

# Worksheets (Lecture Tutorials)

## What it is:

Short worksheets aimed at reducing misconceptions or working through difficult concepts that students complete in groups in class.

## Implementation:

- Give a short, introductory lecture.
  - Students pair up and complete a worksheet (instructors can create their own worksheets or use Lecture Tutorials in a published workbook).
  - Briefly review select questions. Collecting the worksheets is optional.
- ## The worksheet should:
- Address topics with which students have difficulties.
  - Require mid- to high-level thinking.

## Lecture Tutorials have been shown to:

- Increase student learning
- Reduce misconceptions
- Promote interaction
- Provide prompt feedback
- Create a positive response in students

## Directions to create your own:

Lecture Tutorial module:

[http://serc.carleton.edu/sp/library/lecture\\_tutorials/index.html](http://serc.carleton.edu/sp/library/lecture_tutorials/index.html)

## Example

**Igneous Rock Mineral Sizes**

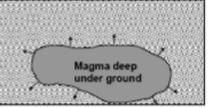
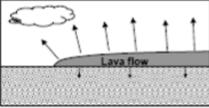
**Part 1: Forming Minerals**  
The size of minerals in an igneous rock is determined by how long the magma takes to cool. To illustrate, everyone should stand up and scatter throughout the room.

1) You have 3 seconds to form groups as big as possible. How many per group? \_\_\_\_\_

2) Scatter again. Now you have 10 seconds. How many per group? \_\_\_\_\_

3) Two students are debating about how this activity relates to mineral size in rocks.  
**Student 1:** It seems to me that with a longer amount of time, it is possible for all the atoms to form really large minerals.  
**Student 2:** I don't know, I would think that more time means that more minerals will form, and only a little bit of time means only a few big minerals will form.  
With which student do you agree? Why?

**Part 2: Mineral Formation Location**  
Two bottles of magma are shown in cross section below. One is above ground and the other is deep within the crust. The arrows represent heat escaping from the molten rock as it cools.



4) Which will cool faster? Lava erupted onto the surface      Magma deep underground

5) The igneous rocks granite and gabbro have large minerals. In which location would they have formed?  
on the surface      deep underground

6) The igneous rocks rhyolite and basalt have minerals so small it is difficult to distinguish them with the naked eye. In which location would they have formed?  
on the surface      deep underground

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**Igneous Rock Mineral Sizes**

7) Circle the two rocks that formed deep beneath the surface.



Images courtesy School of Ocean and Earth Science, National Oceanography Centre

Check your answers with your answer for questions 5 and 6.

**Part 3: Porphyry**

8) The igneous rock to the right has large, light colored minerals and many small, dark minerals. You can tell it is an igneous rock because the minerals inside are rectangular and not rounded like sediments. How might the igneous rock shown to the right have formed?

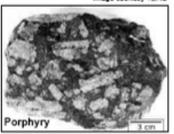


Image courtesy TERC  
**Porphyry**

9) Two students are debating about the cooling rate of this rock and the formation of the large minerals.  
**Student 1:** The magma must have gotten large pieces of sediments that we can see trapped in it, and the sediments didn't melt even though they were in the magma.  
**Student 2:** This is an igneous rock, so everything started off as magma. The large minerals must have formed deep underground when the magma was cooling slowly, like in a magma chamber. But the rest of the rock has very small minerals, so they cooled quickly at the surface.  
With which of these students do you agree? Why?

10) Student 2 said that the large minerals formed deep underground, like in a magma chamber, and the small minerals formed at the surface. Describe what actually happened to form the rock. In other words, what story does this rock tell about its history?

(hint to Question 10: in what situation is magma from a magma chamber moved to the surface?)

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## References

Kortz, Murray, and Smay (2008) Increasing Learning in Introductory Geoscience Courses Using Lecture Tutorials. JGE, v. 56, 280-290

Kortz and Smay (2012) Lecture Tutorials for Introductory Geoscience, 2e. W.H. Freeman.

Kortz and Smay (2014) Lecture Tutorials for Earth Science. W.H. Freeman

