1. Some igneous rocks are said to be felsic (acidic) and others mafic (basic). This distinction is based upon the **SILICA** of the rock. [i.e. Felsic Rocks > 66%, Intermediate Rocks 52-66%, Mafic Rocks 45-52%, Ultramafic Rocks < 45%]

2. In what way would you expect the ‘acidity’ of a rock to affect the parent material and soil formed from it.

   **MORE ACID ROCK WILL = MORE ACID SOIL**

   **HIGH SI CONTENT WILL ALSO MEAN ROCKS ARE MORE RESISTANT TO PHYSICAL WEATHERING**

3. Complete the following table by naming the two basic types of weathering processes (column headings) and giving additional examples of each type.

<table>
<thead>
<tr>
<th>Examples of PHYSICAL weathering.</th>
<th>Examples of CHEMICAL weathering.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion</td>
<td>Hydrolysis</td>
</tr>
<tr>
<td>Freeze-thaw</td>
<td>Hydration</td>
</tr>
<tr>
<td>Differential weathering – different minerals in rock will weather differently</td>
<td>Acidification</td>
</tr>
<tr>
<td></td>
<td>oxidation</td>
</tr>
</tbody>
</table>

4. Physical weathering acts primarily to change the **A** of the rock.
   (a) particle size
   (b) color
   (c) mineral composition
   (d) oxidation state
   (e) moisture content

5. (a) [Choose the words that make the statement correct.] When water freezes at 0°C and forms ice, it **expands** contracts) thus becoming (more/less) dense by 9%. This change in volume takes place with a force of about 146 kg/cm².

   (b) Explain how this phenomenon can play a role in the physical weathering of rocks and soils.
   Water within rocks will expand and freeze, this will break rocks apart. This is an example of physical weathering of rocks.

   (c) In what type of climate would this action be most active in weathering?
   (1) polar
   (2) **temperate**
   (3) tropical
6. In the highly simplified case of rock weathering shown in the figure below, identify the processes represented by arrows a-h, indicating whether each is primarily a physical or chemical change and whether the process is synthetic or destructive in nature.

(a) Physical - reduces particle size

(b) Physical destruction and chemical weathering of biotite into mica clays

(c) Further physical weathering of quartz sand

(d) Chem and phys weathering of feldspars synthesis of new clays

(e) Destructive, chemical going to dissolved ions

(f) Destructive chemical of mica clays, synthesis of oxides

(g) Physical and chemical destruction and synthesis of new clay

(h) Chemical destruction of mica clay, synthesis of new clay
7. [7a-7e] Compute the missing percent changes in Table 7. Make these computations on the same basis used to arrive at those percent change figures already provided in the table.

Table 7: Elemental analysis of Two Igneous Rocks and Well-Developed Soils Derived from Them. (Percent of Total Composition)

<table>
<thead>
<tr>
<th></th>
<th>Rock A</th>
<th>Soil A</th>
<th>Change (%</th>
<th>Rock B</th>
<th>Soil B</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₂O₅</td>
<td>0.13</td>
<td>0.08</td>
<td>-38</td>
<td>0.34</td>
<td>0.13</td>
<td>-62</td>
</tr>
<tr>
<td>K₂O</td>
<td>3.75</td>
<td>0.54</td>
<td>-86</td>
<td>1.84</td>
<td>0.54</td>
<td>-71</td>
</tr>
<tr>
<td>CaO</td>
<td>1.50</td>
<td>0.33</td>
<td>7a. -78</td>
<td>8.06</td>
<td>0.46</td>
<td>-94</td>
</tr>
<tr>
<td>SiO₂</td>
<td>70.47</td>
<td>46.70</td>
<td>7b. -34</td>
<td>52.37</td>
<td>45.94</td>
<td>-12</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>14.50?</td>
<td>27.13</td>
<td>7c. +46</td>
<td>15.72</td>
<td>21.29</td>
<td>7d. +40</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3.57</td>
<td>12.20</td>
<td>+242</td>
<td>9.88</td>
<td>19.31</td>
<td>7e. +95</td>
</tr>
<tr>
<td>SiO₂/Al₂O₃</td>
<td>4.83</td>
<td>1.72</td>
<td>-64</td>
<td>10a.</td>
<td>10b. 3.33</td>
<td>10c. -34</td>
</tr>
</tbody>
</table>

8. Examine Table 8. By how much do rocks A and B differ with respect to K₂O, CaO, SiO₂, and Fe₂O₃? Would you say these rocks must have had mineral compositions very different from one another? Why or why not?

Rocks differ significantly from each other in terms of K₂O (2x), CaO (5x), SiO₂(70% vs 52%) and Fe₂O₃ (5x).

Mineral composition of rocks is different as elemental concentrations of rocks are different.

Table 8: Differences in Elemental Concentrations Between Felsic (Acid) and Mafic (Basic) Rocks and Soils Formed From Them (Percent of Total Composition)

<table>
<thead>
<tr>
<th></th>
<th>Rock A</th>
<th>Rock B</th>
<th>Difference</th>
<th>Soil A</th>
<th>Soil B</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>K₂O</td>
<td>3.75</td>
<td>1.84</td>
<td>1.91</td>
<td>0.54</td>
<td>0.54</td>
<td>0</td>
</tr>
<tr>
<td>CaO</td>
<td>1.50</td>
<td>8.06</td>
<td>6.56</td>
<td>0.33</td>
<td>0.46</td>
<td>0.13</td>
</tr>
<tr>
<td>SiO₂</td>
<td>70.47</td>
<td>52.37</td>
<td>18.10</td>
<td>46.70</td>
<td>45.94</td>
<td>0.76</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3.57</td>
<td>9.88</td>
<td>6.31</td>
<td>12.20</td>
<td>19.31</td>
<td>7.11</td>
</tr>
</tbody>
</table>
9. Now compare soils A and B with respect to the same elements (See table 9). Are the soils more or less different from each other than were their respective parent rocks? Can you draw any conclusions about the influence of the parent material upon soil properties? (Note that the soils described in Table 7) are both mature, well-developed soils—Uitisols.)

Soils are much more similar in chemical composition than rocks were. This suggests that the influence of parent material on soil type and properties decreases as soils weather and age.

10. [10a-10c] Calculate the SiO$_2$/Al$_2$O$_3$ ratios for soil B and rock B and the percent change to complete table 7. The low ratios for both soil A and soil B indicate that these are quite mature or highly weathered soils. What approximate SiO$_2$/Al$_2$O$_3$ value would you expect for a young soil only recently formed from parent material?

Young soil the SiO$_2$/Al$_2$O$_3$ ratios would approximate the parent material. As soils get older, Si will weather out of soil profile (ultisols and oxisols) and the ratio will decrease.

11. Indicate which one of each of the following would probably undergo chemical weathering more readily and briefly explain your choice.

   (a) sandstone with (calcitic/siliceous) cementation of grains
   Softer on Moh’s scale and more soluble

   (b) shale/slate - softer

   (c) quartzite/marble – quartzite consists of quartz = SiO$_2$ marble consists of calcite more soluble more easily weathered

   (d) gravel deposit/fine sand deposit – smaller particle size will weather more rapidly
12. *(Optional)*—Match each reaction with one or more of the following weathering processes.

(1) carbonation  (2) solution  (3) hydration  (4) hydrolysis  (5) oxidation

a. 2, 4
b. 4

c. 3

d. 5

e. 2

g. 4