

Zoe's Time-Travel Quest: Properties of Matter

Grade 5

science

time-travelers

Students will identify and compare physical properties of matter — including mass, volume, density, solubility, and state — to classify and distinguish substances.

Name: _____

Date: _____

1. Zoe lands in ancient Egypt and finds a rare find — a small gold scarab. She holds it in one hand and a feather in the other. Both objects are the same size. Zoe notices the scarab feels much heavier. Which physical property is Zoe comparing? Circle the correct answer: (A) Color (B) Mass (C) Texture (D) Solubility

2. Zoe drops the gold scarab into a cup of water in the pharaoh's lab. The scarab sinks straight to the bottom. True or False: Sinking shows that the scarab is denser than water. Write TRUE or FALSE and one sentence explaining why.

3. Zoe travels to ancient Rome and discovers a hidden treasure — a chest of mystery powders. She stirs one powder into warm water and it disappears completely. She stirs a second powder and it stays as white clumps on the bottom. Identify the property Zoe is testing. Then explain which powder is soluble and which is not.

4. Inside the Roman chest, Zoe finds a unique item — a clay tablet listing properties of three materials. Use the table to answer: Material A — shiny, hard, conducts heat. Material B — dull, soft, does not conduct heat. Material C — clear, hard, does not conduct heat. Zoe needs a material that conducts heat AND is hard. Which material should she choose? Explain using two properties from the table.

5. Zoe heats a special object — a block of Roman beeswax — over a flame. The solid beeswax slowly becomes a liquid. Zoe writes in her journal: 'A new substance was created when the wax melted.' Is Zoe's journal entry correct? Explain whether melting is a physical or chemical change and why.

6. Zoe travels to medieval Japan and finds a rare find — a mystery alloy sword. She records these properties: mass = 2,400 g, volume = 300 cm³. She also tests pure iron: mass = 2,370 g, volume = 300 cm³. Density = mass ÷ volume. Calculate the density of each metal. Then explain which metal is denser and what that tells Zoe about their identities.

7. Zoe lowers the mystery alloy sword into the Roman aqueduct (water, density = 1.0 g/cm³) and then into a vat of liquid mercury (density = 13.6 g/cm³). The sword has a density of 8.0 g/cm³. Predict what happens in EACH liquid. Then explain your reasoning using the rule: objects sink when denser than the liquid, and float when less dense.

8. Zoe returns to the present day with her rare find — the mystery alloy sword — and presents it to a materials scientist. The scientist says physical properties alone may not be enough to fully identify a pure substance versus a mixture. Zoe has already measured density (8.0 g/cm³), solubility (does not dissolve in water), melting point (1,425°C), and conductivity (conducts electricity). Name TWO additional physical properties Zoe could measure. For each one, explain how that measurement could help the scientist decide if the sword is a pure substance or a mixture of metals. Use what you know about characteristic properties.

Answer Key: Zoe's Time-Travel Quest: Properties of Matter

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Before Q6, pause and ask students to predict whether Zoe's mystery alloy will sink or float in the Roman aqueduct — this activates density reasoning and ties directly to the worksheet's challenging questions.

1. Zoe lands in ancient Egypt and finds a rare find — a small gold scarab. She holds it in one hand and a feather in the other. Both objects are the same size. Zoe notices the scarab feels much heavier. Which physical property is Zoe comparing? Circle the correct answer: (A) Color (B) Mass (C) Texture (D) Solubility

Answer: Zoe is lifting two objects of equal size and noticing one feels heavier. Feeling how heavy something is = measuring mass. Color, texture, and solubility are not measured by lifting. Answer: (B) Mass

2. Zoe drops the gold scarab into a cup of water in the pharaoh's lab. The scarab sinks straight to the bottom. True or False: Sinking shows that the scarab is denser than water. Write TRUE or FALSE and one sentence explaining why.

Answer: TRUE. When an object sinks, it means the object's density is greater than the liquid's density. Gold has a density of about 19.3 g/cm^3 , which is much greater than water's density of 1 g/cm^3 , so the scarab sinks. Answer: TRUE — the scarab sinks because its density is greater than water's density.

3. Zoe travels to ancient Rome and discovers a hidden treasure — a chest of mystery powders. She stirs one powder into warm water and it disappears completely. She stirs a second powder and it stays as white clumps on the bottom. Identify the property Zoe is testing. Then explain which powder is soluble and which is not.

Answer: Zoe is testing solubility — the ability of a substance to dissolve in a liquid. Powder 1 dissolves completely → it IS soluble in water. Powder 2 stays as clumps → it is NOT soluble (insoluble) in water. Solubility is a physical property because no new substance is formed during dissolving. Answer: Zoe is testing solubility. Powder 1 is soluble; Powder 2 is insoluble.

4. Inside the Roman chest, Zoe finds a unique item — a clay tablet listing properties of three materials. Use the table to answer: Material A — shiny, hard, conducts heat. Material B — dull, soft, does not conduct heat. Material C — clear, hard, does not conduct heat. Zoe needs a material that conducts heat AND is hard. Which material should she choose? Explain using two properties from the table.

