1. The diagram below represents a solid object with a density of 3 grams per cubic centimeter.

(Not drawn to scale)

What is the mass of this object?
A) 0.5 g  B) 2 g  C) 18 g  D) 36 g

Base your answers to questions 2 through 5 on the diagram below, which represents a solid material of uniform composition.

Density = 2.7 g/cm³

2. Which graph best represents the relationship between the mass and volume of various-sized pieces of this material?
A)  
B)  
C)  
D)  

3. If this material is heated and expands, the density of the material will
A) decrease  B) increase  C) remain the same

4. When this material is placed in a container of water, it sinks to the bottom of the container. Compared to the density of water, the density of this material is
A) less  B) greater  C) the same

5. The mass of this piece of material is approximately
A) 0.23 g  B) 4.4 g  C) 9.3 g  D) 32 g

6. As air on the surface of Earth warms, the density of the air
A) decreases  B) increases  C) remains the same

7. Under the same conditions of temperature and pressure, three different samples of the same uniform substance will have the same
A) shape  B) density  C) mass  D) volume

Base your answers to questions 8 through 10 on the diagrams below, which represent two different solid, uniform materials cut into cubes A and B.

Mass of A = 320 g  Density of B = 3 g/cm³
Volume of A = 64 cm³  Volume of B = 27 cm³

(Not drawn to scale)

8. What is the density of cube A?
A) 0.2 g/cm³  B) 5.0 g/cm³  C) 12.8 g/cm³  D) 64.0 g/cm³

9. If a parcel of air is heated, its density will
A) decrease  B) increase  C) remain the same

10. Assume cube B was broken into many irregularly shaped pieces. Compared to the density of the entire cube, the density of one of the pieces would be
A) less  B) greater  C) the same
11. The data table below shows the mass and volume of three samples of the same mineral. [The density column is provided for student use.]

<table>
<thead>
<tr>
<th>Sample</th>
<th>Mass (g)</th>
<th>Volume (cm³)</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>100</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>150</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

Which graph best represents the relationship between the density and the volume of these mineral samples?

A) ![Graph A]  
B) ![Graph B]  
C) ![Graph C]  
D) ![Graph D]

12. The mineral shown below is of uniform composition and has a density of 4 grams per cubic centimeter. What is the mass of this mineral?

![Mineral Diagram]  

A) 9 g  
B) 12 g  
C) 54 g  
D) 108 g

13. Which graph best represents the relationship between the density of a substance and its state of matter (phase) for most earth materials, excluding water?

[Key: S = solid, L = liquid, G = gas]

A) ![Graph A]  
B) ![Graph B]  
C) ![Graph C]  
D) ![Graph D]
14. The cartoon below presents a humorous look at science.

The correct explanation of why ice floats is that, compared to liquid water, solid ice
A) has less mass B) has more mass C) is less dense D) is more dense

15. The diagram below is a cross section of an ice-covered lake in New York State during the month of January. Points A, B, C, and D are locations at various levels in the lake. The temperature of the water at location D is 4°C.

Which graph best represents the relationship between location and density of the ice or water?
A) ![Graph A] B) ![Graph B] C) ![Graph C] D) ![Graph D]

16. Compared to the density of liquid water, the density of an ice cube is
A) always less B) always greater C) always the same D) sometimes less and sometimes greater

17. The diagrams below represent two differently shaped blocks of ice floating in water. Which diagram most accurately shows the blocks of ice as they would actually float in water?
A) ![Diagram A] B) ![Diagram B] C) ![Diagram C] D) ![Diagram D]

18. A pebble has a mass of 35 grams and a volume of 14 cubic centimeters. What is its density?
A) 0.4 g/cm³ B) 2.5 g/cm³ C) 490 g/cm³ D) 4.0 g/cm³

19. The diagram below shows a glass jar containing a clear liquid and a floating rock.

Which conclusion about the relative density of the rock and the liquid is true?
A) The rock is less dense than the liquid. B) The rock is more dense than the liquid. C) The rock and the liquid have the same density.
20. The diagram at the right represents a cylinder which contains four different liquids, \(W\), \(X\), \(Y\), and \(Z\), each with a different density \((D)\) as indicated. A piece of solid quartz having a density of 2.7 g/cm\(^3\) is placed on the surface of liquid \(W\). When the quartz is released, it will pass through

A) \(W\), but not \(X\), \(Y\), or \(Z\)  
B) \(W\) and \(X\), but not \(Y\) or \(Z\)  
C) \(W\), \(X\), and \(Y\), but not \(Z\)  
D) \(W\), \(X\), \(Y\), and \(Z\)

21. The data table below shows the density of four different mineral samples.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Density (g/cm(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>corundum</td>
<td>4.0</td>
</tr>
<tr>
<td>galena</td>
<td>7.6</td>
</tr>
<tr>
<td>hematite</td>
<td>5.3</td>
</tr>
<tr>
<td>quartz</td>
<td>2.7</td>
</tr>
</tbody>
</table>

A student accurately measured the mass of a sample of one of the four minerals to be 294.4 grams and its volume to be 73.6 cm\(^3\). Which mineral sample did the student measure?

