

**Assessment Schedule – 2025****Chemistry and Biology: Demonstrate understanding of how the physical properties of materials inform their use (92023)****Assessment Criteria**

<b>Achievement</b>	<b>Achievement with Merit</b>	<b>Achievement with Excellence</b>
<p><i>Demonstrate understanding of how the physical properties of materials inform their use involves:</i></p> <ul style="list-style-type: none"> <li>describing the use of materials with reference to their physical properties</li> <li>describing the physical properties of materials, with reference to the arrangement of particles and the relative strength of attractive forces between the particles.</li> </ul>	<p><i>Explain how the physical properties of materials inform their use involves:</i></p> <ul style="list-style-type: none"> <li>explaining the physical properties and use of the materials in relation to the arrangement of particles and the relative strength of attractive forces between the particles.</li> </ul>	<p><i>Evaluate how the physical properties of materials inform their use involves:</i></p> <ul style="list-style-type: none"> <li>evaluating how materials behave when used, by linking physical properties to the arrangement of particles in the materials and the relative strength of attractive forces between the particles.</li> </ul>

**Cut Scores**

<b>Not Achieved</b>	<b>Achievement</b>	<b>Achievement with Merit</b>	<b>Achievement with Excellence</b>
0–6	7–12	13–18	19–24

## Evidence

Question One	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
(a)	A polymer is a large / long chain molecule made from many small units / repeating units / monomers.	<ul style="list-style-type: none"> <li>Defines polymer.</li> </ul>		
(b)	Polyethylene is made of long, branched chains of covalently bonded carbon atoms with weak intermolecular forces between the chains. The branched chains of the polymer and weak forces of attraction between the molecules mean that the chains are not packed tightly together, so the density of polyethylene is low. The density of the kayak is less than water, enabling it to float on the surface of the water.	<ul style="list-style-type: none"> <li>Describes the weak intermolecular bonds between molecules / chains. <i>OR</i> Describes covalent bonds between C atoms / monomers.</li> <li>Identifies that branched chains have low density.</li> <li>Identifies that the kayak won't dissolve.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the structure and bonding of polyethylene related to density <i>OR</i> solubility.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the structure of polyethylene related to density <i>AND</i> use in a kayak.</li> </ul>
(c)(i)	Covalent network	<ul style="list-style-type: none"> <li>Identifies the type of substance.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies the type of substance. <i>AND</i> Explains the structure and bonding.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies the type of substance, explains the structure and bonding, linking to the strength of covalent bonding. <i>AND</i> Identifies the force needed to break the bond so that the kayak can withstand weight.</li> </ul>
(ii)	Graphite is a 2D network of carbon atoms held together by strong covalent bonds. Each carbon atom is covalently bonded to three other carbon atoms in layers of hexagonal rings, with (weak forces of attraction between the hexagonal layers in the carbon fibre sheets). The covalent bonds between the carbon atoms in the lattice are strong and require a lot of force / energy to break, enabling the kayak to withstand the weight of kayakers without deforming.	<ul style="list-style-type: none"> <li>Identifies that a 2D network structure / one C atom is joined to three other C atoms within the layer. <i>OR</i> Identifies that a 2D network is strong. <i>OR</i> Identifies that a large force / energy is needed to break the bond.</li> </ul>	<ul style="list-style-type: none"> <li>Explains that strong covalent bonds require large force / energy to break.</li> </ul>	

N1	N2	A3	A4	M5	M6	E7	E8
ONE evidence point at Achievement.	TWO evidence points at Achievement.	THREE evidence points at Achievement.	FOUR evidence points at Achievement.	TWO evidence points at Merit.	THREE evidence points at Merit.	ONE evidence point at Excellence.	TWO evidence points at Excellence.

