



SCIENCE, TECHNOLOGY,
ENGINEERING, AND MATH
COLORADO STATE UNIVERSITY
EXTENSION

ST[EMpower]



CAREERS

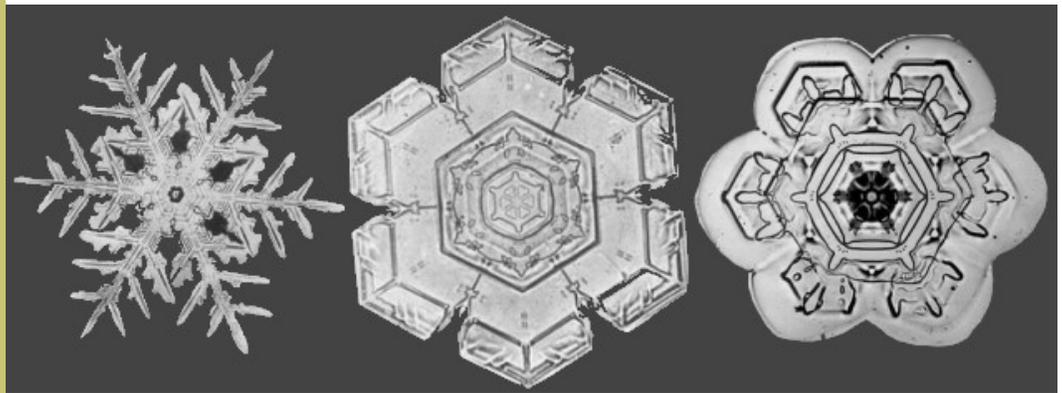
For our first step in exploring careers, you need to determine what are your interests and talents. Check each response if it is something that you would really like to do, or you do regularly. There is no wrong answer unless you do not answer honestly! Be picky!

Keep this until next month for the results.

1. Rescue a cat stuck in a tree.
2. Visit the pet store every time you go to the mall.
3. Paint a mural on the cafeteria wall.
4. Run for a 4-H county council officer position.
5. Send e-mail to a "4-H pen pal" in a different state.
6. Survey your 4-H club members to find out what they do after school.
7. Try out for the school play.
8. Dissect a frog and identify the different organs.
9. Play baseball, soccer, basketball, football, or ____ (fill in your favorite sport).
10. Talk on the phone to just about anyone who will talk back.
11. Try foods from all over the world: Thailand, Poland, Japan, etc., and do the Passport to Foreign Cookery project.
12. Write poems about things

SNOWFLAKE SCIENCE ARE THERE REALLY NO TWO SNOWFLAKES ALIKE?

Dr. Barbara J. Shaw



BACKGROUND

Information

"Under the microscope, I found that snowflakes were miracles of beauty; and it seemed a shame that this beauty should not be seen and appreciated by others. Every crystal was a masterpiece of design and no one design was ever repeated. When a snowflake melted, that design was forever lost. Just that much beauty was gone, without leaving any record behind."
Wilson "Snowflake" Bentley 1925

Wilson Bentley attached a microscope lens to the bellows of his camera. It took years of trial and error, and he finally was the first person to photograph a single snowflake in 1884. During his lifetime, he photographed more than 5000 snowflakes, no two alike.

Objectives

You will make a **macro lens** for your cellphone camera to take individual snowflake images! If you don't have a cellphone camera, you can use a digital camera with a macro-lens feature. Check with your extension office to help you find a camera to borrow if you don't have one.

DO:

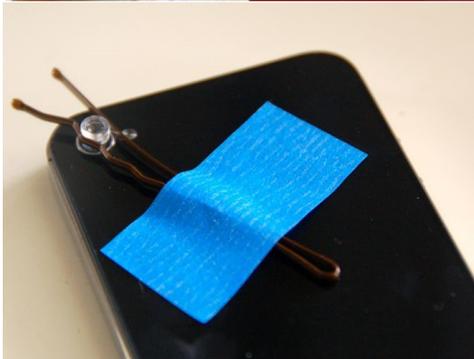
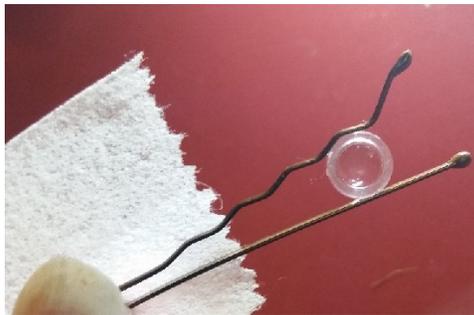
Materials:

- Cellphone camera
- **CHEAP** laser pointer (i.e. dollar store)
- Needle nose pliers
- Bobby pin
- Tape
- Black construction paper

Directions:

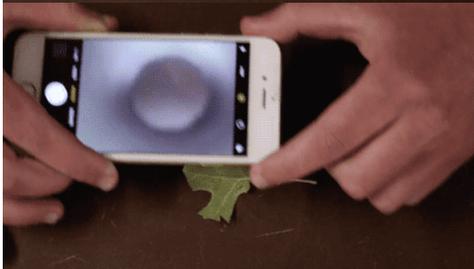
Macro Lens

- Unscrew the cap on the laser pen, and inside you will see a black ring, and in the center is the lens.
- Use the needle nose pliers to remove the black ring, then tap out the lens. Careful, it is very small and easy to lose. (You can still use the laser pointer, but the light will not be focused to a sharp point.)
- Carefully insert the lens in the first groove of the bobby pin.
- Take your cell phone (any cellphone with a camera will work) and find the lens. It will be small. You may have a flash on the camera, so be sure that it is the lens and not the flash.
- Place the laser lens over the lens of the camera lens and tape in place.
- Turn off the auto-focus (if necessary).
- Use something small (for example a dime) to verify that you have installed your **macro lens** correctly. Hold the camera about 2 or 3 inches above the battery, and move your hand back and forth until you find the correct focal distance.