A) corundum  
B) galena  
C) hematite  
D) quartz

22. A quantity of water is frozen solid and then heated from 0\(^\circ\)C to 10\(^\circ\)C. Which statement best describes the properties of the water during this time?

A) Mass and volume change.  
B) Volume and density change.  
C) Mass changes but volume remains constant.  
D) Volume changes but density remains constant.

23. Which graph best represents the relationship between mass and volume of a material that has a density of 5 grams per cubic centimeter?

A)  
B)  
C)  
D)  

24. The graph below shows the relationship between the mass and volume of a mineral.

What is the density of this mineral?

A) 6.0 g/cm\(^3\)  
B) 9.0 g/cm\(^3\)  
C) 3.0 g/cm\(^3\)  
D) 4.5 g/cm\(^3\)
25. A 5.0-milliliter sample of a substance has a mass of 12.5 grams. What is the mass of a 100 milliliter sample of the same substance?

A) 40.0 g  
B) 125 g  
C) **250 g**  
D) 400 g

26. As shown below, an empty 1,000-milliliter container has a mass of 250.0 grams. When filled with a liquid, the container and the liquid have a combined mass of 1,300 grams.

![Image of empty and filled container](image)

What is the density of the liquid?

A) 1.00 g/mL  
B) **1.05 g/mL**  
C) 1.30 g/mL  
D) 0.95 g/mL

27. A black hole is a celestial feature believed to have a mass millions of times the mass of our Sun and a diameter less than the diameter of Earth. An object of such high mass and small volume would have

A) a very low density  
B) **a very high density**  
C) an elliptical orbit with the Sun at one focal point  
D) an elliptical orbit with Earth at one focal point
28. Water (W) was added to the graduated cylinder containing liquid C. Objects A and D were then dropped into the cylinder. Which diagram most accurately shows the resulting arrangement of these substances?

A) A and B  
B) B and E  
C) C and D  
D) A and E

29. Which two substances could be made of the same material?

A) A and B  
B) B and E  
C) C and D  
D) A and E
30. The graph below shows the relationship between mass and volume for three samples, A, B, and C, of a given material.

![Graph showing mass and volume relationship]

What is the density of this material?

A) 1.0 g/cm³  
B) 5.0 g/cm³  
C) 10.0 g/cm³  
D) 20.0 g/cm³

31. Base your answer to the following question on the data table below, which lists some properties of four minerals that are used as ores of zinc (Zn).

<table>
<thead>
<tr>
<th>Mineral Property</th>
<th>Smithsonite</th>
<th>Sphalerite</th>
<th>Willemite</th>
<th>Zincite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition</td>
<td>ZnCO₃</td>
<td>ZnS</td>
<td>Zn₂SiO₄</td>
<td>ZnO</td>
</tr>
<tr>
<td>Hardness</td>
<td>4–4.5</td>
<td>3.5–4</td>
<td>5.5</td>
<td>4</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>4.4</td>
<td>4.0</td>
<td>4.0</td>
<td>5.6</td>
</tr>
<tr>
<td>Color</td>
<td>white, gray, green, blue, yellow</td>
<td>brown, yellow, red, green, black</td>
<td>white, yellow, green, reddish brown, black</td>
<td>deep red to orange yellow</td>
</tr>
<tr>
<td>Streak</td>
<td>white</td>
<td>white to yellow to brown</td>
<td>white</td>
<td>orange yellow</td>
</tr>
</tbody>
</table>

A sample of sphalerite has a mass of 176.0 grams. What is the volume of the sample?

A) 22.7 cm³  
B) 31.4 cm³  
C) 40.0 cm³  
D) 44.0 cm³
32. A rock sample has a mass of 16 grams and a volume of 8 cubic centimeters. When the rock is cut in half, what is the volume and density of each piece?

A) 8 cm$^3$ and 0.5 g/cm$^3$
B) 8 cm$^3$ and 1.0 g/cm$^3$
C) 4 cm$^3$ and 2.0 g/cm$^3$
D) 4 cm$^3$ and 4.0 g/cm$^3$

33. Water has its greatest density at a temperature of

A) –6º C  B) 10º C  C) 32º C  D) 4º C

34. Water has the greatest density at

A) 100ºC in the gaseous phase
B) 0ºC in the solid phase
C) 4ºC in the solid phase
D) 4ºC in the liquid phase

35. The diagram below represents a rectangular object with a mass of 450 grams. What is the density of the object?

A) 1 gram per cubic centimeter
B) 2 grams per cubic centimeter
C) 3 grams per cubic centimeter
D) 4 grams per cubic centimeter

36. The diagrams below represent two solid objects $A$ and $B$, with different densities.

What will happen when the objects are placed in a container of water (water temperature = 4ºC)?

