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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Chemistry and Biology 2024

92023 Demonstrate understanding of how the physical properties of materials inform their use

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of how the physical properties of materials inform their use.	Explain how the physical properties of materials inform their use.	Evaluate how the physical properties of materials inform their use.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Pull out Resource Booklet 92023R from the centre of this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

Do not write in the margins (). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Merit

TOTAL 15

Page 1

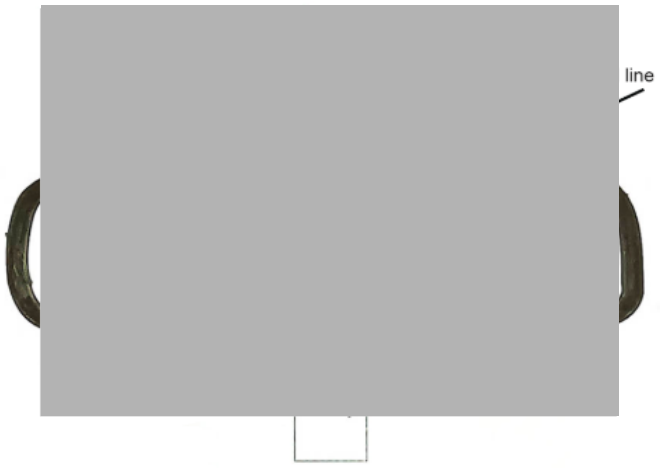
Make sure you have the paper Resource Booklet 92023R.

QUESTION ONE: Paper electrical circuits

A pencil containing graphite (carbon), C, has been used to draw an electrical circuit, which is an outline of a car.
A 9V battery and light-emitting diode (LED) are also part of the circuit.

Table 1: Physical properties of graphite (carbon), C

Physical property	Numerical values	Comment
Melting point	3 650 °C	Very high
Solubility in water	-	Insoluble
Electrical conductivity	3×10^5 σ (S / m) at 20 °C	Good
Malleability	4.80 GPa	Brittle
Hardness	1 to 2 Moh	Soft



(a) Describe TWO physical properties of graphite (carbon) and link these two physical properties to their use in drawing and creating an operating electrical circuit.

graphite is a soft material. it is also electrically conductive. graphite being soft is important for its use in drawing, as it needs to be able to have force applied to it without breaking. this allows a person drawing to be able to make a thick line on the paper without the pencil tip breaking. graphite being electrically conductive is very important when making an electrical curcuit. this is due to it needing to be able to conduct electricity for the curcuit to function. graphite needs to be electrically conductive to create a functional electrical curcuit.

(b) Explain these TWO physical properties with reference to the structure and bonding of graphite (carbon).

graphite is electrically conductive, this is due to it having delocalised electrons capable of carrying charge and moving throughout the network. graphite has delocalised electrons due to the carbons it consists of forming strong covalent bonds with three other carbons, leaving one free delocalised electron from each carbon. graphite is a soft substance, due to the weak forces between layers. these weak forces allow the layers of the graphite network to slide over each other without breaking the 2D lattice structure

(c) Evaluate how graphite (carbon) will behave when used to draw and create an operating electrical circuit by linking the TWO physical properties to the structure and bonding.

the electrical conductivity of graphite will allow for charge to transfer in the circuit that has been drawn. this is due to the delocalised electrons in graphite. these delocalised electrons are present due to the carbon atoms bonding to three other carbons, leaving one free electron. this electrical conductivity allows for the curcuit to funciton with the graphite lines, as the graphite is able to conduct electricity to act as the wires in the curcuit. the graphite will be able to used to draw a line, due to its softness. this softness is due to the weak forces between layers of the graphite network and will be able to be used in a pencil to draw the line due to the softness.

Source (adapted)

Car: Steam Powered Family. (2024). *Simple curcuit project* [Image]. steampoweredfamily.com/paper-simple-circuit-project

Arrow: [Vector image]. stock.adobe.com/770919389

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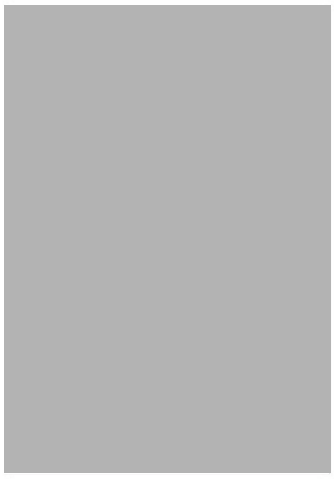
QUESTION TWO: Electrical fire

Carbon dioxide fire extinguishers can be used safely to put out electrical fires. These extinguishers are filled with non-flammable carbon dioxide, CO_2, gas.

Table 2: Physical properties of carbon dioxide and air		
Physical property	**CO_2**	**Air**
Density at 20°C (kg/m^3)	1.98	1.20
Electrical conductivity	Insulator	Insulator



A carbon dioxide fire extinguisher

(a) Describe TWO physical properties of carbon dioxide and link these two physical properties to the safe use of carbon dioxide to prevent oxygen in the air from fuelling a fire.

carbon dioxide has a low boiling point, causing it to be a gas at room temperature. the low boiling point is key as it needs to be a gas to be able spray and prevent oxygen from reaching the fire. carbon dioxide is an electrical insulator. this is key in preventing oxygen from reaching fires, as it will not allow the electricity from the electrical fire to conduct through the carbon dioxide and start another fire.

