Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Core: \_\_\_\_\_\_

1. Which are composed of atoms? (Mark all that apply.)

\_\_\_ A desk is composed of atoms.

\_\_\_ Air is composed of atoms.

\_\_\_ A shadow is composed of atoms.

\_\_\_ Water is composed of atoms.

\_\_\_ An idea is composed of atoms.

1. A particle is so small you can’t see it with your eye or feel it resting on your palm.

An object made of 1,000 of these particles has about as much mass as a paperclip.

A single particle (that you can’t see or feel) would have a mass of

\_\_\_ nothing. \_\_\_ a little.

1. Pretend you can see the atoms in a tiny metal block:

What is between the atoms of metal? (Mark all that apply.)

\_\_\_ oxygen atoms

\_\_\_ nitrogen atoms

\_\_\_ air

\_\_\_ nothing

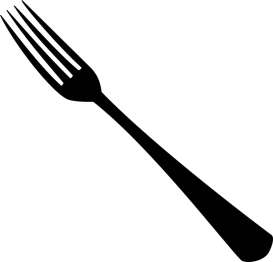
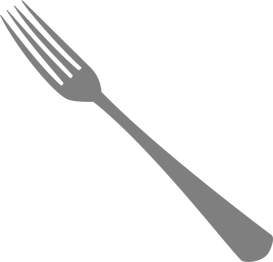
1. If the object below is divided exactly in half, draw the new particle diagram for each of the halves.

→

1. A plastic fork and a metal fork are the same size and shape. It is very likely that

\_\_\_ one fork has more mass than the other.

\_\_\_ the forks have the same mass.

1. You are given two solid objects, one very large and one very small. Both objects have masses of 25 grams.

25 g

25 g

Please explain how they can have the same mass: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Cut a block of gold into two equal pieces.

Fine Gold

U. S. Mint

Fine

U. S.

Gold

Mint

Each half will have Each half will have

\_\_\_ half the mass of the full block. \_\_\_ half the volume of the full block.

\_\_\_ twice the mass of the full block. \_\_\_ twice the volume of the full block.

\_\_\_ the same mass as the full block. \_\_\_ the same volume as the full block.

\_\_\_ no mass at all. \_\_\_ no volume at all.

Each half will have

\_\_\_ half the density as the full block.

\_\_\_ twice the density of the full block.

\_\_\_ the same density as the full block.

\_\_\_ no density at all.

1. A stick of string cheese has a volume of 4 cm³ and has a mass of 8 g. What is the density of the string cheese? \_\_\_\_\_\_

Mass: 8 g Volume: 4 cm³

1. Sarah finds a golden coin on the beach. Her friend thinks it might be solid gold, but Sarah is not so sure. She measures its volume to be 3 cm3 and its mass to be 26 g.

Is the coin solid gold? (See the table.) \_\_\_\_ Yes, it is gold. \_\_\_\_ No, it is not gold.

Please explain how you determined your answer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Material** | Brass | Copper | Gold | Lead | Steel |
| **Density (g/cm3)** | 8.7 | 8.9 | 19.3 | 11.3 | 7.9 |

Name: \_\_\_Key\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Core: \_\_\_\_\_\_

Note that this instrument uses 1/0 scoring, i. e., each item is simply scored as correct or incorrect.

1. (1 point) Which are composed of atoms? (Mark all that apply.) 1 = completely correct

\_X\_ A desk is composed of atoms. 0 = at least one error

\_X\_ Air is composed of atoms.

\_\_\_ A shadow is composed of atoms.

\_X\_ Water is composed of atoms.

\_\_\_ An idea is composed of atoms.

1. (1 point) A particle is so small you can’t see it with your eye or feel it resting on your palm.

An object made of 1,000 of these particles has about as much mass as a paperclip.

A single particle (that you can’t see or feel) would have a mass of

\_\_\_ nothing. \_X\_ a little. 1 = correct; 0 = incorrect

1. (1 point) Pretend you can see the atoms in a tiny metal block:

What is between the atoms of metal? (Mark all that apply.)

\_\_\_ oxygen atoms 1 = completely correct

\_\_\_ nitrogen atoms 0 = at least one error

\_\_\_ air

\_X\_ nothing

1. (1 point) If the object below is divided exactly in half, draw the new particle diagram for each of the halves.

