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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Chemistry and Biology 2025

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 2–15 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.

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QUESTION ONE

Low-density polyethylene (LDPE) is a type of polymer that can be used to make the body of a kayak.

(a) Define the term polymer.

LDPE is widely used due to its versatility, moisture resistance, and low melting point. It is characterised by its low density and flexibility.

A kayak needs to be buoyant and insoluble in water, so it can float on the water with kayakers.

Figure 1: Carbon, C, and hydrogen, H, bonds form long chains and branches in LDPE

Figure 2: Skeleton structure of LDPE (top) compared with the related high-density polyethylene (HDPE) (bottom)

(b) Explain how the structure and bonding of LDPE results in a low-density polymer that is suitable for use in kayaks.

A kayaker is looking for a new kayak made out of stronger and harder carbon fibre sheets.

Figure 3 shows three layers of carbon fibre sheets, with a close-up of the atomic structure of the planes of carbon atoms that make up these layers.

Figure 3: Layers of carbon fibre sheets, with close-up of atomic structure

(c) (i) Select (✔) the type of material a carbon fibre sheet is.

☐ covalent network ☐ ionic material ☐ metallic solid

☐ molecular substance ☐ polymer

(ii) Explain why the structure and bonding within a carbon fibre sheet results in a kayak that is hard and strong.

QUESTION TWO

The shaft of a kayak paddle is made of aluminium, Al.

(a) (i) Select (✔) the type of material aluminium, Al, is.

- ☐ covalent network
- ☐ ionic material
- ☐ metallic solid
- ☐ molecular substance
- ☐ polymer

(ii) How does the structure and bonding of aluminium, Al, allow it to be malleable, forming the long, hollow tube of the shaft of the paddle?

Figure 4 shows aluminium, Al, and the alloying of aluminium and magnesium, Mg.

Figure 4: The alloying process of aluminium and magnesium

(b) (i) Define the term alloy.

(ii) Explain how adding magnesium, Mg, to aluminium, Al, to make an alloy, changes the malleability of the material.

Table 1 shows the physical properties of aluminium, Al, and two different alloys that could be used for a kayak paddle.

The shaft of a kayak paddle is formed of a long, hollow tube. It needs to:

- float if it is dropped into the water
- be hard enough to pull the blades through the water
- be light enough for a kayaker to lift and use.

Table 1: Density and hardness of substances

Substance	Density	Relative hardness
Pure aluminium	$2.7\,g/cm^3$	Low
Aluminium and magnesium alloy	$2.60–2.7\,g/cm^3$	Medium
Steel (iron and carbon alloy)	$7.75\,g/cm^3$	High

(c) Using the information in Table 1 and your knowledge of structure and bonding of materials, discuss why an aluminium and magnesium alloy would be preferred over both pure aluminium and steel (iron and carbon alloy) as the material used for kayak paddles.

QUESTION THREE

Sea water is made up of water, H_2O, and salt, NaCl. Figure 5 shows the structure and bonding of the individual substances.

Figure 5: Structure and bonding of water, H_2O (left), and salt, NaCl (right)

(a) (i) Select (✔) the type of material water, H_2O, is.

- ☐ covalent network
- ☐ ionic material
- ☐ metallic solid
- ☐ molecular substance
- ☐ polymer

(ii) Select (✔) the type of material salt, NaCl, is.

- ☐ covalent network
- ☐ ionic material
- ☐ metallic solid
- ☐ molecular substance
- ☐ polymer

White solid salt, NaCl, is visibly left behind on the surface of the sea kayak. The salt is brittle, and it crumbles easily when touched.

(b) Explain how the arrangement of particles in salt, NaCl, and the attractive forces between these particles leads to this brittleness.

(c) Explain how the properties and attractive forces of water, H_2O, and salt, NaCl, allow for water to visibly remove the salt from the surface of the sea kayak.

Question Three continues on the next page ➤

A plastic bottle floats on the sea water. The plastic bottle contains both air and fresh water. Table 2 shows the density of each of the materials.

Table 2: Density and arrangement of particles of materials

	Types of material			
	Sea water	**Fresh water**	**Plastic bottle**	**Air**
Density	1.02–1.03 g / cm^3	~1 g / cm^3	0.94–0.965 g / cm^3	0.0012 g / cm^3
Arrangement of particles	Mixture containing both sodium chloride and water	Pure substance (water molecules)	Pure substance (long chain molecules)	Mixture (gaseous molecules and atoms)

(d) Using the information in Table 2 and your own knowledge of properties of materials, explain why the plastic bottle containing both air and fresh water floats on sea water.

Extra space if required.
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QUESTION NUMBER

Acknowledgements

Material from the following sources have been adapted for use in this assessment:

Page 2 https://stock.adobe.com/76309374 (kayak); https://ik.imagekit.io/v2onc6i6hiu/content/Polymers-LDPE.png (Fig. 1)

Page 3 Impact Consumer Products Group. (2017, September 28). *Learn about your packaging materials: 5 facts about low density polyethylene*. https://blog.impactplastics.co/blog/learn-about-your-plastic-sheet-5-facts-about-low-density-polyethylene (Fig. 2)

Page 4 Dambrot, S.M. (2016, April). [Image] Figure 3 from *Chemistry helps athlete keep moving*, American Chemical Society. https://www.acs.org/education/chemmatters/past-issues/2015-2016/april-2016 (Fig. 3)

Page 5 https://stock.adobe.com/123068147 (paddle)

Page 6 Nagwa. [Image] from *Lesson explainer: Alloys*. https://www.nagwa.com/en/explainers/210181727968 (Fig. 4)

Page 8 Water. [Image] https://s3-us-west-2.amazonaws.com/courses-images-archive-read-only/wp-content/uploads/sites/887/2015/05/23213524/CNX_Chem_10_01_HBonding.jpg; Hydrogen. priyamstudycentre.com. [Image] Hydrogen. https://www.priyamstudycentre.com/wp-content/uploads/2022/06/Sodium-chloride-uses-chemical-formula-and-crystal-structure-of-NaCl-salt.png

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