**N0** = No response; no relevant evidence.

Question Two	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
(a)(i)	Metallic solid	<ul style="list-style-type: none"> <li>Identifies the type of substance.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies the type of substance.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies the type of substance.</li> </ul>
(ii)	<p>Aluminium is made up of a 3D network of metal atoms / cations surrounded by delocalised / free-moving electrons. The atoms / cations are held together by strong (non-directional) metallic bonds between the metal atoms / cations and delocalised electrons. Aluminium is malleable – when a force is applied, metal atoms / cations slide over each without breaking the attraction between the delocalised electrons of the metal atoms / cations, allowing the aluminium to be shaped into a hollow tube and used as a shaft for the paddle.</p>	<ul style="list-style-type: none"> <li>Describes the metallic bond (electrostatic attraction) OR structure (delocalised electrons).</li> </ul>	<p><i>AND</i></p> <p>Explains the structure and bonding.</p> <ul style="list-style-type: none"> <li>Explains how atoms slide over each other when force is applied, without breaking the attraction and allowing malleability.</li> </ul>	<p><i>AND</i></p> <p>Explains the structure and bonding, linking to malleability.</p> <p><i>AND</i></p> <p>Links to use in paddle shaft.</p>
(b)(i)	An alloy is a mixture of metal(s) and other element(s) (M+M or M+NM).	<ul style="list-style-type: none"> <li>Defines alloy.</li> <li>Identifies that the alloy is less malleable / aluminium is more malleable.</li> </ul>	<ul style="list-style-type: none"> <li>Defines alloy and identifies that the alloy is less malleable as atoms / cations are <b>different sizes</b> so less able to slide over each other (or <b>more force is needed</b> to slide).</li> </ul> <p><i>OR</i></p> <ul style="list-style-type: none"> <li>Defines alloy and identifies that aluminium is more malleable as atoms / cations are <b>the same size</b> so can easily slide over each other (or <b>less force is needed</b> to slide).</li> </ul>	
(ii)	<p>Aluminium is more malleable than the alloy because aluminium is made up of atoms / cations that are all the same size. This allows one layer of pure aluminium atoms to slide over another layer of aluminium metal atoms easily without breaking the attraction between the metal atom / cations and the delocalised electrons.</p> <p>Alloys are less malleable because they are made up of at least two different types of atoms / cations of different sizes. The magnesium atoms / cations are larger than the aluminium atoms / cations, so when a force is applied, it is harder to push the irregular arrangement of atoms / cations over each other without breaking the metallic bond / attractive forces, making the alloy less malleable.</p>			

(c)	<p>A kayak paddle / shaft needs to be hard enough to not flex / bend as a force is applied as the paddle / blade moves the water, and be light enough to hold while paddling.</p> <p>Aluminium and steel alloys are harder than pure aluminium as alloys contain atoms of different sizes, which disrupts the regular arrangement of atoms in the crystal / 3D lattice, making it more difficult for layers of atoms to slide over each other. The differently sized atoms 'lock' the structure in place, preventing easy movement. While steel is the hardest of the three substances and can most easily withstand the force of water on the paddle, it is also the heaviest as it is the most dense.</p> <p>The particles in steel are tightly packed and have the highest mass per unit volume, which would make the paddle heavy when paddling for a long time. The density of aluminium and its alloy is very similar, indicating the particles in both substances are tightly packed with strong forces of attraction between the metal atoms / cations and the delocalised electrons. The alloy is harder than pure aluminium, meaning it can more easily withstand the force of water.</p>	<ul style="list-style-type: none"> <li>Identifies that aluminium is too soft / will deform.</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Identifies that steel is too dense/heavy.</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Identifies that the alloy has medium hardness and lowest density.</li> </ul>	<ul style="list-style-type: none"> <li>Explains density OR hardness of the alloy in terms of structure.</li> </ul> <p>(Hardness: size of atom; density: number of particles in a volume.)</p>	<ul style="list-style-type: none"> <li>Justifies behaviour of the aluminium alloy when used as a paddle in comparison to pure aluminium and steel.</li> </ul>
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N1	N2	A3	A4	M5	M6	E7	E8
ONE evidence point at Achievement.	TWO evidence points at Achievement.	THREE evidence points at Achievement.	FOUR evidence points at Achievement.	TWO evidence points at Merit.	THREE evidence points at Merit.	ONE evidence point at Excellence.	TWO evidence points at Excellence.

