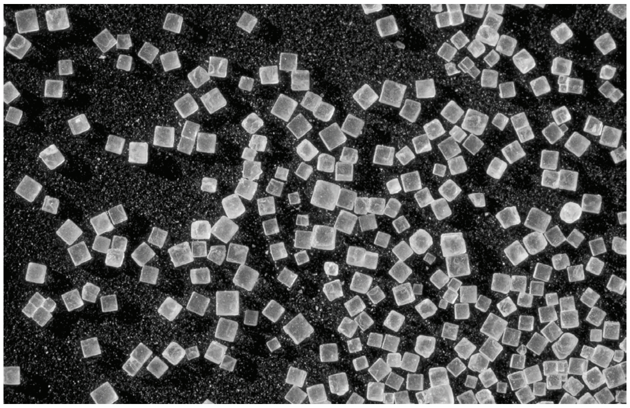


Salt Crystals

Activity 1: Understanding Magnification and Scale

Understanding magnification and scale is vital to the use of a microscope and the analysis of what is observed. In this activity, you will explore magnification and scale using the digital capabilities of the Swift *Digital Microscope and by building models. You will refer back to this activity and build upon it in subsequent activities.*

Safety Note:

Remember to practice proper safety techniques in all science laboratory activities and to teach your students how to conduct themselves responsibly in the lab or classroom. *Swift* Optical Instruments, Inc. supports proper safety techniques and practices. We hope these activities and proper adherence to safety guidelines give you and your students the opportunity to teach, learn, and practice responsibility in the science lab.

Purpose:

To explore scale and magnification for the purpose of preparing for the following activities, and to understand that things viewed under a microscope might look two-dimensional but do actually have depth. This will lay the groundwork for later activities

Overview:

Students observe and measure salt crystals at various magnifications and as viewed at different scales, including with the naked eye, through the various lenses of the microscope, on the microscope's mini-digital screen, on a computer screen, and projected in front of the class. They consider physical models of salt crystals at various scales. They consider how the field of view decreases with an increase in magnification.

Time:

One (50 minute) session—Note: If students are new to the use of the *Swift* Digital Microscope, this activity may take longer.

Materials:

- *Swift* Digital Microscopes
- Computers
- Transparent ruler (with microns)
- Table salt
- Clay
- Microscope slides and cover slips
- Projector (for one computer)
- Meter stick or ruler
- Dark paper

Background:

The eyepiece (including for the camera) on the *Swift* Digital Microscope magnifies objects 10 times. Each lens then further magnifies the objects: 4X (or 4 times magnification), 10X, and 40X, as marked on the lens used. These magnification numbers combine to give the actual magnification of the object. For example, using the eyepiece plus the 4X lens, the magnification is 10 x 4 or 40 times or 40X. Any object viewed this way will appear 40 times its actual size.

Eyepiece Magnification	10X	10X	10X	10X
Lens Magnification	4X	10X	40X	100X
Total Magnification	**40X**	**100X**	**400X**	**1000X**

Also, as the magnification increases, the field of view, or total area that can be seen, decreases. At 40X, the field of view is a circle about 4.5 mm in diameter. The change in the field of view is inversely proportional to the magnification increase. It's like zooming in: the closer you go, the less area you see.

4.5 mm x 40 / ___ = ___

For example, the field of view at 100X is:

4.5 mm x 40 / 100 = 1.8 mm

Total Magnification	40X	100X	400X	1000X
Field of View	4.5 mm	1.8 mm	0.45 mm	0.18 mm

Notes:

In this activity, students make physical models of the salt crystals at the various magnifications. Table salt is approximately 0.3 millimeters on each side, so a 40X salt crystal model would be about 0.3 x 40, or 1.2 cm in each dimension.

Actual	40X model	100X model	400X model	1000X model
0.3 mm	1.2 cm	3 cm	12 cm	30 cm*

Under a microscope, things typically look only two dimensional, but it is important for your students to understand that—just like the salt crystals look like squares, while they are actually cubes—other items viewed under a microscope are also (typically) three dimensional.

* Making an actual clay model of this is obviously not practical. Even for the 400X model, you might want to simply have a few examples available for your class.

Preparation:

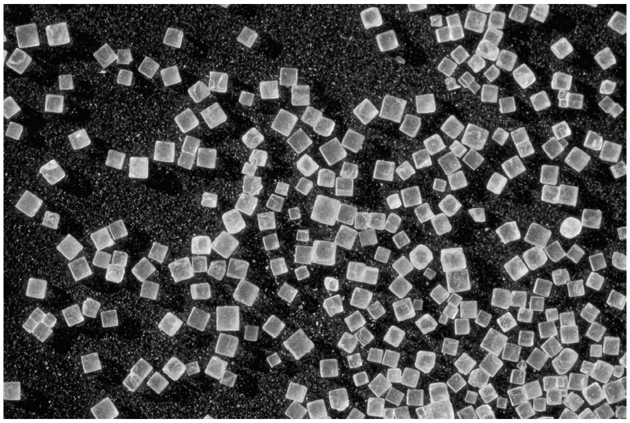
Gather the necessary materials, set up the microscopes and computers, and prepare one computer to project in front of the class. NOTE: *These general preparation instructions will not be included in future activities, as they are appropriate for all the activities in this guide.*

Procedure:

1. Have students work in pairs or small teams to complete the activity.
2. Toward the end of the activity, when the class is ready, project a view of salt crystals at 40X magnification and have students measure the size of the image.
3. Lead a discussion on the size of the salt crystal, the magnification of the crystal, and the size of the image.
   - The 4X objective results in a 40X magnification; the 10X objective a 100X magnification, and the 40X a 400X magnification.
   - The salt crystals are 3-dimensional, despite how they appear under the microscope.
   - The scale at which an image is viewed (mini-screen, computer screen, projector) doesn't change the magnification of the microscope.