A) Both objects will sink.
B) Both objects will float.
C) Object $A$ will float and object $B$ will sink.
D) Object $B$ will float and object $A$ will sink.

37. An empty 250-milliliter beaker has a mass of 60 grams. When 100 milliliters of oil is added to the beaker, the total mass is 140 grams. The density of the oil is approximately

A) 1.7 g/ml  B) 1.4 g/ml
C) 0.8 g/ml  D) 0.6 g/ml
38. Base your answer to the following question on the bedrock cross section below, which represents part of Earth's crust where natural gas, oil, and water have moved upward through a layer of folded sandstone and filled the pore spaces at the top of the sandstone layer.

The final arrangement of the natural gas, oil, and water within the sandstone was caused by differences in their

A) density  B) specific heat  
C) relative age  D) radioactive half-life

39. Base your answer to the following question on the two tables below and on your knowledge of Earth science. Table 1 shows the composition, hardness, and average density of four minerals often used as gemstones. Table 2 lists the minerals in Moh's Scale of Hardness from 1 (softest) to 10 (hardest).

If the mass of a spinel crystal is 9.5 grams, what is the volume of this spinel crystal?

A) 0.4 cm$^3$  B) 2.5 cm$^3$  C) 5.7 cm$^3$  D) 36.1 cm$^3$
Base your answers to questions 40 through 42 on the diagram and table below.

![Mineral Sample A](image)

**Mineral Density Table**

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum</td>
<td>2.3</td>
</tr>
<tr>
<td>Orthoclase</td>
<td>2.6</td>
</tr>
<tr>
<td>Quartz</td>
<td>2.7</td>
</tr>
<tr>
<td>Calcite</td>
<td>2.7</td>
</tr>
<tr>
<td>Dolomite</td>
<td>2.9</td>
</tr>
<tr>
<td>Fluorite</td>
<td>3.2</td>
</tr>
<tr>
<td>Hornblende</td>
<td>3.2</td>
</tr>
<tr>
<td>Chalcopirite</td>
<td>4.2</td>
</tr>
<tr>
<td>Pyrite</td>
<td>5.0</td>
</tr>
<tr>
<td>Magnetite</td>
<td>5.2</td>
</tr>
<tr>
<td>Galena</td>
<td>7.5</td>
</tr>
<tr>
<td>Copper</td>
<td>8.9</td>
</tr>
</tbody>
</table>

40. When a sample of the mineral calcite is heated, it expands, causing its density to be
   A) **less than 2.7 g/cm³**  
   B) **exactly 2.7 g/cm³**  
   C) between 2.7 and 3.0 g/cm³  
   D) **greater than 3.0 g/cm³**

41. Under identical conditions, several samples of the mineral pyrite are measured, and their densities are compared. The values obtained should show that
   A) rounded samples are more dense than rough samples
   B) large samples are more dense than small samples
   C) small samples are more dense than large samples
   D) **all the pyrite samples have the same density**

42. A student measured the mass of a sample of quartz three times. The mass was the same the first and second times, but was less the third time. This decrease in mass could have occurred before the third measurement if the sample had been
   A) heated and expanded
   B) cooled and contracted
   C) soaked in water
   D) **dropped and a piece was lost**

43. A student calculates the densities of five different pieces of aluminum, each having a different volume. Which graph best represents this relationship?

   A) ![Graph A](image)
   B) ![Graph B](image)
   C) ![Graph C](image)
   D) ![Graph D](image)

44. A mineral sample is found to have a density of 3.0 grams per cubic centimeter. It is then broken into two pieces, with one piece twice as large as the other. The smaller of the two pieces will have a density of
   A) 1.0 g/cm³
   B) 1.5 g/cm³
   C) **3.0 g/cm³**
   D) 6.0 g/cm³
45. The data table below shows the mass and volume of four different minerals.

<table>
<thead>
<tr>
<th>Mineral Sample</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>50 g</td>
<td>60 g</td>
<td>55 g</td>
<td>40 g</td>
</tr>
<tr>
<td>Volume</td>
<td>20 mL</td>
<td>15 mL</td>
<td>10 mL</td>
<td>5 mL</td>
</tr>
</tbody>
</table>

Which mineral has the greatest density?

A) $A$  B) $B$  C) $C$  D) $D$