(b) Explain these TWO physical properties, with reference to the structure and bonding of carbon dioxide.

carbon dioxide is a covalent molecule. it has strong covalent bonds, with weak intermolecular forces. these weak intermolecular forces require much less energy than the covalent bonds to break. for carbon dioxide to boil, either the covalent bonds all need to be broken or all of the intermolecular forces need to be broken. the intermolecular forces require much less energy to break so much less heat energy is required. as the intermolecular forces are much weaker, the heat energy goes into breaking them, giving carbon dioxide a low boiling point and making it a gas at room temperature. carbon dioxide is not electrically conductive. this is due to it not having delocalised electrons or free to move ions. this prevents carbon dioxide from conducting electricity and makes it an electrical insulator.

(c) Evaluate how carbon dioxide will behave when used as a fire extinguisher by linking the TWO physical properties to the structure and bonding.

the carbon dioxide will spray out as a gas. this will surround the electrical fire and prevent oxygen from reaching it. this will put out the electrical fire. the carbon dioxide will be a gas at room temperature due to the low boiling point. this low boiling point is due to the weak intermolecular forces of attraction between the carbon dioxide molecules. these forces require a low amount of energy to break, so a low amount of heat energy is needed to break them. the carbon dioxide is an electrical insulator. this will stop the electricity from conducting, and creating another fire. it is an electrical insulator due to it not having any delocalised electrons or free moving ions capable of carrying charge.

Source

Extinguisher: [Photograph]. stock.adobe.com/204932761

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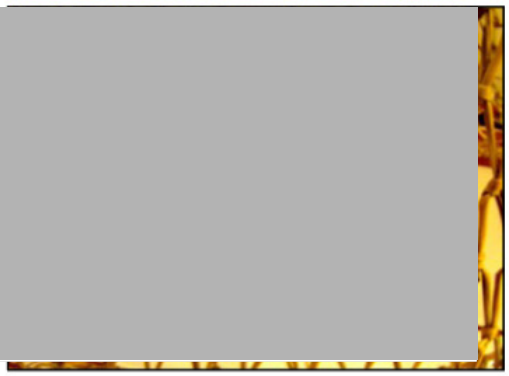
QUESTION THREE: Harakeke

Harakeke (New Zealand flax) has long upright leaves that can grow up to four metres (4 m) in length. When the green flesh is removed by scraping, a long, white fibre (**polymer**) called **muka** is revealed. This fibre can be spun or plaited.

Muka fibre is a natural polymer material.

The spun muka can be used for many things, including making a kupenga (fishing net). Kupenga could then be weighed down with stones so that the kupenga would sink.

Harakeke leaves (green) and muka fibres (white)



Kupenga made by knotting muka fibres together

Table 3: Young's modulus and solubility of various materials		
Material	**Young's modulus* GPa**	**Solubility in water**
Muka	8.6	Insoluble
Hemp	11.8	Insoluble
Wool	2.3	Insoluble
Glass	70–100	Insoluble

* A high value of Young's modulus means that a material is brittle

(a) Describe TWO physical properties of muka and link these two physical properties to their use in making a working kupenga.

muka is insolubile in water. this is very useful as fish nets need to be fully submerged for hours or even days at a time. so it needs to be insolubile so that the net does not break whilst in use. muka is also maleable. this allows for it to be shaped (woven) into nets. this is useful as it is not an extremely brittle substance so it can be mostly bent and shaped without breaking.

(b) Explain these TWO physical properties, with reference to the structure and bonding of muka.

the insolubility of muka is due to it being an non polar substance. muka is a polymer. pure water is a polar substance, meaning it will dissolve other polar substances, for example sodium chloride by the negative parts in water, oxygen being attracted to the positive parts of a the substance for this example the sodium . the positive molecules in water will be attracted to the negative parts of a substance in this example the chlorine ions. this allows water to seperate polar substances. muka is a polymer, which has no charge as all valence electrons are used in the strong covalent bonds it consists of. this causes muka to be insolubile in water. muka is a maleable substance, due to the weak forces between the polymer chains. this allows for the chains to be moved closer or further apart without substantial energy. the chains in muka will repel if they get to close, breaking the structure, causing for it to have a slight brittleness.

(c) Evaluate how muka will behave when used as a kupenga by linking the TWO physical properties to the structure and bonding.

the muka will work well under water, as it is insolubile in water. this will cause it to not dissolve, keeping its strength underwater. this will allow it to catch fish, as the net will not be weakened by prolonged exposure to the water. the slight maleability will allow for the fish to struggle, as the net can bend slightly before breaking. the muka is insolubile in pure water, as it is non polar and water is polar, only allowing it to dissolve other polar substances. this is due to the nature of the covalent bonds in the polymer, all electrons are used in the bonding, leaving no partial charges in the polymer. the maleability of muka is due to it having weak forces between chains. this allows for the chains to be moved closer or apart slightly without breaking, although if they get too close they will repel each other, causing for the muka to break. this slight maleability allows for muka to make effective nets.

Merit

Subject: Chemistry and Biology

Standard: 92023

Total score: 15

Q	Grade score	Marker commentary
One	M6	Described that graphite has good electrical conductivity and is soft. Described that graphite is a network with strong covalent bonds between carbon atoms and weak intermolecular forces of attraction between the layers. Electrical conductivity in graphite has been linked to the arrangement of carbon atoms and the presence of delocalised electrons. Softness has been linked to the weak forces between the graphite layers allowing them to slide over each other without breaking the lattice.
Two	M5	Described that carbon dioxide is a poor electrical conductor. Carbon dioxide has been identified as a covalent molecule that has strong covalent bonds, with weak intermolecular forces. Poor electrical conductivity has been linked to the absence of delocalised electrons / ions capable of carrying a charge.
Three	A4	Malleability and insolubility have been described as the two physical properties of muka. Explained that muka being insoluble, it will not dissolve the net. Stated that the net must be strong under water to allow it to catch fish.