PRINCIPAL EXAMINER'S REPORT

BOTSWANA
EXAMINATIONS
COUNCIL

BGCSE SCIENCE DOUBLE

2024

PAPER 1: MULTIPLE CHOICE

General Comments

The performance of the candidates was similar to that of the 2023 cohort in terms of the mean for the paper. It is however worrisome that the candidates are finding questions difficult even where the question is targeting the lowest levels of cognitive scales. There were nine (9) questions in which the candidates struggled with selecting the correct answer. The best performance was noted in the Biology section where many candidates were able to get most of the items correct while the least performance was observed at the Chemistry section with less than 30% of the candidates selecting the correct option in about ten (10) of the questions. The lowest scored item was item 13 with only 6% selecting the correct option while item 52 was the best performed with about 91% of the candidates able to get the item correct.

The candidates did poorly in questions where they were expected to recall simple scientific concepts or to apply their knowledge of the concept and solve the question. Centres are encouraged to give candidates more opportunities for them to interact with application of the skills. The item reports are given as tables that include key information as indicated:

N the number of candidates who selected each of the options

Key the option that was taken as the answer

Comments on Individual Items

Item 1: Perform Accurate Measurement of Length and Time

Option	N	Key	Comment
A	8721	B	The item was poorly done. Most candidates selected A as their answer thus ignoring the .5 divisions at the lower part of the sleeve. Candidates should be encouraged to understand the scale before choosing an answer.
B	8254		
C	1613		
D	265		

Item 2: Equations of Motion

Option	N	Key	Comment
A	5876	C	Poorly done. Most candidates selected B and A as their answers. This is a sign that they did not know the formula which they were expected to use or were not able to use the formula correctly.
B	7477		
C	4719		
D	781		

Item 3: Forces: Effects on Motion

Option	N	Key	Comment
A	6173	A	Poorly done. The popular distractor was B. Candidates ignored the key word in the question constant speed thereby making them to believe that the forces were not equal.
B	8334		
C	2913		
D	1433		

Item 4: Forces: Turning Effects of Forces

Option	N	Key	Comment
A	4860	A	Poorly done. Most candidates selected B as the answer. Candidates should be made aware that the moment of a force is the product of force and perpendicular distance about a point. The total distance for force *F* from the pivot should be $d_1 + d_2$.
B	9220		
C	2733		
D	2040		

Item 5: Energy, Work and Power

Option	N	Key	Comment
A	11214	A	Fairly done. Most candidates selected A as their answer. The strongest distractor was B showing that the candidates just multiplied the numbers that were provided with acceleration due free fall, *g*.
B	6138		
C	693		
D	808		

Item 6: Energy, Work and Power

Option	N	Key	Comment
A	692	B	Well done. Most of the candidates were able to recall and use the formula for gravitational potential energy relative to point P with ease.
B	15573		
C	1687		
D	901		

Item 7: Transfer of Thermal Energy

Option	N	Key	Comment
A	5953	D	Poorly done. The candidates were mainly split between options A, C and D. Candidates should be made aware that a molecule does not expand and as a result its density does not change. Expansion that results in rising of hot molecules is as a result of an increase of the spaces between the molecules.
B	4399		
C	2203		
D	6298		

Item 8: Measurement of Temperature

Option	N	Key	Comment
A	2549	C	Fairly done. An average number of candidates were able to apply the concept of linearity correctly to determine the temperature of the tap water.
B	2676		
C	9364		
D	4264		

Item 9: Transfer of Thermal Energy

Option	N	Key	Comment
A	2016	B	Fairly done. The candidates were able to relate the colour of petrol tankers to reflection of thermal energy. Shiny tankers reflect thermal energy thus ensuring that the inside remains cool for longer time.
B	12341		
C	793		
D	3703		

Item 10: General Wave Properties

Option	N	Key	Comment
A	6459	B	Poorly done. Some candidates used the diagram to determine the frequency of the wave. The strongest distractor was option A.
B	8365		
C	2774		
D	1255		

Item 11: Light

Option	N	Key	Comment
A	7241	A	Poorly done. This is a recall question that should be done well by the candidates. However, there seems to be a confusion between real and virtual image since the candidates were distributed evenly between options A and B. Candidates should be made aware that real images can be located on a screen.
B	7099		
C	3442		
D	1071		

Item 12: Light

Option	N	Key	Comment
A	2361	C	Poorly done. The strongest distractor was D showing that the candidates did not recall the correct formula for refractive index. They used the angles without determining the sine of the angle first.
B	3299		
C	8565		
D	4628		

Item 13: Sound

Option	N	Key	Comment
A	1444	B	Poorly done. This was the most difficult item for the candidates even though it is a recall item. There are various uses of ultra-sonic sound, and it seems candidates were not aware of the many uses including cutting glass. Candidates should be encouraged to research especially on topics that are dynamic. The strongest distractor was D even though the name X-ray should have indicated to candidates that it cannot be the answer.
B	1067		
C	5537		
D	10805		

Item 14: Electromagnetic Spectrum

Option	N	Key	Comment
A	7646	A	Poorly done. The candidates were expected to recall the value but performed poorly with the strongest distractor being speed of sound. Most of the candidates were able to recall the speed of light in a vacuum.
B	2801		
C	5471		
D	2935		

Item 15: Magnetism

Option	N	Key	Comment
A	2144	B	Fairly done. A recall question which candidates are expected to do well. Candidates should be made aware that hitting the magnets makes them to lose their magnetism. The strongest distractor was D which is for a method used to make a magnet.
B	10394		
C	1177		
D	5138		

Item 16: Electricity

Option	N	Key	Comment
A	2459	B	Fairly done. This is a recall question which many were expected to do better in. However, the performance was average with D being the strongest distractor.
B	10151		
C	2322		
D	3921		

Item 17: Electricity

Option	N	Key	Comment
A	3740	C	Poorly done. A recall question which candidates were expected to remember with ease. Most candidates were split between distractors B and A which were on energy. Candidates should be made aware of the different formulas and how they translate to definitions.
B	6888		
C	5312		
D	2913		

Item 18: Electricity

Option	N	Key	Comment
A	742	B	Poorly done. Most candidates were split between distractors D and C. The candidates did not use the equation for components in series as expected. The candidates should be made aware that for components in series the current is the same at every point and $V = IR$ where the R is the resistance of the component.
B	7640		
C	4907		
D	5564		

