) Many of the candidates found this question demanding and tried to explain in terms of an increasing rate of reaction due to a temperature increase. The best responses recognised that the rate of reaction would decrease and eventually stop due to fewer particles being available to react as the reaction progresses.
- (ii) Most candidates were able to state that an increase in temperature would increase the kinetic energy of the particles. A common inaccuracy was to state that particles collide more or faster rather than more frequently.
- (c)(i) Some good suggestions were seen, either relating to how dilute the acid is in acid rain or to the small surface area of the marble.
- (ii) There were some very vague responses to this question. Responses such as cars, petrol or factories could not be credited. Candidates needed to specify that the source of sulfur dioxide is the combustion of sulfur-containing fossil fuels.
- (d) Most candidates were able to state a correctly balanced equation. Correct multiples were also accepted. Occasionally candidates tried to include hydrogen as a product.

Question 4

- (a) Most candidates were able to complete the sentences to explain changes in breathing rate. Some candidates stated that oxygen was required for anaerobic respiration rather than aerobic respiration.

- (b) (i) A common misconception was that cilia are responsible for trapping of pathogens. Pathogens are trapped by mucus in the respiratory system and it is this mucus containing the pathogens that the cilia move out of the respiratory system.
- (ii) Alveoli was the most common incorrect response. Candidates should be reminded to use the proper terminology as stated in the syllabus, such as trachea rather than windpipe.
- (c) (i) A significant number of candidates misinterpreted the axes on the graph and identified incorrectly that the maximum number of cigarettes smoked and deaths caused by lung cancer were the same. Candidates should practise interpreting graphical data, paying close attention to the units and scales on the axes.
- (ii) Most candidates were able to state the correct answer of tar. Nicotine was the most common incorrect response.
- (iii) Most candidates were able to name a disease caused by smoking. The two most popular being COPD or coronary heart disease.

Question 5

- (a) Almost all candidates were able to describe a metal atom.
- (b) This question was particularly well answered with many candidates showing good knowledge about ionic bonding. Occasionally candidates thought that gaining electrons led to the formation of a positive ion.
- (c) (i) Nearly all candidates were able to correctly state covalent bonding.
- (ii) Most candidates recognised that electrons were shared between the two nitrogen atoms in a molecule of nitrogen. Fewer appreciated that a molecule of nitrogen has a triple bond and so shares three pairs of electrons.
- (iii) There was some confusion between intermolecular forces and covalent bonds. Many candidates referred to the breaking of bonds between the atoms as necessary for a change in state rather than the forces between the molecules. Candidates should understand the difference between the separation of molecules involved in a change of state and the breaking of bonds in a chemical reaction.

Question 6

- (a) (i) Most candidates were able to correctly calculate the speed. Occasionally there were some inaccuracies in rounding.
- (ii) Some candidates tried to calculate the acceleration by multiplying time and speed together giving a value of 3.172 m/s^2 . A number of candidates used the distance of 1.5 m as the initial velocity. Again, there were some inaccuracies in rounding.
- (iii) Many candidates were able to give an example of forces that would cause the acceleration not to reach its theoretical maximum. Fewer explained this in terms of the force acting in the opposite direction to gravity.
- (b) (i) Candidates were able to give excellent descriptions of how to determine the volume of the shape using a displacement method.
- (ii) Most candidates were able to calculate the correct density. Very occasionally candidates used the wrong formula and multiplied the mass and volume together.

Question 7

- (a) (i) It was clear that some candidates did not know the meaning of receptor and effector. A wide range of incorrect parts of the eye were suggested for both the receptor and the effector. Effectors are muscles or glands that cause a response. In the pupil reflex it is the circular and radial muscles of the iris that effect the change.

- (ii) Most candidates were able to identify that the hormone adrenaline causes dilation of the pupils.
- (iii) Most candidates were able to give some suitable features of reflex actions.
- (b) Nearly all candidates were able to identify the voluntary actions. A small number of candidates incorrectly identified sneezing as a voluntary action.
- (c) Candidates were required to read the question carefully. This question asked how the action differs between nervous and hormonal control.
- (d) Most candidates were able to name a pancreatic enzyme that controls the concentration of glucose in the blood.

Question 8

- (a) Candidates tended to answer this in terms of the necessity of nitrate for the synthesis of proteins or in terms of increased growth or yield. Both responses were acceptable for the mark.
- (b) The inclusion of brackets in the formula of ammonium nitrate was often omitted by candidates.
- (c) Some candidates did not consider the 2:1 ratio of potassium hydroxide and potassium sulfate, multiplying 174 by 0.5 giving a mass of 87. Some candidates calculated the relative formula mass of potassium hydroxide as 112.
- (d)(i) A significant number of candidates were unable to interpret the graph accurately, possibly confusing temperature and pressure, and suggested that the percentage of ammonia decreased with increased pressure.
- (ii) Most candidates found this question demanding. The concept of equilibrium position was not well understood. An increased temperature giving an increased rate of reaction was more widely understood.