**N0** = No response; no relevant evidence.

Question Three	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
(a)(i)	Molecular substance	<ul style="list-style-type: none"> <li>Identifies the type of substance.</li> </ul>		
(ii)	Ionic material	<ul style="list-style-type: none"> <li>Identifies the type of substance.</li> </ul>		
(b)	Sodium chloride / salt is made up of a 3D lattice of oppositely charged $\text{Na}^+$ and $\text{Cl}^-$ ions, with strong ionic bonds / attractive forces between them. This structure is brittle because the strong bonds are (directional) / do not allow for flexibility. If a stress is applied to a salt crystal, the ion layers shift slightly, bringing ions of the same charge together. The like-charged ions repel, and the 3D lattice shatters / crumbles as it falls apart.	<ul style="list-style-type: none"> <li>Describes the structure.</li> <li>Describes the bonding.</li> <li>Identifies that like-charges repel.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the structure and bonding in solid.</li> <li>Explains that when force is applied, like-ions line up, repel, and shatter.</li> </ul>	
(c)	Sodium chloride is an ionic solid that is soluble in water. The attraction between the water molecules and the $\text{Na}^+$ and $\text{Cl}^-$ ions is stronger than the forces of attraction between the oppositely charged ions within the 3D lattice of sodium and chloride ions and the weaker attraction between neighbouring water molecules. The positive end of water molecules will surround the $\text{Cl}^-$ ion and pull it out from the lattice. The negative end of water molecules will surround the $\text{Na}^+$ ion and pull it out from the lattice structure. As a result, the ions will float among the water particles. The dissolved ions are no longer packed closely together, as they were in the solid (so are not visible). Solid salt, $\text{NaCl}$ , is now dissolved / no longer visible / observable.	<ul style="list-style-type: none"> <li>Identifies that <math>\text{NaCl}</math> / salt is soluble / dissolvable.</li> <li>Describes attractive forces of <math>\text{Na}^+</math> and <math>\text{Cl}^-</math> in salt OR <math>\text{H}_2\text{O}</math> to ions in the solid / lattice.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the strength of the attractive forces of <math>\text{Na}^+</math> and <math>\text{Cl}^-</math> ions AND <math>\text{H}_2\text{O}</math> to ions in the solid / lattice.</li> </ul>	<ul style="list-style-type: none"> <li>Compares the strength of the attractive forces of <math>\text{Na}^+</math> and <math>\text{Cl}^-</math> ions, <math>\text{H}_2\text{O}</math> to ions in the solid AND links to salt dissolved / no longer visible.</li> </ul>
(d)	The density of sea water is greater than the density of fresh water, air and plastic, so the drink bottle will float. The strongest force of attraction is between the sodium and chloride ions and water molecules in the sea water. This means the mass / unit volume is greater than fresh water, where the attraction between neighbouring water molecules is weak. The plastic bottle is made of long chain molecules (polymers). The forces between the molecules are weak, and the length of the long chains mean that they do not pack as tightly together, causing the plastic bottle to have a lower density than both sea and fresh water. The air in the bottle contains a mixture of atoms and water molecules, with little / no attractive forces between the molecules / atoms. As they are in the gaseous state, particles are far apart and will fill all the space in the bottle.	<ul style="list-style-type: none"> <li>Identifies that sea water is more dense than the plastic bottle. OR Identifies that the plastic bottle is less dense than sea water.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the attractive forces and particles of TWO of the substances of: water molecules, plastic polymer, air, and / or sea water.</li> </ul>	<ul style="list-style-type: none"> <li>Compares the relative strength of the attractive forces of all FOUR particles AND makes links as to why the bottle floats in sea water.</li> </ul>

	This means that air has the least mass / unit volume, so air has the lowest density of all four substances. Therefore, the bottle will float in sea water.			
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