Item 19: Electromagnetic Effects

Option	N	Key	Comment
A	1473	C	Well done. The majority of the candidates selected option D as their answer. The candidates have noticed that the transformer is a step-down and as such the voltage in the secondary should be less than the voltage in the primary coil. There is only one answer that was larger than the 400 V in the secondary coil. The candidates recalled and used the correct transformer equation $\frac{Np}{Ns} = \frac{Vp}{Vs}$.
B	956		
C	3198		
D	13226		

Item 20: Radioactivity

Option	N	Key	Comment
A	11356	A	Well done. The majority of the candidates were able to recall the nature and charge of an alpha particle.
B	2006		
C	2761		
D	2730		

Item 21: Particulate Nature of Matter

Option	N	Key	Comment
A	13796	A	Well done. Most candidates identified Cl2, which has the larger mass, as the gas that takes a longer time to reach the detector.
B	1095		
C	1762		
D	2199		

Item 22: Chemical Calculations

Option	N	Key	Comment
A	2849	D	Poorly done. Many candidates either missed the fact that fluorine is diatomic or failed to recognise the significance of 2.0 moles. Many calculated the mass of a fluorine atom. Most of the candidates selected C as their answer.
B	1033		
C	13198		
D	1772		

Item 23: Periodic Table

Option	N	Key	Comment
A	1005	B	Poorly done. Most candidates selected option C as their answer. The reactivity of the elements decreases as you go down the group and this is the reason why fluorine displaces both chlorine and iodine.
B	6449		
C	8885		
D	2513		

Item 24: Chemical Reactions

Option	N	Key	Comment
A	4075	A	Poorly done. The candidates were evenly distributed across the options indicating guess work. While some of the reactions can produce Copper(II) Nitrate, the candidates should evaluate the dangers associated with each of the reactions so that they can select the one that can be carried out in the laboratory safely.
B	6176		
C	3794		
D	4807		

Item 25: Alkanoic Acids

Option	N	Key	Comment
A	4836	D	Poorly done. This is a recall statement which is expected to be known by most candidates. The strongest distractor was A. Candidates should be made aware that an acid regardless of the name turns litmus paper red.
B	3613		
C	3492		
D	6911		

Item 26: Nitrogen

Option	N	Key	Comment
A	2662	D	The candidates did very well in this item. The candidates were able to recall the properties of solids especially the one for particles being closely packed and used it correctly to describe solid nitrogen.
B	786		
C	991		
D	14413		

Item 27: Chemical Reactions

Option	N	Key	Comment
A	2386	C	Poorly done. Most candidates selected oxidation as their answer. The candidates failed to notice that CO_2 acts as a weak acid when it reacts with an aqueous solution which is also a strong base to form salt and water, thus resulting in a neutralisation reaction.
B	1259		
C	4950		
D	10256		

Item 28: Chemical Bonding

Option	N	Key	Comment
A	9089	A	Fairly done. Even though most candidates noted that ionic compounds are good electrical conductors with high melting points, the majority of the candidates were split between options B and C. Thus, the candidates were confused by either the electrical conductivity or melting point of ionic compounds.
B	4400		
C	4360		
D	1001		

Item 29: Chemical Reactions

Option	N	Key	Comment
A	3816	D	Poorly done. Though candidates who selected the corrected option were in the majority, their proportion was very low, less than 40%. The rest of the candidates were split equally across all the three distractors showing that they did not have an idea of the reaction between sodium and water. Candidates should be made aware that exothermic reactions release heat thus temperature increases while endothermic reactions absorb heat hence temperature decreases.
B	4088		
C	4436		
D	6510		

Item 30: Electrolysis

Option	N	Key	Comment
A	9348	A	The item was fairly done with an average proportion of the candidates noting that the electrolyte remains blue. There is no change in the concentration of the Copper(II) Sulphate since the copper deposited at the cathode is replaced by copper from the anode.
B	3337		
C	2572		
D	3593		

Item 31: Chlorine

Option	N	Key	Comment
A	6200	B	Poorly done. The candidates were spread evenly on the options showing that they did not understand which of the elements was being oxidised and which one was being reduced.
B	6071		
C	3847		
D	2731		

Item 32: Properties of metals

Option	N	Key	Comment
A	7730	C	Poorly done. Distractors A and B worked better than the key as they were both selected by a larger proportion of the candidates than the key. The candidates were not aware of the reaction taking place with iron being displaced by magnesium to form Magnesium Sulphate and Iron.
B	5893		
C	4023		
D	1203		

Item 33: Macromolecules

Option	N	Key	Comment
A	9692	D	Poorly done. Most of the candidates selected option A as their answer. Candidates should be made aware of the different structures.
B	2614		
C	1232		
D	5311		

Item 34: Properties of metals

Option	N	Key	Comment
A	5117	A	Poorly done. The candidates were split mainly between options A, B and C with most of the candidates going for B.
B	7785		
C	4834		
D	1113		

Item 35: Alkanoic acids

Option	N	Key	Comment
A	4736	C	Poorly done. The candidates were evenly spread across all the options. The candidates should be aware of the pH values of acids, less than 7 and the number of carbon atoms used for naming carboxylic acids which is 3 for propanoic.
B	5646		
C	3773		
D	4694		

Item 36: Extraction of metals

Option	N	Key	Comment
A	2998	B	Well done. Most candidates were able to use the information provided to arrange the metals in their correct order of reactivity.
B	13162		
C	1151		
D	1538		

Item 37: Acids, Bases and Salts

Option	N	Key	Comment
A	13098	A	The candidates were able to easily note that the gas that turns lime water milky is from a carbonate anion. Carbon dioxide is produced from carbonates, and it turns lime water milky.
B	3437		
C	1155		
D	1158		

Item 38: Acids, Basis and Salts

Option	N	Key	Comment
A	4034	B	Fairly done. The candidates used the information provided correctly. Since the reaction is 1:1 the candidates were required to multiply the mass by the ideal volume and divide by molecular mass.
B	10405		
C	2247		
D	2162		

Item 39: Water

Option	N	Key	Comment
A	8216	A	Fairly done. Though most candidates selected the corrected answer, their proportion was still less than 50% for an item that is considered to be recall. The strongest distractors were D and B.
B	3007		
C	2406		
D	5219		

Item 40: Air

Option	N	Key	Comment
A	6270	C	Poorly done. Another question which is considered a recall type but had candidates spread almost evenly across the options. Candidates should be made aware that because of the gases present in the atmosphere, rain water is not neutral as it reacts with the gases forming a weak acid.
B	2477		
C	5152		
D	4949		

