6. Minerals II

What is a mineral?

The five characteristics required in order for a compound to be a mineral are:

- it must be ________________________________________
- it must be ________________________________________
- it must have been formed by _________________________
- it must have ______________________________________
- it must have ______________________________________

Characteristics of Minerals

We will work through the following list of items to determine which of them, if any, are minerals:

- steel, plastic, sugar, table salt, mercury, ice, coal, sea shell,
- obsidian, mica, chalk, coral, paper, gold.

Naturally Formed

No substance created artificially is a mineral.

Examples of artificial substances: ______________________________________

Solid

Liquids and gases are not minerals, irrespective of their chemical composition.

e.g. petroleum cannot be a mineral.

Is water a mineral? _________. What about ice? YES / NO / CAN'T DECIDE YET

Is molten rock (lava) a mineral? ________

What can we eliminate from the list because it isn't a solid? ____________________

Formed by Inorganic Processes

Anything formed from a living organism and containing organic materials is not a mineral.

Is coal a mineral? ________

Explanation: ________________________________________________________________

So which were the organic materials (i.e., not minerals)?: ______________________
General Chemical Formula

Minerals always have a generally consistent chemical formula, so atoms are always present in very specific ratios.

Is glass a mineral? _______

Explanation: ___________________________________________________________

Which sample can we eliminate that is a naturally formed type of glass? __________

Chemical formulae may be:

- **Simple (consisting of a single element, called ________________)**:
  
  Examples: __________ - chemical formula: _____
  __________ - chemical formula: _____

- **Simple (consisting of more than one element)**:
  e.g. _______ (__) - always contains one Si atom for every two O atoms.

- **Complex (many elements)**
  
  e.g. ________________________: KMg₃AlSi₃O₁₀(OH)₂

What is atomic substitution? ______________________________________________
_____________________________________________________________________

Two similar-sized and similar-charged ions that often substitute for each other in minerals are _______ and ________.

Example of atomic substitution: Olivine - (Mg, Fe)₂SiO₄

In olivine, there will always be two atoms of either Mg or Fe (or one of each) for every one Si atom and every four O atoms.

Characteristic Crystal Structure

The atoms in a mineral are organized into regular, repetitive geometric patterns in three dimensions, called a ____________________.

We therefore say that all minerals are ________________.

The crystal structure of any mineral is a unique characteristic of that mineral.
Does glass have an internal crystal structure? _________

What term is used to describe the internal structure of glass? __________________________

Items remaining on the list that we can classify as minerals:

1) _______________
2) _______________
3) _______________
4) _______________

How many types of minerals are there? ______________________

Why aren't there a lot more?:

(1) some combinations are chemically impossible
(2) relative abundances of minerals in the crust (see table) don’t allow more

Table of Element Abundances in the Crust

<table>
<thead>
<tr>
<th>Element</th>
<th>Symbol</th>
<th>% of crust (by weight)</th>
<th>% of crust (by atoms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>46.6</td>
<td>62.6</td>
</tr>
<tr>
<td>Silicon</td>
<td>Si</td>
<td>27.7</td>
<td>21.2</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Al</td>
<td>8.1</td>
<td>6.5</td>
</tr>
<tr>
<td>Iron</td>
<td>Fe</td>
<td>5.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca</td>
<td>3.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Sodium</td>
<td>Na</td>
<td>2.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>2.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>2.1</td>
<td>1.8</td>
</tr>
<tr>
<td>All others</td>
<td></td>
<td>1.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Based on the above element abundances in the crust, it is not surprising that the majority of common minerals contain both ________ and ________.

How do we Identify Minerals?

Physical properties:
Physical Geology 101

- color or streak
- luster
- crystal shape
- cleavage
- hardness
- density

Color:
What causes a certain type of mineral (e.g., quartz) to come in a variety of colors?
___________________________________________________________________

For what type of minerals do we find the streak? ________________________

Luster:
Luster refers to how a mineral surface reflects light.
The two types of luster are ______________ and ___________________.

Crystal Shape:
The planar surfaces on the outside of a crystal are called ________________.
The angles between different faces are called _______________________, and they are always constant for any particular mineral.

Cleavage:
What are cleavage planes? ________________________________

Do not confuse cleavage planes with crystal faces. They look very similar, but only the very outside edges of a crystal are crystal faces, but there are many potential cleavage planes inside the mineral along which the crystal may break apart.
The angles between different cleavage planes inside a crystal are always constant for a particular mineral. This is why cleavage is such a useful way of identifying a mineral.
Do ALL mineral crystals have cleavage planes? ______

What are the curved fracture surface in minerals without cleavage planes?
________________________________________

Hardness:
Hardness is how easy it is to scratch the mineral. The strength of the atomic bonds controls hardness.
What scale do we use to identify mineral hardness?: ________________________

The softest known mineral is: __________
The hardest known mineral is: ____________

**Density or Specific Gravity:**

This is the mass per unit volume (different for different minerals). _________ minerals tend to have the highest specific gravities.

**Other Properties**

Halite (table salt): __________________________

Talc: ____________________________

Magnetite: __________________________

**FINAL QUESTION:**

What happens to calcite when hydrochloric acid is spilled on it?

__________________________________________

__________________________________________