Name _____ Date _____
Regents Chemistry

Miscibility In Solids

I. Introduction:

*Two substances in the same phases are **miscible** if they may be completely mixed (in liquids a meniscus would not appear). Substances are said to be **immiscible** if the will not mix and remain two distinct phases.*

A. **Intro Activity:**

1. Add 10 mL of olive oil to 10 mL of water.

   a) Please record any observations:

   _____

   _____

   b) Based upon your observations, indicate if the liquids are miscible or immiscible. Support your answer.

   _____

   _____

2. Now add 10 mL of grain alcohol to 10 mL of water.

   a) Please record any observations:

   _____

   _____

   b) Based upon your observations, indicate if the liquids are miscible or immiscible. Support your answer.

   _____

   _____

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II. Observation Of Perthite

A. Perthite Observation:

With the hand specimens and hand lenses provided, list as many observations possible in the space below.

_____

_____

_____

_____

B. 1) What did you observe that is similar to the meniscus in Part A?

_____

a) Using any resources available, define exsolution lamellae and explain why they occur in solids.

_____

_____

b) Using any resources available, explain why the exsolution lamellae occur in perthite.

_____

_____

III. Application of the concept of miscibility to solids:

A. **Solid Solutions:**

*Solid solutions are a **homogenous** and stable **solution** of one **solid** substance in another. **Olivine ($(Mg,Fe)_2SiO_4$)** is a common rock forming mineral. The olivine solid solution series is formed by the end-members forsterite (Fo) (Mg_2SiO_4) and fayalite (Fa) (Fe_2SiO_4). Compositions between the end members are indicated by the percent of each composition (i.e. $Fo_{80}Fa_{20,}$this may be shortened to Fo_{80}).*

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1. Calculate the atoms per formula unit (apfu) then the gram formula mass (gfm) for the following end-member compositions:

End Member	*apfu*	*gfm*
Fo_{100}	Mg_2SiO_4	
Fo_{80}		
Fo_{50}		
Fa_{80}		
Fa_{100}	Fe_2SiO_4	

2. What valence is Fe in this solid solution series?

   _____

3. Which cation has a larger ionic radius (Mg or Fe)?

   _____

4. Which cation would more attracted to O (Mg or Fe)? Please explain.

   _____

   _____

5. a) Which end member would have a higher melting point? Please explain.

   _____

   _____

   b) Which end member would solidify first from an olivine melt?

   _____

6. What do you think a miscibility "gap" means?

   _____

   _____

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7. Using any references available, provide another example of a solid solution.

_____

IV. Extensions:

A) Use the internet to provide another example of minerals that exhibit exsolution lamellae (please provide a photograph).

_____

B) At what scale (how large?) do these exsolution lamellae occur?

_____

_____

C) What types of technology would allow these examples to be observed? The website www.ccmr.cornell.edu may be a good beginning site to explore.

_____

_____

References:

1) www.antoine.frostburg.edu/chem/senese/101/liquids/faq/miscible-immiscible.shtml; Fred Senese senese@antoine.frostburg.edu

2) www.chem.purdue.edu

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Lesson Plan

Class: *High School Elective 11th or 12th Grade (e.g. Advanced Earth Science or Geochemistry)*

Topic: *Introduce Concept Of Miscibility/Immiscibility Within Solids*

Estimated Time: 1 hour

MST Standards: *Standards Science (Physical Setting):*

(4-3) Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

(4-4) Energy exists in many forms, and when these forms change energy is conserved.

Standard Mathematics:

(3-3) Students use mathematical operations and relationships among them to understand mathematics.

Performance Indicators:

Regents Earth Science:

(3.1a) Minerals have physical properties determined by their chemical composition and chemical composition.

Regents Chemistry:

(3.1s) Mixtures are composed of two or more different substances that cam be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed.

(3.1 oo) A solution is a homogeneous mixture of solute dissolved in a solvent. The solubility of the solute is dependent on the temperature, the pressure, and the chemical natures of the solute and the solvent.

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SWBAT: ▫ Observe/Communicate/identify/Ob concept of miscible/immiscible phases in natural (geologic) materials.

▫ Relate why phases are miscible/immiscible as solids when cooled from liquids (melts).

Purpose: Recognize role of ionic size in a crystal system. Identify role of energy as phases transfer from a liquid to a solid.

Learning: ▫ Miscible/Immiscible Phases
▫Why they occur in solids.
▫Exsolution Lammellae
▫ Binary Solid Solution

Methods: ▫ Review solutions and introduce concept of miscibility/immiscibility with oil-water;ethanol-water examples.

▫ Use hand specimens of perthite (microcline and plagioclase feldspars) exsolved. The exsolution lamellae are clearly visible. Make the connection with exsolution lamellae to meniscus with immiscible liquids. Use thin sections and microscopes to show exsolution at a smaller scale.

▫ Transfer relationship between technology and ability to make observations at a fine scale with spectroscopy and CCMR website (www.ccmr.cornell.edu)

▫ Relate concept of miscibility (binary solid-solution) with olivine (forsterite-fayalite) absence of exsolution lamellae.

Transfer: ▫ Relate introductory activity with liquids to solids.

Input: ▫ Miscibility/Immiscibility
▫ Exsolution Lamellae
▫ Calculation atoms per formula unit
▫ Calculating gram formula mass
▫ Relationship between technological advancements and ability to make fine scale observations.

Reinforcement: Students should explore/provide examples of other binary joins, with visual examples from the internet and scales at which they occur.

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Materials List:

Graduated cylinders	Water	Oil
Ethanol	Perthite Samples	Olivine samples (Forsterite and Fayalite)

Optical Microscopes Mineralogy Texts
Computers (Internet Capability)

Resources:

- www.chem.purdue.edu
- http://mineral.galleries.com
- http://geology.about.com
- www.geology.wisc.edu
- **Hurlburt**, Cornelius S., Jr. and **Klein**, Cornelis. **Manual of Mineralogy**. John Wiley & Sons, Inc. Oxford University Press: New York, 21st ed. 704p., 1998.

Contributors:

a) www.antoine.frostburg.edu/chem/senese/101/liquids/faq/miscible-immiscible.shtml; Fred Senese senese@antoine.frostburg.edu

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Guided Practice: Instructor should reinforce relationship between meniscus in liquid and exsolution lamellae in solids. Review calculating atoms per formula unit and gram formula mass prior to lab.

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Closure: Have students share examples found through other resources, scales at which they occur, and technology they could use to observe these examples.

Future Ideas: This may be used for an introductory lab activity for phase diagrams.

Teacher Notes:

- *Instructors should stress connection between meniscus and lamellae in immiscible liquids and solids respectively.*
- *Perthite is microcline and plagioclase feldspar exsolved. At lower temperatures the difference in ionic radii of the cations (K^+ and Na^+) between the compositions will not "fit" in the crystal structure of the respective phases.*

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