Item 41: Cell Processes and Maintenance

Option	N	Key	Comment
A	1058	D	Well done. The candidates were able to recognise the structure that is responsible for respiration from the diagram of the animal cell.
B	2230		
C	3250		
D	12309		

Item 42: Cell Processes and Maintenance

Option	N	Key	Comment
A	2752	D	The candidates were able to use the diagram correctly to determine the processes that are involved in the movement of the water and the dye.
B	2186		
C	1977		
D	11932		

Item 43: Nutrition

Option	N	Key	Comment
A	2944	C	Well done. The candidates had to know the products of photosynthesis and which of them moves through the stomata. The product should be in gaseous state for it to be able to move through the stomata.
B	1516		
C	11072		
D	3315		

Item 44: Transport and Circulation

Option	N	Key	Comment
A	8909	C	Poorly done. Most candidates could not link the accumulation of fatty deposits to smoking which damages the lining of the artery promoting accumulation of fatty deposits. The strongest distractors were A and C.
B	3080		
C	3566		
D	3292		

Item 45: Transport and Circulation

Option	N	Key	Comment
A	1621	D	Poorly done. Red blood cells transport both oxygen and carbon dioxide throughout the body assisted by the all the three features of biconcave shape, no nucleus and presence of haemoglobin. Most candidates omitted the lack of nucleus and selected C as the answer.
B	2965		
C	7409		
D	6852		

Item 46: Sexual Reproduction in Flowering Plants

Option	N	Key	Comment
A	670	C	Well done. Almost all the candidates were able to note that self-dispersal is the form of seed dispersal portrayed in the diagram.
B	166		
C	16387		
D	1624		

Item 47: Sexual Reproduction in Mammals

Option	N	Key	Comment
A	493	D	Well one. Most of the candidates were able to identify the testes as the site for production of the testosterone.
B	1733		
C	1074		
D	15546		

Item 48: Transport and Circulation

Option	N	Key	Comment
A	4578	B	Poorly done. The candidates were spread evenly across all the options, a sign of guess work. Thus, the candidates failed to translate the information provided to graphical presentation with highest water loss (steeper gradient) in leaf that is untreated and lowest in leaf with both surfaces covered with Vaseline.
B	4543		
C	4408		
D	5317		

Item 49: Ecology

Option	N	Key	Comment
A	6827	A	Poorly done. Untreated sewage is released into water streams and rivers and as such its long-term effects should be related to changes that can be observed on waters. Most of the candidates selected option B as their answer.
B	9867		
C	672		
D	1480		

Item 50: Sexual Reproduction in Mammals

Option	N	Key	Comment
A	16105	A	Well done. Almost all candidates recalled that the condom is effective against pregnancy and spread of sexually transmitted diseases.
B	798		
C	898		
D	1044		

Item 51: Homeostasis

Option	N	Key	Comment
A	1804	D	Fairly done. The candidates were mainly split between vasoconstriction and vasodilation.
B	2145		
C	5427		
D	9469		

Item 52: Drugs

Option	N	Key	Comment
A	597	C	Well done. Almost all the candidates were able to recall that the liver is damaged by regular drinking of too much alcohol.
B	379		
C	17135		
D	733		

Item 53: Ecology

Option	N	Key	Comment
A	2199	D	Well done. Candidates noted that the increase in soil erosion is undesirable effect of deforestation.
B	838		
C	1249		
D	14558		

Item 54: Respiration

Option	N	Key	Comment
A	3121	B	Fairly done. Candidates were able to remember the equation for aerobic respiration, the only one with oxygen that is needed for 'burning fuel'.
B	10886		
C	2433		
D	2401		

Item 55: Transport and circulation

Option	N	Key	Comment
A	5078	B	Poorly done. This is a recall question, but candidates were mainly split between atrium and ventricle.
B	8741		
C	2633		
D	2383		

Item 56: Nutrition

Option	N	Key	Comment
A	15700	A	Well done. Almost all the candidates were able to remember the regions where ingestion, absorption and egestion take place being the mouth, small intestine and the anus.
B	2592		
C	284		
D	254		

Item 57: Nutrition

Option	N	Key	Comment
A	2610	B	Well done. Most of the candidates were able to select B as the point where temperature is optimum for enzyme activity.
B	13738		
C	1730		
D	730		

Item 58: Respiration

Option	N	Key	Comment
A	5250	B	Poorly done. Though most candidates selected the key as their answer they were still lower than 50% in proportion. The candidates were able to identify the products of respiration and use them to answer the item.
B	8313		
C	2404		
D	2821		

Item 59: Sexual Reproduction in Mammals

Option	N	Key	Comment
A	2686	B	Poorly done. The candidates were not able to recall the hormones and their uses with ease and were mainly split between the answer and distractor C.
B	8243		
C	4946		
D	2842		

Item 60: Excretion

Option	N	Key	Comment
A	914	B	Poorly done. A simple label of the diagram but many failed to get the correct option. The candidates were mainly split between options B and C.
B	8447		
C	5312		
D	3520		

PAPER 3. WRITTEN THEORY

General Comments

The questions were fairly done by most candidates in Physics section. Most candidates scored more marks in recall type of questions. On the same note, candidates seemed to struggle with continuous writing responses. On most occasions candidates would over-write, thus distorting or contradicting what could have been correct responses. Candidates are to be made aware of the use of appropriate terms that have the potential to distort concepts e.g. words like conduct vs absorb vs attract; etc. More emphasis is needed on the use of comparable terms such as faster, easier etc. where appropriate as this helps capture the essence of the answer. Centres are advised to help candidates familiarise themselves with scientific terms and processes, so as to use them appropriately in context. Concepts with similar words are often confused e.g. conductor of heat and conductor of electricity , expansion and vaso-dilation of blood vessels.

Generally, some candidates displayed poor mathematical skills. Most of them failed to correctly align ratios, presented answers with incorrect significant figures, and wrong rounding off in their responses. They also used wrong symbols for quantities they used in the formulae or equations in Physics and Chemistry sections. Where units are given, centres are advised to encourage the candidates not to give their own units. Centres are advised to encourage their Candidates to always bring scientific calculators when writing a science double award paper.

In Biology, Centres must encourage their candidates to always use a solid line not an arrowed one to label structures or parts of a scientific diagram. Candidates still have a problem with explanation and description questions. Centres are advised to give candidates more practice on questions that require explanation and description.

