

One characteristic that can be used to identify pure metals is density. If you determine the density of a pure metal, you can determine what the metal is, as shown in the table below.

Metal	Gold	Lead	Silver	Copper	Tin
Density (gram/cm <sup>3</sup> )	19.3	11.3	10.5	8.9	7.3

1. Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

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## Scoring Guide

### Score & Description

#### **Complete**

Student demonstrates the ability to design a procedure to determine the density of a solid object by describing a procedure similar to the procedure presented below.

Step A. Weigh ring using a scale, recording its mass (M),

OR "find the weight of the ring".

Step B. Put the ring in a graduated cylinder that has water in it and record the volume (V) of water displaced. The volume of water displaced equals the volume of water in the cylinder with the ring in it less the volume of the water before the ring was put in the cylinder.

Step C. Calculate the density (D), according to the formula  $D = M/V$ .

#### **Essential**

Student response describes two of the steps presented above.

#### **Partial**

Student response describes one of the steps presented above.

#### **Unsatisfactory/Incorrect**

Student response does not mention any of the steps presented above.

OR

Student response confuses quantities such as weight or volume with density.

Complete - Student Response

- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

I would determine the objects mass by using a scale. Then I would drop the object into a beaker of water and measure its displacement, which is its volume I would then divide the mass by the volume

Scorer Comments:

Student response describes all three components of the correct procedure: methods for measuring the mass, measuring the volume, and calculating the density.

- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

First you would have to weigh the ring, then you would take a beaker of water and put the ring in it. To know how much space the ring took up you would have to measure the amount of water that was displaced. All you have to do then is divide the number of grams the ring weighed by the amount of water it displaced in  $\text{cm}^3$ .

Scorer Comments:

Student response describes all three components of the correct procedure: weighing the ring, methods for measuring the volume, and calculating the density.

#### Essential - Student Response

- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

I would weigh it on a scale in grams. I would also place it in a beaker filled with water and see the displacement when it is added compared to the other rings.

Scorer Comments:

Student response describes two components of the correct procedure: methods for measuring the mass for and measuring the volume.

- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

First I would use a scale and determine the mass of the ring.

Then I would take a ruler and measure the length, width, and height to determine the volume.

Finally, I would use the formula: Density equals mass divided by volume.

Scorer Comments:

Student response describes two components of the correct procedure: methods for measuring the mass and for calculating the density. The method provided for measuring the volume is not appropriate for a ring.

Partial - Student Response

- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

weigh the ring, get the dimensions, use a formula to get density. then look on a chart to find which density matches the one you found.

Scorer Comments:

Student response describes one component of the correct procedure: weighing the ring. The response addressed the other two components, but only vaguely.

- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the

equipment that you would use, and how you would use this equipment to determine the ring's density.

I would fill a graduated cylinder with 50 ml of water. Then I would put the ring in the cylinder and measure the new level of the water. I would then take the difference between both measurements. Then find the density of gold with the measurements and the equation for density.

Scorer Comments:

Student response describes one component of the correct procedure: method for measuring the volume. The response does not address measurement of the mass and mentions the calculation of the density without stating a method.

#### Unsatisfactory/Incorrect - Student Response

- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

You could place the ring in a beaker of water. Subtract the first level from the second level to determine the density.

Scorer Comments:

Student response describes a method for measuring volume, but mistakenly states that the method would determine the density.

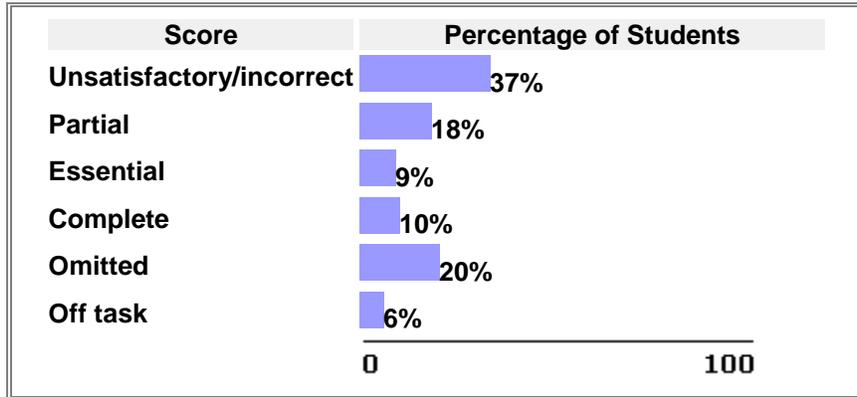
- 1 Suppose that you have been given a ring and want to determine if it is made of pure gold. Design a procedure for determining the density of the ring. Explain the steps you would follow, including the equipment that you would use, and how you would use this equipment to determine the ring's density.

28 would make a solution that is less dense than  $19.3 \text{ gram/cm}^3$ , but more dense than  $11.3$ . This way, the gold will sink, but the rest will float.

Scorer Comments:

Student response describes a faulty procedure. The procedure is appropriate to distinguish rings made of pure substances given in the table, but the method does not determine density and cannot be used to distinguish between rings made of many composites of gold.

### 2000 National Performance Results



Note:

- These results are for public and nonpublic school students.
- Percentages may not add to 100 due to rounding.

**The Fields of Science:** *Physical Sciences* (Sub content classification: *Matter and Its Transformations*)

**Knowing and Doing Science :** *Scientific Investigation*

## **The Fields of Science**

### ***Physical Sciences***

This question measures basic knowledge and understanding of the following:

## **Knowing and Doing Science**

### ***Scientific Investigation***

Scientific investigation probes students' abilities to use the tools of science, including both cognitive and laboratory tools. Students should be able to acquire new information, plan appropriate investigations, use a variety of scientific tools, and communicate the results of their investigations.