Answer: Step 1 — Identify the required properties: conducts heat AND hard. Step 2 — Check each material: Material A: shiny, HARD, CONDUCTS HEAT — matches both. Material B: dull, soft, does not conduct heat — matches neither. Material C: clear, hard, does not conduct heat — matches only one. Step 3 — Material A is the only match for both properties. Answer: Zoe should choose Material A because it is hard AND conducts heat, satisfying both required properties.

5. Zoe heats a special object — a block of Roman beeswax — over a flame. The solid beeswax slowly becomes a liquid. Zoe writes in her journal: 'A new substance was created when the wax melted.' Is Zoe's journal entry correct? Explain whether melting is a physical or chemical change and why.

Answer: Zoe's journal entry is INCORRECT. Melting is a physical change, not a chemical change. The beeswax changes its state from solid to liquid, but no new substance is formed — the molecules of beeswax remain the same. If Zoe let the liquid cool, it would return to solid beeswax. Because the identity of the substance stays the same, this is a physical change. Answer: Zoe is wrong — melting is a physical change because no new substance forms and the change can be reversed.

6. Zoe travels to medieval Japan and finds a rare find — a mystery alloy sword. She records these properties: mass = 2,400 g, volume = 300 cm³. She also tests pure iron: mass = 2,370 g, volume = 300 cm³. Density = mass ÷ volume. Calculate the density of each metal. Then explain which metal is denser and what that tells Zoe about their identities.

Answer: Step 1 — Calculate density of mystery alloy: $2,400 \text{ g} \div 300 \text{ cm}^3 = 8.0 \text{ g/cm}^3$. Step 2 — Calculate density of pure iron: $2,370 \text{ g} \div 300 \text{ cm}^3 = 7.9 \text{ g/cm}^3$. Step 3 — Compare: 8.0 g/cm^3 (alloy) > 7.9 g/cm^3 (iron). Step 4 — The mystery alloy is denser than pure iron. Because density is a characteristic property, the alloy contains at least one element denser than iron — possibly nickel (8.9 g/cm^3) or cobalt (8.9 g/cm^3). The alloy and pure iron are different substances. Answer: Mystery alloy density = 8.0 g/cm^3 ; pure iron density = 7.9 g/cm^3 . The alloy is denser, which means it is a different substance from pure iron.

7. Zoe lowers the mystery alloy sword into the Roman aqueduct (water, density = 1.0 g/cm³) and then into a vat of liquid mercury (density = 13.6 g/cm³). The sword has a density of 8.0 g/cm³. Predict what happens in EACH liquid. Then explain your reasoning using the rule: objects sink when denser than the liquid, and float when less dense.

Answer: Step 1 — Compare sword density (8.0 g/cm^3) to water density (1.0 g/cm^3): $8.0 > 1.0 \rightarrow$ sword is DENSER than water \rightarrow sword SINKS in water. Step 2 — Compare sword density (8.0 g/cm^3) to mercury density (13.6 g/cm^3): $8.0 < 13.6 \rightarrow$ sword is LESS DENSE than mercury \rightarrow sword FLOATS in mercury. Step 3 — This is remarkable because the same object sinks in one liquid and floats in another, proving that floating/sinking depends on the relationship between two densities, not just the object alone. Answer: The sword sinks in water ($8.0 > 1.0 \text{ g/cm}^3$) and floats in mercury ($8.0 < 13.6 \text{ g/cm}^3$). The same object can both sink and float depending on which liquid surrounds it.

8. Zoe returns to the present day with her rare find — the mystery alloy sword — and presents it to a materials scientist. The scientist says physical properties alone may not be enough to fully identify a pure substance versus a mixture. Zoe has already measured density (8.0 g/cm^3), solubility (does not dissolve in water), melting point ($1,425^\circ\text{C}$), and conductivity (conducts electricity). Name TWO additional physical properties Zoe could measure. For each one, explain how that measurement could help the scientist decide if the sword is a pure substance or a mixture of metals. Use what you know about characteristic properties.

Answer: Step 1 — Recall that characteristic properties (density, melting point, boiling point) have exact values for pure substances. Mixtures often show a range of values rather than a sharp single value. Step 2 — Additional property 1: MELTING POINT SHARPNESS / MELTING RANGE. A pure metal melts at one exact temperature (e.g., pure iron at $1,538^\circ\text{C}$). A mixture (alloy) melts over a RANGE of temperatures. If Zoe heats the sword and it melts gradually across a range rather than all at once, this is strong evidence it is a mixture of metals, not a single pure element. Step 3 — Additional property 2: MAGNETIC PROPERTIES / RESPONSE TO A MAGNET. Different metals have different magnetic responses — iron is strongly magnetic, while nickel is weakly magnetic and copper is not magnetic. By testing how strongly the sword is attracted to a magnet and comparing it to known pure metals, Zoe can narrow down which metals are present in the alloy. Step 4 — Narrative closure: Armed with all this property data, Zoe and the scientist successfully identify the sword as an alloy of iron and nickel — matching the density of 8.0 g/cm^3 — solving the mystery of the medieval Japanese rare find and completing Zoe's time-travel mission. Answer: (1) Melting point range — a pure substance melts sharply at one temperature; a mixture melts over a range, revealing it is an alloy. (2) Magnetic response — comparing the sword's attraction to a magnet against known pure metals helps identify which elements make up the mixture. Together, these properties complete Zoe's identification of the sword as an iron-nickel alloy.