Centres are advised to encourage their candidates to write something in the answer line rather than leaving blank spaces and write their answers within the margins not outside the margins. Candidates must be encouraged not to write their answers to the question on a specific page on a different page. Centres are advised to encourage candidates not to copy the questions in the answer space as this results in them running out of space for the answer. Candidates should be encouraged to correctly copy the readily available symbols provided in the given Periodic Table.

Comments on Individual Questions

1 **(a)** Poorly done. A larger number of candidates were describing the motion of the cars as moving in straight line, uniform acceleration, moving in diagonal lines instead of describing the graphs. Despite that there were those that still managed to describe the graphs being straight lines.

(b) **(i)** Fairly done. Most candidates were able to score a compensation mark for the correct formula and lost the answer mark. The candidates also failed to make correct substitutions. The challenge was in identifying the correct time with most candidates using 20 s instead of 10 s.

(ii) Poorly done. Most candidates were adding instead of subtracting the two areas or distances. There was a high prevalence of the use of the wrong formulas for the calculations of the areas.

(iii) Poorly done. Very few candidates got all the marks for identifying and using correctly the relevant formula $v = u + at$. Majority of the candidates used wrong formula or were unable to recall the formula to use in the section.

Answers: **(b) (i)** 3 m / s^2 **(b) (ii)** 450 m **(b) (iii)** 90 m / s

2 **(a)** **(i)** Poorly done. The glass allows short wave radiation from the Sun to enter and does not allow long wave radiation emitted by the absorber plate from escaping. There was prevalence of answers such as to allow sunlight instead of heat to enter indicating a bit of misconception on the part of the candidates.

(ii) Fairly done. The candidates were aware that black has to do with the trapping of heat but confused the words with many referring to black substances as good conductors or good emitters of heat. The black painted surface has to absorb heat for the temperature to increase. A few candidates lost this mark due to long statements that ended up with contradictions. e.g., Black absorbs more heat as they are good conductors of heat.

(b) **(i)** Well done. Most Candidates were aware that copper is a good conductor of heat while others included further explanations and ended up nullifying their answers. There were some candidates who gave answers such as copper is a good absorber or copper is a good conductor of electricity.

(ii) Well done. Coiling increases the length of the conductor and the surface area that is available for conduction. A few candidates tried to elaborate which led to their answers being wrong eventually. Some candidates were not able to indicate why the surface area was increasing. Majority of candidates related larger surface area to larger amount of heat conducted.

(c) Well done. Most of the candidates identified the process as radiation. A few candidates lost the mark by stating either convection or conduction.

(d) Poorly done. Most candidates were aware that the intention of the insulation was to reduce or minimise heat loss. However, the candidates used terms such as to prevent, to stop, to avoid, which imply that the process will not happen at all. Some common responses alluded to issues of avoiding burns indicating lack of conceptualisation of the solar panel itself.

3 **(a)** Well done. Most candidates were able to remember the components of the electromagnetic spectrum. Centres are advised to emphasise on which component are rays and which are just waves. The common wrong responses included “alpha and beta”. Some candidates gave the instruments / machines used to detect EM waves, some defined radioactivity / ultrasound and stated uses of EM waves.

(b) Poorly done. Most candidates failed to note that time was plotted on the horizontal axis and as such the time for a complete wave, which was denoted by X, was the period. Most common wrong responses were wavelength, frequency, the starting to the end of the wave, distance between two crests. Centres are advised to encourage the candidates to understand the labels on both axes of the graph when answering questions. Furthermore, Centres should encourage candidates to interpret distance-time and displacement- distance graphs and differentiate them.

(c) Fairly done. Some candidates recalled the speed of electromagnetic waves, 3×10^8 m / s but failed to present it in correct standard form in the answer line. Centres are advised to encourage their

candidates to write the value in a long form if they cannot present the answer in standard form. The common wrong responses included 3, 330 m / s, 3.8×10^8 m / s and 3×10^6 m / s.

(d) Fairly done. Some candidates were able to recall the equation $v = f \times \lambda$. Some candidates missed a mark because they used a wrong symbol for wavelength. However, most candidates didn't convert the Mega to the SI unit. Therefore, Centres are advised to encourage candidates to use appropriate symbols and prefixes. Also, Centres should give Candidates more exercises on the value of different prefixes.

(e) **(i)** Fairly done. A good number of candidates were able to score a mark in this question for noting that frequency stays the same. Candidates should be enlightened on the use of the bolded words and follow instructions.

(ii) Poorly done. Most candidates failed to note that the speed changes since the waves are moving from one medium to another. The optical densities of the mediums are different hence the speed will also vary. The common wrong responses included increases, which was not even part of the words included in the list to choose from.

Answers: **(c)** 3.0×10^8 m / s **(d)** 0.3(3) m

4 **(a)** Well done. A good number of candidates noticed that the voltage across components in a parallel circuit is equal to terminal voltage. However, there were some candidates who gave responses such as 240 V, double the terminal voltage, 60 V, half the terminal voltage and 80 V which is the value obtained if the voltages were shared according to the ratio of the resistance in each branch. Centres are advised to cover the electric circuitry in detail for candidates to understand principles.

(b) Fairly done. Most candidates were able to recall the correct equation, but some failed to use the equation correctly. The candidates should be made aware that when they use the equation for resistors in parallel, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ they should find the inverse of the answer to determine the value of R. For two resistors in parallel, candidates should be advised to use the formula which gives them resistance directly $R = \frac{R_1 R_2}{R_1 + R_2}$. Centres are advised to emphasise on the difference between series and parallel circuits. Furthermore, give more practice to candidates on series and parallel circuit to apply the equations.

(c) Fairly done. A good number of candidates were able to recall the correct equation, $V = IR$ but failed to substitute correctly and lost the mark for the correct answer.

(d) Well done. Majority of the candidates noted that the current can be determined from voltage and the resistance. A few candidates were able to recall the correct equation but got answer wrong due to wrong units.

(e) Well done. A larger number of the candidates demonstrated the knowledge on component symbols and their names. Centres are advised to encourage candidates to use a rule when they draw an open switch.

(f) Fairly done. Candidates were able to identify that the current decreases but lost the mark because they tried to explain further thereby contradicting themselves. The total resistance of resistors in parallel is smaller than the smallest resistor in the circuit hence when an open switch is connected, the resistance of the circuit increases. Centres are advised to emphasise on the correct use of words such as current and electricity which candidates are still confusing.