Assessment:

Have your students prepare a summary of the various magnifications and their implications. What is the magnification using each lens of the *Swift* Digital Microscope? What is the field of view at each magnification? What is gained by going to a higher magnification? What is lost? How does magnification relate to image size?


Salt Crystals

Student Sheet

Activity 1: Understanding Magnification and Scale

Understanding magnification and scale is vital to the use of a microscope and the analysis of what is observed. In this activity, you will explore magnification and scale using the digital capabilities of the Swift *Digital Microscope and by building models. You will refer back to this activity and build upon it in subsequent activities.*

1. Examine crystals of table salt using your naked eye. (Try pouring a small amount of salt onto a dark piece of paper.)
   - Describe a salt crystal.
   - Draw a picture of a salt crystal.
   - Measure the size of a salt crystal, in millimeters, as best you can and record this information.
2. Place a number of salt crystals on a microscope slide.
3. Working with a partner, examine the salt at 40X magnification (i.e., the 4X lens) using the eyepieces on the microscope. Do NOT use the mini-digital screen or computer screen.
   - Describe a salt crystal as viewed under the microscope at 40X. Focus on what details you can see at this magnification that you could not see before.
   - Draw a picture of a salt crystal as viewed at this magnification.
   - Draw a picture of the entire field of view of the microscope at this magnification. The field of view is the entire circle, or area, that can be seen.)
   - Measure the size of a salt crystal, in microns, using a transparent ruler, and record this information.

     A micron, or micrometer (symbol μm), is one millionth of a meter or one thousandth of a millimeter: 1000 microns = 1 millimeter.
   - Measure the diameter of the field of view, in millimeters or microns, and record this information.
4. Make a physical model of a 40X magnification salt crystal.
   - Calculate the dimensions of a model crystal that is 40X the size of an actual crystal.
   - Use clay and a ruler to make a 3-dimensional model of the appropriate size.
5. Repeat the observations and model-making for 100X (i.e., the 10X lens) and 400X (i.e., the 40X lens).
   - Notice and record additional details about the crystals as the magnification increases.

! REMEMBER to practice proper safety techniques in all science laboratory activities!

6. Repeat the observations for 1000X (i.e., the 100X, oil immersion lens).
   - Why are you not asked to make a physical model of a 1000X magnification salt crystal?

7. Compare your drawings and the physical models at each magnification.
   - Compare the level of detail visible at each magnification.
   - Compare an actual salt crystal to your clay models. Think about how much they increase in size and what this means about what can be viewed at each magnification.
   - Compare the fields of view. Think about how much they decrease in size and what this means about what can be viewed at each magnification.
   - In later activities, keep in mind that what you are viewing under the microscope is almost always 3-dimensional, just like the salt crystals.

8. Calculate the field of view when using each lens.
   - At 40X, the field of view of the *Swift* Digital Microscope is approximately 4.5 mm.
   - The field of view is inversely proportional to the increase in magnification:

     4.5 mm x 40 / ___ = ___

     For example, the field of view at 100X is 4.5 mm x 40 / 100 = 1.8 mm.
   - Compare these calculated values to your measured diameters of the field of view. *How closely do they match?*

9. Return to 40X magnification and examine the salt crystals again, this time using the mini-digital screen that is on top of the *Swift* Digital Microscope.
   - Using the transparent ruler, again measure the size of the salt crystal. (This is the same measurement you made earlier.)
   - Compare the level of detail you can see this way to what you see using the eyepieces. This view is comparable to looking through the eyepieces, in terms of the magnification and the level of detail you can see (though sometimes the digital view isn't quite as crisp).
   - Take the transparent ruler, hold it in front of the mini-digital screen, and measure the size of the salt crystal image. *How does the size of the salt crystal on the mini-screen compare to the size of a salt crystal? Is it 40X as large?*

10. Examine and measure the salt crystals on your computer screen.
   - Using the software's measurement tool, again measure the size of the salt crystal. You are using a different tool, but the measurement is the same one you've made several times now.
   - Take the transparent ruler, hold it in front of the computer screen, and measure the size of the salt crystal image. *How does the size of the salt crystal on the computer screen compare to the size of a salt crystal? Is it 40X as large? How does it compare to the size of the image on the mini-screen?* Image size is distinct from level of magnification.

- Under Tools, access the Magnifier option.
- Observe your image of the salt crystals at 2X, 4X, 8X, and 16X magnification using this tool. Note: Despite the term used by the software, you haven't changed the microscope's level of magnification, just the size of the image. The image is larger, but you aren't getting additional details.

11. Examine and measure the salt crystals that are projected in front of the class, and discuss what you see in terms of the size of the crystal, the magnification of the crystal, and the size of the image.
    - Take a ruler or meter stick, hold it in front of the projection screen (trying to stay out of the way as much as possible), and measure the size of the salt crystal image. *How does the size of the salt crystal on the screen compare to the size of a salt crystal? To the sizes of the salt crystal as viewed on the other screens?* Again, image size is distinct from level of magnification. If you want to see additional details, you need to go to a higher level of magnification.