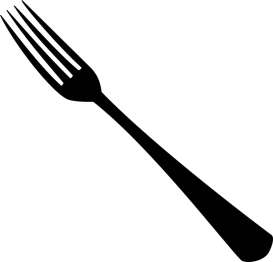
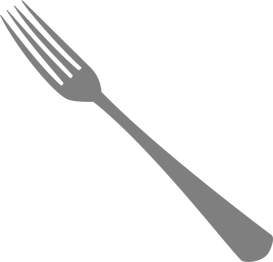
→

1 = completely correct; 0 = at least one error

1. (1 point) A plastic fork and a metal fork are the same size and shape. It is very likely that

\_X\_ one fork has more mass than the other. 1 = correct

\_\_\_ the forks have the same mass. 0 = incorrect

1. (2 points) You are given two solid objects, one very large and one very small. Both objects have masses of 25 grams.

25 g

25 g

Please explain how they can have the same mass: \_One material could be more dense than the other. The atoms in one material may be more compressed and/or the atoms of one material may be more massive than the atoms of the other material.\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| Mastery (1) | Proficient (1) | Developing (0) |
| Explains that:  the atoms in one material may be closer together (the crowdedness model)  AND/OR  the atoms in one material may be more massive than the atoms of the other material | Identifies density difference as an explanation. | Does not use the density concept (although use of the word “density” is not required)  AND/OR  identifies the larger object as the more dense object  AND/OR  other incorrect explanations |

1. (3 points) Cut a block of gold into two equal pieces.

Fine Gold

U. S. Mint

Fine

U. S.

Gold

Mint

a. Each half will have b. Each half will have

\_X\_ half the mass of the full block. \_X\_ half the volume of the full block.

\_\_\_ twice the mass of the full block. \_\_\_ twice the volume of the full block.

\_\_\_ the same mass as the full block. \_\_\_ the same volume as the full block.

\_\_\_ no mass at all. \_\_\_ no volume at all.

c. Each half will have For each part a–c, 1 = correct; 0 = incorrect

\_\_\_ half the density as the full block.

\_\_\_ twice the density of the full block.

\_X\_ the same density as the full block.

\_\_\_ no density at all.

1. (1 point) A stick of string cheese has a volume of 4 cm³ and has a mass of 8 g. What is the density of the string cheese? \_\_\_\_\_\_

Mass: 8 g Volume: 4 cm³

Density = Mass / Volume = 8 g / 4 cm³ = 2 g/cm³

|  |  |  |
| --- | --- | --- |
| Mastery (1) | Proficient (1) | Developing (0) |
| Uses correct numbers in the calculation  AND  uses correct units in the calculation  AND  calculates the correct numerical answer  AND  Includes the correct units with the answer | Calculates the correct numerical answer | Does not calculate the correct numerical answer. |

1. (2 point) Sarah finds a golden coin on the beach. Her friend thinks it might be solid gold, but Sarah is not so sure. She measures its volume to be 3 cm3 and its mass to be 26 g.

Is the coin solid gold? (See the table.) \_\_\_\_ Yes, it is gold. \_X\_\_ No, it is not gold.

1 = correct; 0 = incorrect

Please explain how you determined your answer:

Density = Mass / Volume = 26 g / 3 cm³ = 8.7 g/cm³

Since the coin’s density is 8.7 g/cm3, it cannot be solid gold whose density is 19.3 g/cm3

The coin’s density is most similar to that of brass.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Material** | Brass | Copper | Gold | Lead | Steel |
| **Density (g/cm3)** | 8.7 | 8.9 | 19.3 | 11.3 | 7.9 |

Rubric for explanation:

|  |  |  |
| --- | --- | --- |
| Mastery (1) | Proficient (1) | Developing (0) |
| Shows correct calculation of coin’s density  AND  Explains that the coin’s density did not match the density of gold  AND  Uses table to identify possible identity of the coin’s material | Shows correct calculation of coin’s density  AND  Explains that the coin’s density did not match the density of gold | Shows incorrect or no calculation of coin’s density  AND/OR  identifies coin object as being gold  AND/OR  other incorrect explanations |

Item 1: Drawn from Keeley, P., F. Eberle, and L. Farrin. 2005. *Uncovering student ideas in science, vol. 1*. Arlington, VA: NSTA Press.”

Item 2: Based on an oral question in Smith, C., D. Maclin, L. Grosslight, and H. Davis. 1997. Teaching for understanding: A study of students' preinstruction theories of matter and a comparison of the effectiveness of two approaches to teaching about matter and density. *Cognition and Instruction* 15 (3): 317–93.