Answers: **(a)** 120 V **(b)** 24 W **(c)** 5 A **(d)** 3 A

5 **(a)** **(i)** Fairly done. A good number of candidates recalled the emission being described by the stated nature. However, there were some cases of blank spaces. The most common wrong answer was gamma. Centres are advised to encourage candidates to always write something in the answer line space rather than leaving it blank. They should not doubt their capability.

(ii) Fairly done. Generally, candidates noted that the beta particles are greatly deflected. This is mainly due to it being charged and also being lighter than alpha particles which are also charged. Some candidates gave descriptions instead of the names of the emission.

(iii) Well done. A good number of candidates identified the emission as a gamma.

(b) Well done. Most candidates were able to recall the uses of radioactive materials. A few candidates stated scanning of unborn babies as an application despite its danger on cells and tissues. There were a few observations of misconceptions e.g. failing to differentiate between chemotherapy and radiotherapy.

6 **(a)** Well-done. Most candidates did well in this question .They were able to remember that argon, Ar is used to protect the filament in electric bulbs. The most common incorrect response was aluminium, A*l*.

(b) Poorly done. Very few candidates were aware that Pt (platinum) is used as a catalyst. The candidates may have known that platinum is used as a catalyst but may have had challenges with the symbol for platinum. Candidates should be encouraged to make use of the Periodic Table attached at the back of the question paper whenever they answer questions related to the Periodic Table. The most common incorrect responses were A*l*, K and Br.

(c) Fairly done. A good number of candidates noted that A*l*, which is in group III, forms an ion with a charge of +3. Some candidates presented the symbol of the element in capital letters, i.e. AL

(d) Poorly done. A few candidates deduced that the answer was I. Most candidates gave responses such as F, Br, N, Ca and A*l*. Centres are advised to cover the physical properties and symbols of elements in details.

(e) Fairly done. A good number of candidates were able to deduce that Ca (calcium) reacts with aqueous sodium hydroxide to produce an insoluble white precipitate. Some of the candidates wrote responses such as C*l* and A*l*.

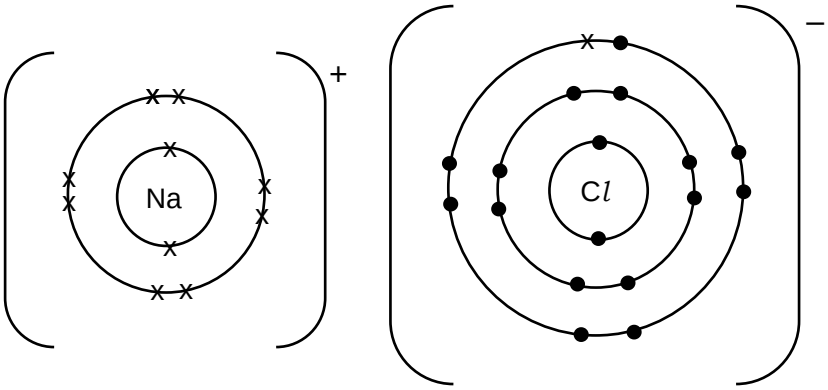
(f) Poorly done .Though this is a general knowledge question, most candidates failed to recall that nitrogen (N) is the largest gas by proportion in the atmosphere. The most common wrong answer was oxygen (O).

7 **(a)** Well done. Generally, the candidates were aware that chlorine is used to sterilise water in the water treatment process. A few candidates gave incorrect responses referring to purification and cleaning of water.

(b) Fairly done. Generally, the candidates recalled that a damp litmus paper is used to test for chlorine gas. Some candidates omitted the word 'damp' and only wrote test with litmus paper which results in no reaction taking place. Centres are advised to put emphasis on describing tests instead of just stating the substances to use in the test. Some candidates who stated test with blue/red litmus paper mentioned that it turns red/remains red which was an incomplete test result for chlorine gas test as it excluded the bleaching aspect. Some candidates wrote limewater or burning splints as tests for chlorine gas.

(c) Well-done. Most candidates recalled substances that could pollute water like detergents, sewage, etc. A few gave descriptions of processes that lead to pollution instead of the substances which pollute river water.

(d) Poorly done. Most candidates got the answer to this question wrong. The response was for the correct structure of sodium [2, 8] and the correct structure of chlorine [2, 8, 8] with correct charges of common responses were. Candidates should also indicate that the extra electron in chlorine is from sodium.



Centres are advised to discourage candidates from drawing multiple structures of ions, filling the whole answer space and avoid including empty shells in their structures.

(e) **(i)** Well done. Most candidates were able to deduce that chlorine is formed at the anode. A smaller number of candidates wrote cathode, which was the most common wrong response, while some wrote sodium chloride.

(ii) Well done. A large number of candidates noted that bubbles will be observed at the electrode. The most common incorrect response was pop sound produced, which is the test for hydrogen gas. Some candidates referred to the electrode coated in brown or size of the electrode decreasing.

(iii) Poorly done. The candidates were to draw an arrow on the connecting wires from negative terminal towards the cathode or from the anode to the positive terminal. Most candidates confused conventional current with electron current. Most common wrong responses were

arrow in the electrolyte drawn in the middle of the beaker facing left or right and arrow positioned between test tubes facing downward or upward.

8 **(a)** **(i)** Fairly done. A good number of candidates made the correct reading from the graph for the time. A few candidates omitted units and others used wrong units such as m which represents metre. Candidates who struggled with the scale gave answers such as 3.2 s, 2.8 s and 3.4 s. Centres are advised to encourage candidates to always use the given units on the graph.

(ii) Poorly done. Most candidates failed to address the rate of change which should decrease, and collisions were fewer. On the explanation they failed to use correct comparing words.

(b) **(i)** Fairly done. Most candidates recalled the correct formula that is used to determine the number of moles and got a mark for that. However, there were some candidates who lost a mark due to wrong rounding off. A few lost some numbers as they were copying from the calculator to the answer line.

(ii) Fairly done. A good number of candidates noted that the number of moles for hydrogen were equal to those of iron. Those who did not get it correct was due to wrong rounding off and failure to use the mole ratio from the given chemical equation.

(iii) Well done. Most candidates were able to recall the formula to determine the volume and they used it correctly to determine the volume.

(iv) Poorly done. Most candidates failed to refer to or use the given graph to calculate the volume of hydrogen collected during the experiment.

Answers: **(a)** 3.0 minutes **(b) (i)** 0.00165 moles **(b) (ii)** 0.00165 moles

(b) (iii) 0.0396 dm^3 **(b) (iv)** 0.0056 dm^3

9 **(a)** Poorly done. Most candidates confused the words inter- and intra-. Most candidates mentioned that inter- forces are inside, and intra- forces are outside the molecule, which should have been the other way round.