Question 9

- (a) Candidates generally understood the effect of resistance on current and the resultant power output. Some candidates described an increase in temperature of the thermistor leading to an increase in resistance rather than a decrease.
- (b) The conversion of kJ to J proved troublesome for some candidates. Candidates should practise the conversion of units. A common error was to rearrange the formula incorrectly and divide the energy by the power giving a value of 8.9 s.
- (c) Only the strongest candidates answered this question effectively. A significant number stated the black cup would decrease in temperature more slowly because black is a better absorber of thermal energy. The cups started at the same temperature and the decrease in temperature was due to differences in emission of thermal energy rather than absorption.
- (d) Occasionally candidates confused a virtual and a real image. A common correct response was that a real image can be formed on a screen.

Question 10

- (a)(i) The majority of candidates were able to interpret the graph to give the optimum pH value of 8.
- (ii) There were some excellent responses seen to this question. Many candidates were able to explain this in terms of deformation of the enzyme's active site and the resulting effect on the substrate's ability to bind to the enzyme.
- (b) Amylase was commonly given as the enzyme. Carbohydrase was also an acceptable response.
- (c) The majority of candidates were able to suggest a suitable acidic pH value.

- (d) Candidates needed to give both fatty acids and glycerol as the smaller molecules that fats and oils are made from. Quite often only one or the other was seen. The name of the chemical test required was the ethanol emulsion test. A significant number of candidates simply referred to the emulsion test. Some candidates attempted to state the elements that carbohydrates, fats and proteins are composed of rather than the smaller molecules.

Question 11

- (a) The majority of candidates were able to give the correct compound as **C**.
- (b) The correct answer of bromine was commonly seen. The most common incorrect answer was aqueous barium chloride.
- (c) Ethanol was commonly seen. Some candidates gave the general group name of alcohols. Some candidates used the incorrect prefix of meth- or prop-.
- (d)(i) Most candidates were able to state that the small units of polymers were called monomers. Rarely were polymers described as long chain molecules. Several candidates described polymers as hydrocarbons or macromolecules.
- (ii) Ethene was correctly drawn by many of the candidates. Occasionally candidates drew a repeating unit of ethane.
- (e)(i) On this question, it was not enough to simply say that the energy level decreases. Candidates should carefully examine all the information provided to them and use this in their responses. The best responses referred to the relative energy of the products and reactants. Very occasionally candidates tried to explain in terms of activation energy.
- (ii) Almost all candidates were able to give the type of reaction as exothermic.
- (iii) A common misconception is that bond breaking releases energy. Some candidates tried to answer in terms of the number of bonds broken and the number of bonds made. Occasionally candidates attempted to explain this in terms of only bond making. Candidates that understood that bond breaking requires energy, generally scored highly.

Question 12

- (a)(i) Candidates found this question demanding and often repeated the information in the stem in their answer, rather than providing any new information. The best responses described the effect on the wire and that due to the wire experiencing a changing magnetic field an e.m.f. is induced. Few candidates included the term e.m.f. in their responses.
- (ii) This question was generally answered well with most candidates gaining at least partial credit. The most common error was to suggest that a decreased resistance would lead to a decreasing ammeter reading.
- (b)(i) Almost all candidates were able to state the correct types of radiation.
- (ii) This question was generally well answered with most candidates able to complete the correct nuclide notation. Very occasionally candidates stated the incorrect nuclide notation for the alpha particle but recognised that the totals on the right-hand side needed to match the left-hand side.
- (iii) Most candidates gave at least one reasonable suggestion, mostly referring to alpha particles being the least penetrating or referring to the ease of shielding. Few described the alpha particles being easily stopped by smoke particles. A significant number of candidates repeated the information in the stem and simply stated that alpha particles are ionising.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

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

CO-ORDINATED SCIENCES

Paper 0654/62 Alternative to Practical

Key messages

In the planning question, candidates would benefit from using the bullet points given in the question to structure their answers. In this way, important aspects of the question, such as drawing a results table, are not omitted.

Candidates should ensure that the working out in calculations is shown. The working out should be clear and legible. The working out is particularly important where the question is worth more than one mark and some credit can be given for either the steps in the calculation or for an error carried forward.

General comments

Candidates often found questions that focused on the evaluation of experimental procedures or the analysis of results the most demanding.

Candidates were often able to take the correct readings from diagrams of pieces of equipment.

Candidates must take care to give the answer to the correct number of decimal or significant figures as appropriate for the calculation.

