Materials From Within

Connect molecular structure, forces, and designed material functions.

HS-PS2-6 "Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each molecular-level structural feature. Circle each statement about attraction or repulsion, then write 1, 2, or 3 beside places where the text connects structure, force, and material function.

Forces Build Useful Materials

(1) Engineers choose materials by looking below the visible scale. At the molecular level, particles attract or repel one another because of electric charges and electron arrangements. Attractive forces pull particles together, while short-range repulsion prevents atoms from occupying the same space. Those forces affect whether a material carries charge, bends, stretches, or attaches to a target. A structure is not a tiny decoration inside a material. It determines which particles can move and which attractions hold the material together. Scientific communication links a structural feature to a force, then connects that force to a useful property. For example, a bridge cable needs a different molecular arrangement from a skin patch that delivers medicine.

(2) Metal wires conduct electricity because their atoms form a closely packed lattice with positive metal ions and delocalized electrons. The delocalized electrons are not fixed to one atom. When a voltage creates an electric field, these electrons can move through the lattice and carry electric charge. Attractive forces between the positive ions and the shared electrons help keep the solid metal together. The same structure gives engineers a material that is both conductive and shapeable into wires. A ceramic may contain charged particles too, but electrons are usually held in bonds or ions, so they cannot move freely through the solid.

(3) A reusable food-container seal uses a polymer made of long molecular chains. Within each chain, strong covalent bonds keep the atoms connected. Between neighboring chains, weaker attractions allow sections of the chains to slide when the seal is bent or pressed. The chains also become tangled, and many attractions act together, so the material does not pull apart easily. This combination makes the seal flexible but durable. If the chains were short and had few attractions between them, the material would flow or tear more easily. If attractions between chains were much stronger, the seal would be stiffer and harder to bend.

2 ANSWER WITH EVIDENCE

Use the passage

1. How does the structure of a metal wire allow it to conduct electricity?

2. What attractive interaction helps a metal wire remain a solid while its electrons move through it?

3. Explain how the long-chain structure of the polymer seal makes it both flexible and durable.

4. Predict how the seal would change if attractions between its polymer chains became much stronger.

3 YOUR TURN

Your own words

A rain-jacket coating has a fluorine-rich outer surface. Water molecules are weakly attracted to this surface, and strong covalent carbon-fluorine bonds hold the coating molecules together. Write exactly three sentences that explain how this molecular structure and these forces help the jacket resist wetting.

ANSWER KEY

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HIGH SCHOOL · HS-PS2-6

PART 1 · READ AND MARK

Underline each molecular-level structural feature. Circle each statement about attraction or repulsion, then write 1, 2, or 3 beside places where the text connects structure, force, and material function. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How does the structure of a metal wire allow it to conduct electricity?	**Its delocalized electrons are not fixed to individual atoms, so an electric field can move them through the metal lattice to carry charge.**
2	What attractive interaction helps a metal wire remain a solid while its electrons move through it?	**Attraction between positive metal ions and the shared, delocalized electrons helps hold the metal together.**
3	Explain how the long-chain structure of the polymer seal makes it both flexible and durable.	**Weaker attractions between chains allow sections to slide when bent, while tangled long chains and many attractions keep the material from pulling apart easily.**
4	Predict how the seal would change if attractions between its polymer chains became much stronger.	**It would become stiffer and harder to bend.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The coating has a fluorine-rich outer surface whose atoms attract water molecules only weakly. Water molecules attract one another more strongly than they attract this surface, so they form droplets instead of spreading across the fabric. Strong covalent carbon-fluorine bonds help the coating remain stable, and the weak water-surface attraction helps the jacket resist wetting.

Accept equivalent explanations that accurately connect a stated molecular feature to attractive or repulsive forces and then to a material function. For the open task, require all three links: fluorine-rich surface, weak attraction to water or water beading, and resistance to wetting.