(b) Fairly done. A good number of candidates were able to write the correct chemical formula but failed to balance it correctly hence got a mark for formula and lost a mark for balancing.

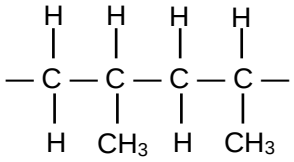
$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

(c) Fairly done. A good number of candidates recalled that a hydrocarbon is a compound that contains carbon and hydrogen elements. Some candidates mentioned that it is a mixture of atoms / molecules / particles.

(d) **(i)** Well done. Most candidates got the answer correct or deduced that the reaction is cracking. A smaller number of candidates identified the reaction as endothermic or substitution or redox or combustion.

(ii) Fairly done. A good number of candidates were able to define a macromolecule as being a large molecule made by joining together of many small monomers. Those who failed the question defined polymerisation or referred to a macromolecule as an element.

(iii) Poorly done. Most candidates got the answer wrong because they failed to include a methyl in the chain and show continuous bonds of a polymer at the ends of the structure. All carbon atoms should also have single bonds.



10 (a) Poorly done. Most candidates misinterpreted the word coordinating for regulating and as such answered in relation to the skin, which regulates rather than the brain which coordinates. In some instances, they used brackets even when they gave a correct response, and this spoiled their answers. Whatever is written in brackets must be correct and should emphasize the answer outside brackets. Candidates also failed to note that the question asked for organ and as a result incorrectly gave hypothalamus as an answer.

(b) (i) Poorly done. Most candidates did not know the arteriole and therefore dilated all the blood vessels shown in the figure. This was despite the guidance provided with the labelling of the arteriole. Some candidates did not draw the dilated arteriole on the figure as per the rubric but rather drew it next to the figure.

(ii) Fairly done. The majority of the candidates could tell that more heat got lost. However, many failed to express that more blood flows near the skin surface. Instead, they just indicated that blood flow to the skin giving the impression that the blood was not in the skin. There are those who stated that heat loss through the skin was by conduction which nullified their answers. In addition, many candidates omitted the key words in answering this question, which are. more blood and more heat.

(c) (i) Poorly done. Many candidates failed to describe the graph using the variables shown being temperature of the environment and rate of sweat production. Many just stated that the graph was constant. Candidates failed to describe the graph using the relationship between the two variables in the graph. Other candidates described the graph using just one variable; the rate of sweat production was constant.

(ii) Poorly done. Candidates mostly got the mark for the description of the graph and failed on explaining the description. It was clear that candidates were failing to handle this high order question with some candidates even describing the graph using Physics terms such as accelerating uniformly, non-uniform decrease/increase. Candidates failed to establish the coordinating role of the brain that leads to sweat glands producing more sweat.

11 (a) (i) Fairly done. Candidates misspelt the word epidermis using words such as epididymis, epidemic. Some referred to the spongy mesophyll layer as the vascular bundles. Others missed the word mesophyll and just said spongy layer. Lastly there were those who referred to the tissue as just a cell.

(ii) Fairly done. Most candidates used arrows for a label line while others used a label line with a dot to label the lower epidermis. There were those who just put the letter X, without a label line, on the diagram.

(b) Poorly done. Most candidates indicated that the chloroplasts contained in the palisade mesophyll layer are the ones absorbing the light energy instead of chlorophyll. They further failed to show the relationship between the feature and the improved function in answering the question about adaptation. Failure to use key words such as more when talking about light absorption, easy when talking about gaseous exchange was also their shortfall.

(c) Fairly done. A good number of candidates mentioned the reduction in chloroplast production instead of reduced chlorophyll production. Some did not mention the word chlorophyl but rather referred to it as the green pigment. Others alluded that chlorophyll might/may not be produced when in fact they should have been definite that chlorophyll will not be produced or less of it will be produced. Other candidates just narrated general information on magnesium deficiency without answering the question.

12 (a) Poorly done. Most candidates were able to score the first marking point for speed of transmission, noting that they were fast and slow, for nervous system and endocrine system respectively. The candidates failed to state the mode of transmission and duration of response thereby losing some marks for the parts.

(b) Poorly done. Most candidates confused the two terms, receptor and effector, as they failed to differentiate them. Their responses were mostly swapped.

(i) Common incorrect responses for receptor were muscles, glands, spinal cord, heart instead of naming the five sense organs eye, ear, nose, tongue and skin or specific named receptors.

(ii) Common incorrect responses for effector were skin ,eyes, ear, brain instead of muscles and glands or specific named muscles/glands

(c) Poorly done. Most candidates failed to relate the structure of a neurone to its function and stated the name of a neurone and its function. The most accessible marking point by most candidates was that the nerve fibre is myelinated to prevent loss of impulses. Most common incorrect answers were it is long to connect to other body parts instead of it is long to transport impulses to distant parts of the body and it has dendrites to transport impulses around the body instead of dendrites connecting to other neurones.

13 **(a)** Fairly done. A good number of candidates identified the source of energy as the Sun. Candidates who lost the mark wrote sunlight as the source of energy.

(b) Fairly done. Most candidates were able to note that the population of snakes decreases under the description but failed to give an explanation on why that the population decreases. Most candidates used expressions such as snakes will have nothing to feed on instead of saying due to less food / less energy / more competition for food.

(c) Fairly done. Most candidates were able to access the first mark .Grasshoppers increase, but candidates failed to give out a clear explanation as they just said the lizards and toads were decreasing or nothing to feed on instead of less toads and lizards feeding on grasshoppers reduce in number.

(d) Well done. Most candidates constructed the correct food chain with three trophic levels, starting with green plants moving to either snails or squirrels. A few candidates constructed a food chain with more than three trophic levels.

(e) Poorly done. The candidates failed to address the question since they failed to note that the energy between lizards and birds decreases as some of it is lost to the environment while the other is used for protein synthesis. Most candidates were giving energy changes in the food chain e.g. chemical energy changes to kinetic energy for the birds to fly. Some candidates paraphrased the food chain as it is in the food web. The most common incorrect response was birds will have more energy as it feeds on more grasshoppers and lizards.