Comments on specific questions

Question 1

- (a) Many candidates understood that the Benedict's test requires heating. The most common incorrect answer was the biuret test.
- (b) Many candidates were able to give the starting colours for the three test reagents. A common misconception was to give the colour of iodine solution as red rather than brown.
- (c) Many candidates correctly concluded that both **A** and **B** contained protein and that **B** contained starch. Candidates were less likely to identify the presence of reducing sugar in sample **A**. Some candidates just stated carbohydrate as the nutrient present without specifying either reducing sugar or starch.

Question 2

- (a) (i) Most candidates were able to draw a suitable results table. Some candidates added extra columns to include both the tally chart information and the numerical values for the number of drops. Other candidates had a column that related to the concentration of vitamin C in the solution.
- (ii) Many candidates entered the numerical data into their results table. Typically, candidates arranged the solutions in alphabetical order from **E** to **H** although this was not required. Some candidates just copied the tally marks and did not give a numerical value in their tables, this was not awarded a mark.
- (b) (i) Some candidates identified that the drop size from a pipette would vary and recognised that measuring the volume would be a suitable improvement. Human error or using tally marks rather

than numbers were insufficient for a mark to be awarded. Some candidates recognised that the procedure had not been repeated so an average number of drops could not be calculated.

- (ii) Candidates often recognised that blueberry juice would be blue but did not always explain that this would mask the colour change of DCPIP. Other candidates thought that the procedure would not work because blueberry juice does not contain vitamin C.
- (c) (i) Candidates often recognised that fruit juice **H** would be the best at preventing scurvy but often did not give comparative answers. Typically, candidates referred to a low number of drops or that the fruit juice had a high concentration of vitamin C rather than the least number of drops or the highest concentration of vitamin C.
- (ii) Many candidates performed the correct calculation but some neglected to round the answer to two significant figures and left the answer as 62.5 cm^3 .
- (iii) Candidates correctly referred to providing an alternative vitamin C source, often quoting a food that contains vitamin C, such as lemons or limes. Other candidates used vitamin C tablets and this was also given credit. A common incorrect answer was to refer to the presence of sunlight.
- (d) (i) Some candidates ignored the instruction about drawing a quarter of the orange and instead drew the whole orange. These answers did not score the marking point about the diagram being at least half the size of the box. Some candidates drew hatched lines for the outlines rather than a continuous straight line. Other candidates merged the outer line with some of the detail of the inside of the slice and as a result it was not possible to distinguish the outline. In terms of the detail mark, candidates often did not include the outer layer of the orange and just focused on the orange segments. Some candidates drew more segments than were visible.
- (ii) Most candidates were able to calculate the actual diameter of the orange using the formula given. Answers that gave at least two significant figures were accepted.

Question 3

- (a) (i) Some candidates did not give both temperature values to one decimal place. The value of 26.0°C was often quoted as 26°C even though all the values in the table had one decimal place. Candidates were more likely to correctly give the temperature after 10 cm^3 of dilute hydrochloric acid was added.
- (ii) Typically, candidates gave either a pipette or a burette. Some candidates qualified the use of a pipette as a volumetric pipette. Those that mentioned a dropping pipette were not awarded the mark. A small proportion of candidates gave a syringe but this was not given credit since in a titration a volumetric pipette or burette is more suitable.
- (iii) Candidates often appreciated that plastic and glass are poor conductors of heat. Misconceptions included that the plastic might melt or to stop hands getting burnt. Other candidates repeated the information in the stem about stopping the cup from tipping over.
- (b) (i) Candidates found it difficult to choose a correct scale for the temperature axis and often started at 0°C rather than 20°C . As a result, the points plotted filled less than half of the available space on the grid. Other candidates chose scales that made plotting the points more difficult than they could have been, for example going up in 3s for every 2 cm. Some candidates did not appreciate that temperature was the dependent variable so should be the y-axis. Most candidates were able to plot all the temperatures within the tolerance of half a small square.
- (ii) Candidates often followed the instructions in the question and drew two straight lines that intersected. Candidates were expected to ignore the anomalous point at a volume of 20 cm^3 of acid. A small proportion of the candidates plotted dot to dot graphs and included the anomalous point. Most candidates could interpret the graph to state the maximum temperature obtained.
- (iii) Most candidates could interpret the graph to state the volume of dilute hydrochloric acid needed for complete neutralisation.

- (c) Most candidates were able to perform the calculation to work out the thermal energy released. A common misconception was to fail to work out the increase in temperature, using the actual maximum temperature instead. Any correctly rounded value was accepted.
- (d) Most candidates referred to adding a lid to prevent loss of thermal energy. Other candidates used extra insulation either around the glass or the plastic cup.
- (e) Candidates that chose 21.5°C almost always gave a correct explanation, referring either to going back to the initial temperature or going back to room temperature. A variety of other temperatures were given, most of which were between the maximum temperature and room temperature. Only a small proportion of the candidates gave a temperature that was below that of room temperature.