PAPER 4. ALTERNATIVE TO PRACTICAL

General Comments

Candidates generally show lack of experimental skills which include observation, measurement and scale reading to mention a few. Centres are advised to do lots of practice with candidates to significantly improve our alternative to practical results. The graphical skills continue to be a challenge to candidates regardless of being taught on other sister subjects like mathematics. The application of the concepts theoretically clearly shows candidates cannot comprehend hence need for more practical work.

Comments on Individual Questions

1 **(a)** Poorly done. The candidates failed to relate the information provided on the length between each marked point 0.1 m with the moment produced which should have given them the unit of Nm from the units of the length. Most candidates gave answers such as N, Ncm, N/cm.

(b) Well done. The candidates were able to measure the length of the spring and gave their answers to the nearest millimetre, 5.8 ± 0.1. Most candidates gave the correct answer for this question indicating their ability of using a rule properly to measure length.

(c) Fairly done. Even though candidates were provided with an equation to use, they failed to use it correctly to determine the extensions which were 0.4, 0.8, 1.4, 1.8, 2.3. On a positive note, the candidates maintained the consistency in recording the values in the table (to 1 decimal place).

(d) Poorly done. The main marking points for a graph are, labelling of axis, suitability of scale, plotting of points and line. Labelling of axis: most candidates failed to correctly label the axis with both the quantity and units. Suitability of scale: Some scales were inconsistent especially at the beginning which was the origin (0,0) resulting in the loss of the mark for scale. Candidates are advised to consider consistency of the scale from the origin to the end. Candidates used odd scales which made it difficult to accommodate and identify some points. Plotting of points: Some candidates lost the mark for plotting points due to complicated scales chosen that they could not read. Some candidates lost marks since they did not use the correct notations for plotting points. The acceptable notations are crosses (×) or circled dots (ʘ). No anomalous point indication allowed. Some candidates lost a mark due to circling crosses to show anomalous points. Line of best fit: Most candidates lost this mark mainly because their lines did not average the points plotted and touching the axis. Candidates are encouraged to use a sharpened pencil that makes one continuous, smooth line. NB: Centres are highly encouraged to practise candidates on how to plot and interpret graphs.

(e) Fairly done. Some candidates lost the mark due to failure to state effects of moments of force on extension. Some lost the mark due to stating effect of force on extension.

(f) Poorly done. The candidates were expected to read an extension that corresponds to 0.8 Nm. A few candidates recorded the correct value.

(g) Well done. The candidates were able to deduce that parallax error is the source of inaccuracy when measuring length.

Answer: **(b)** 5.8 **(f)** 0.8

2 **(a)** Well done. Most candidates selected the box for direct power supply which was to be used for the experiment.

(b) The question was poorly done with the majority of the candidates scoring one mark only from the four available. The candidates were expected to make a detailed description or a diagram of a complete circuit consisting of a direct current power supply, connected to the insulated wire coiled around the iron rod and a switch. Most candidates were challenged and had difficulties to draw or describe the circuit. The steel pins must be placed next to the electromagnet for the second marking point which candidates failed to show. The candidates had a misconception that the iron rod was a permanent magnet instead of electromagnet. For the third marking point the candidates were to indicate that the experiment was repeated with a different number of coiling or drawing a second circuit with a different number of turns. Most candidates forgot to write repeat, they would just write increase the number of turns and place steel pins. Lastly the candidates were to state that the strength is greater for more coiling or when more pins are picked/attracted for them to get the fourth mark. Candidates related more turns with number of pins instead of strength of the electromagnet. Some candidates were failing to write the conclusion, they would just write compare the results.

(c) Poorly done. Since the candidates were investigating the relationship between the number of coils and strength of the electromagnet, all variables that affect the strength of the electromagnet like the current, voltage, size of the rod and distance of pins to the electromagnet had to be kept constant when repeating the experiment. Most candidates wrote power or power supply, length of the wire for wire. Centres are advised to teach candidates dependent, independent and control variables.

(d) Fairly done. The candidates noted that the experiment should be repeated to check if it produces similar results. Some candidates gave responses such as increasing the number of coils and increasing power or batteries which basically are increasing the strength of the electromagnet rather than the reliability of the results.

(e) Well done. The candidates were expected to suggest any method of demagnetisation that includes heating, hitting, hammering, etc. There were some candidates who confused the electric charges with magnetic poles.

(f) Since aluminium is a non-magnetic material it will not be magnetised hence the experiment will not work. The question was done well by the candidates.

3 **(a)** The question was well done. The candidates had to find the difference between the mass of beaker + mixture and mass of empty beaker which was 19.94 g. Some candidates added the two values while others rounded the answer they got to one decimal place or two significant figures. The answer being exact to two decimal places should not be rounded off. It shows that such candidates were not aware that they were to write the answer correct to the accuracy of the instrument used.

(b) The question was fairly done. Most candidates noted that the diagram shows a filter funnel. A common wrong answer was separating funnel. Centres are advised to expose candidates to laboratory apparatus so that they are able to label them.

(c) **(i)** This question was fairly done. Most candidates lost the mark for accuracy of the burette, which required all values to be written to one decimal place. Some candidates incorrectly read the burette from the bottom not the top. Some failed to calculate the volume of acid used and to tick the best results while others swapped the initial and final readings. Candidates also lost a mark by writing units on the body of the table. There were also notable cases of candidates who could not read the burette at all. Centres are advised to expose candidates to the titration technique.

(ii) The question was well done. The average volume expected was 23.55 cm^3 or 23.6 cm^3. Candidates lost marks by failing to round off 23.55 cm^3 to 23.6 cm^3 but instead wrote 23.5 cm^3. Some also showed no skill of how the average volume is calculated. A few candidates lost marks because they failed to use the calculator properly or they might not have had calculators at all.

(d) This question was fairly done. Candidates failed to round off the answers which were obtained from calculations on the calculator. Some candidates could not use the given equation to calculate the mass. Centres are advised to teach candidates to use titration results to carry out needed calculations. Candidates should be taught how to use the calculator, and they must also be encouraged to use calculators during examinations because it was clear from their work that some did not use calculators.

Answers: **(a)** 19.94 g **(c) (ii)** 23.55 g / 23.6 g **(d)** 0.499 g / 0.500 g

(c) (i)

titration	1	2	3
final burette reading / cm^3	23.6	24.3	26.1
initial burette reading / cm^3	0.1	0.7	2.1
volume of hydrochloric acid used / cm^3	23.5	23.6	24.0
tick (✓) best results	✓	✓	

4 **(a)** Well done. Most candidates did well since they noted that solid S contained a transition metal, or it was a compound of a transition metal. There were some candidates who were specific with names at this stage giving answers such as copper ions, Iron(II) ions, aluminium ions etc. Some candidates struggled with the spelling for the word transition giving words such as transaction, transitional, transion.

(b) **(i)** Well done. Most candidates noted that a blue precipitate will be observed. Some candidates noted that a white precipitate is observed which was only credit worthy for the precipitate while the colour was wrong. Centres are advised to share the test for ions page, that is on the Science Double Award assessment syllabus, with the candidates.

(ii) Fairly done. Most candidates failed to recognise that when testing for ions, they must add a few drops and record observation, then add excess and check for solubility. Many wrote the answer for **(b)(ii)** under **(b)(i)**. Some candidates gave answers such as blue precipitate, white precipitate soluble or dissolves to form a dark blue precipitate or dark blue solution.

(c) **(i)** Fairly done. Many candidates scored a mark for recognising that the litmus paper changes to blue. However, there were some candidates who failed to recognise that the test was for a litmus paper and gave answers such as white precipitate forms, bubbles produced, smelly gas while some thought the litmus paper bleaches.

(ii) Satisfactorily done. Candidates noted that the gas was ammonia though there were some candidates who gave random gases like carbon dioxide gas, chlorine and hydrogen. Some used the name ammonium gas.

(iii) Poorly done. Candidates failed to identify the ion present. Majority of the candidates gave the answer as nitrate. There were others who gave answers such as ammonia NH^{3-}, aluminium ion and copper(II) ion. Candidates wrote the word ammonium well but gave wrong formula which made them to lose the mark. Centres must emphasise and distinguish test for nitrate and ammonium ions.

(d) **(i)** Well done. Most candidates noted that acidified barium nitrate was added to the portion. Many who scored a mark, did not state that barium nitrate is acidified. Some candidates indicated that sodium hydroxide solution or sulphuric acid should be added to the solution.

(ii) Well done. Candidates did well here with most of them noting that a white precipitate was formed.

(e) Well done. Most candidates deduced that the compound contained was copper(II) sulphate. Even though ammonium sulphate was a possible answer, very few candidates made their conclusions to name it as their compound. Most gave the formula instead of name. There were some candidates who gave answers such as copper(II) nitrate, aluminium sulphate, copper sulphate. Centres are advised to focus on the different tests for ions to help candidates to differentiate between various compounds and/or ions.

5 **(a)** **(i)** The task required candidates to draw a longitudinal section of a flower, paying close attention to clarity, realism, size, and specific details such as labelling the anther (W) and ovary (U). The evaluation criteria included precision in structure, smooth outlines, and correct identification of floral parts. The candidates did well in performing the task with most of them adhering to the requirements for the size, which had to be larger than the given photograph. Most drawings were smooth with continuous lines with minimal "woollies" (rough or unclear lines). A few candidates struggled with maintaining smoothness on the outline by leaving the stalk open, adding unnecessary shading or unclear edges. Most candidates drew diagrams that were realistic showing that the drawing was for a flower with the shape of the three petals and two sepals clearly showing, demonstrating attention to detail and realism. The drawings were generally proportional and accurately represented the floral components. There were a few candidates who drew the stamen and/or carpel only without petals and sepals. The carpel with a bulging ovary and at least four ovules on each side were well represented by the majority of the candidates. Candidates also managed to include four stamens and the stalk. A small fraction of candidates ignored key details such as the ovules or misplaced stamens. Double walls, although mentioned to be ignored, were sometimes unnecessarily included. Centres are advised to teach candidates to clearly draw details, e.g. ovules

(ii) Poorly done by most candidates as they failed to even attempt the question. Candidates who attempted the question correctly labelled the anther (W), which is the part that produces pollen grains and the ovary (U), which grows into some fruit after fertilisation. Some failed to follow instructions, writing names instead of using letters or using other letters not prescribed by the question statement. Centres advised to encourage candidates to follow instructions. Centres are advised to encourage candidates to use labelling line not arrows.

(b) (i) Poorly done by most candidates. Few candidates successfully drew the horizontal line on both the diagram and the photograph, aligning it with the longest length. Most candidates drew diagonal or vertical lines and/or non-corresponding lines leading to loss of marks.

(b) (ii) Poorly done. The candidates were expected to measure the lengths to ± 2 mm, and most were within the range of 82 mm ± 2 mm for the photograph. However, most candidates lost marks because of repeating units, expressing/presenting measurements in cm instead of mm, wrong expression of mm. When units are provided, the candidates should be made aware that they are not expected to provide their own units.

(b) (iii) The question was fairly done. Most candidates were able to access the first marking point for correct substitutions but failed to get the second marking point for the answer. The candidates could not correctly express magnification since they gave their answers to more than 1 decimal place, gave the answer without a multiplication sign while some included units in their answer.

6 (a) Well done. The majority of the candidates were able to analyse the experiments noting that starch was absent in K while in L a blue-black colour will be observed. This is an indication of starch being present in L. Some candidates gave responses such as starch was digested by amylase or starch was not digested instead of giving conclusions. Some candidates wrote negative and positive as conclusions. Under colour observed, some candidates wrote blue/black or blue or black instead of blue-black. Centres are advised to teach candidates the proper way of presenting colours.

(b) (i) Fairly done. The candidates were expected to study the variables in the experiment and determine the variables that were kept constant. Thus, the variables such as volume or concentration of starch and volume of amylase should be kept constant. Most candidates who got the question wrong gave responses such as temperature which was the variable under investigation, starch and amylase without indicating the measures (volume, concentration or amount) to be kept constant. Some candidates wrote repeat the experiment and put on a flat surface area.

(ii) Fairly done. Most candidates correctly noted that the enzymes are denatured when exposed to high temperature. There were candidates who gave responses to the effect that there was no reaction and that enzymes were killed or died. Most candidates could not relate the effect of temperature on enzyme activity to the digestion of starch (that denatured enzymes fail to digest starch). Some candidates wrote that 'if starch was present it would be brown and if not, it would be blue-black' i.e. general statement on the possible results of starch test not necessarily being specific to the question.

(iii) The question was performed well by the candidates. The candidates were able to describe the test for starch using Benedict's Solution. However, some candidates failed to describe the test correctly as they did not include a water bath in heating while some wrote place in a water bath without including heating. Some candidates wrote observe colour changes without stating the colours. Those who wrote colour changes used words such as red, reddish brown or yellowish instead of brick red and yellow respectively. Furthermore, some described the test for starch(failure to read and understand the question).