Question 4

- (a) Many candidates correctly stated a lighted splint and that the hydrogen burns with a squeaky pop. A common misconception was to miss out the details of the test and just refer to either a flame test or the 'pop'. Only a small proportion of candidates confused the test for hydrogen with that for oxygen.
- (b)(i) Candidates found this question very challenging and rarely gave correct predictions. The most common answers given were that the universal indicator was green with a pH of 7 and that there was no reaction with magnesium. This answer was given one mark for an error carried forward since if the mixture was neutral there would be no reaction with magnesium.
- (ii) Many candidates did not appreciate that extra hydrochloric acid had been added to the sodium hydroxide in Question 3 and so the reaction mixture at the end would be acidic. The most common answer was that the solution was neutral because the aqueous sodium hydroxide had been neutralised by the hydrochloric acid.

Question 5

- (a) Most candidates knew the symbol for a voltmeter but they were less certain where to include it in the circuit. A small proportion of candidates include the voltmeter in series. Some candidates used two voltmeters, one in parallel with resistor R_1 and the other in parallel with resistor R_2 .
- (b)(i) Many candidates could read the voltmeter and quoted the value to one decimal place. Candidates found the ammeter more challenging to read than the voltmeter. A common misconception was to give an answer of 0.13 A rather than 0.16 A. Almost all candidates quoted an answer to two decimal places for the current.
- (ii) Most candidates were able to calculate the resistance of the circuit and either quoted the value shown on a calculator or correctly rounded the number to two or three significant figures. Not all candidates could recall the unit for resistance.
- (iii) Some candidates appreciated that the wires would become hot if the switch was not opened. Other candidates mentioned that opening the switch saves the battery life. Common misconceptions included checking to see if everything was connected correctly, preventing electrical shocks or to ensure that the readings were accurate or reliable.
- (c) Many candidates did not recognise the extra component as a variable resistor. The most common error was just to mention a resistor, but many other components, such as lamps, were also given. The symbol for a variable resistor was not well known and often the arrow on the variable resistor symbol was omitted. The only error carried forward allowed was the symbol for a resistor if this was given as the extra component.
- (d) Most candidates were able to calculate the resistance although the only acceptable answers had to have two or three significant figures.
- (e) Candidates found this question challenging and quite often did not attempt any calculation to show that the values were within 10% of each other. Many candidates just referred to four times the R_p not being equal to R_s or that the values were close to one another. The best answers multiplied R_p by four and then showed that this value was between the range of 90% and 110% of the R_s value.

Other answers calculated the difference between the two values and worked this out as a percentage of R_s and showed that this was less than 10%.

- (f) Many candidates did not appreciate that the observation would be a reading on the ammeter. Candidates often decided to use a new circuit that could be used to test each lamp individually. A small proportion of the candidates stated that the presence of a broken filament within the lamp could be checked.

Question 6

Typically, candidates used the bullet points to structure their answers, although a significant proportion of the candidates did not include a results table. Candidates found the list of additional apparatus the most accessible marks with the control variables being the next most accessible.

Candidates often mentioned that a stop-watch and a thermometer were needed. Other candidates included a list of apparatus, some of which had been given in the question. A significant proportion of the candidates used the blank space under the question to draw a diagram of the apparatus and often this was where the marks for the stop-watch and thermometer were awarded.

A common misconception was to describe a method in which a sample of water was heated and the temperature monitored every 30 seconds or 1 minute. As a result, candidates did not mention the need to measure the time it takes for the water to boil. The best answers gave a diagram of the apparatus and gave a detailed description of the method including the need to repeat the experiments for each cooking pot.

Candidates often mentioned the variables that would be controlled within the method, rather than having a separate paragraph. The most common correct answers were the volume of water heated and the temperature of the cold water. A common misconception was to refer to the amount of heat supplied which varies depending on the time taken to boil the water or refer to an unspecified temperature. References to keeping the flame the same distance from the pot was given credit.

As mentioned previously, a significant proportion of the candidates neglected to include a table. Those candidates that did draw a table normally gave a table that reflected their method. The best tables had two columns with headings of material and time taken to boil in seconds. Many candidates did not include the units for time in their tables.

A small proportion of the candidates gave an actual conclusion, such as the copper pot would take the least amount of time. This type of answer was not given credit since the candidates had to show how the results could be processed to be able to make a conclusion. The most common answer referred to looking at the time taken and seeing if the times were the same or different. Candidates then went on to state if they were the same the material the pot was made from made no difference to the time taken to boil or *vice versa* if the times were different. A small proportion of the candidates referred to drawing a graph but they were only given credit if it was a bar chart of the times taken to boil against the material. Some candidates referred to calculating the average time but unless a reason was given for repeating and taking an average this was not given credit.