Photographing a Snowflake

- Place the black piece of construction paper outside in a protected area for at least one hour. The paper needs to be chilled, so that the snowflake will not melt when it lands on the paper.
- If it is snowing, you need to find a place where you can capture the snowflakes on the black construction paper close to a covered area (like the front porch) where you can photograph them with your cellphone. If you try to take the snowflake image while it is snowing, especially if it is a heavy snowfall, it will be frustrating to try to capture a single flake.
- Collecting snowflakes can be a fun challenge. The easiest is when it is lightly snowing, although you can get some really nice snowflakes in a heavy snow. Hold the cold paper out and catch several snowflakes. If it is not snowing, you can capture some individual flakes that have already fallen. Make sure that your gloves are the same temperature as outside (either by leaving them outside before putting them on, or staying outside for at least 30 minutes before touching the flakes). Take a small pinch of snow and toss it into the air above your black construction paper and catch the flakes as they come back down.

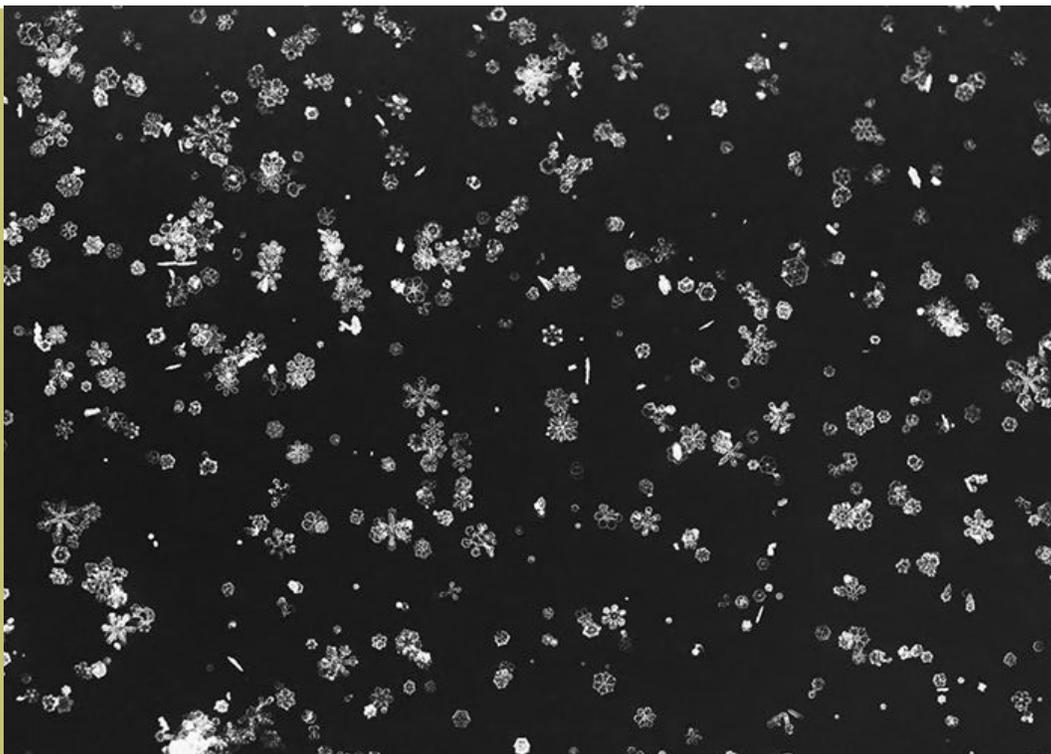


that are happening in your life.

13. Create a really scary haunted house to take your friends through on Halloween.
14. Raise a 4-H lamb for breeding or market and enter in the county fair.
15. Bake a cake and decorate it for your best friend's birthday in the cake decorating project.
16. Sell enough advertisements for the school yearbook to win a trip to Walt Disney World.
17. Simulate an imaginary flight through space on your computer screen.
18. Build model airplanes, boats, doll houses, or anything from scratch or a kit. Model rocket or woodworking heritage arts
19. Teach your friends a new dance routine.
20. Watch the stars come out at night and see how many constellations you can find.
21. Watch baseball, soccer, basketball, football, or ____ (fill in your favorite sport) on TV.
22. Give a speech in front of your 4-H council.
23. Go to Washington D.C. on the Citizenship Washington Focus with your state 4-H teen leaders.
24. Read everything in sight, including the back of the cereal box.
25. Figure out "who dunnit" in a mystery story.
26. Take in stray or hurt animals.
27. Make a display board about your 4-H project.
28. Think up new ways to

make lunch line move faster and explain it to the cafeteria staff.

29. Make your own movie in the 4-H filmmaking project.
30. Invest your allowance in the stock market and keep track of how it does.
31. Go to the ballet or opera every time you get the chance.
32. Do experiments with a chemistry set.
33. Keep score at your sister's little league team game.
34. Use lots of funny voices when reading stories to children.
35. Ride on airplanes, trains, boats, anything that moves.
36. Interview the new exchange student for an article in the monthly 4-H County Newsletter.
37. Build your own treehouse.
38. Help clean up a waste site in your neighborhood.
39. Visit an art museum and pick out your favorite painting.
40. Play Monopoly in an all-night championship challenge.
41. Make a chart on the computer to show how much soda students buy from the school vending machine each week.
42. Keep track of how much your team earns to buy new uniforms.
43. Plan an instrument in the school band or orchestra.
44. Take things apart and put them back together in the Small Engines project.
45. Write stories about sports for the school newspaper.
46. Listen to other people talk

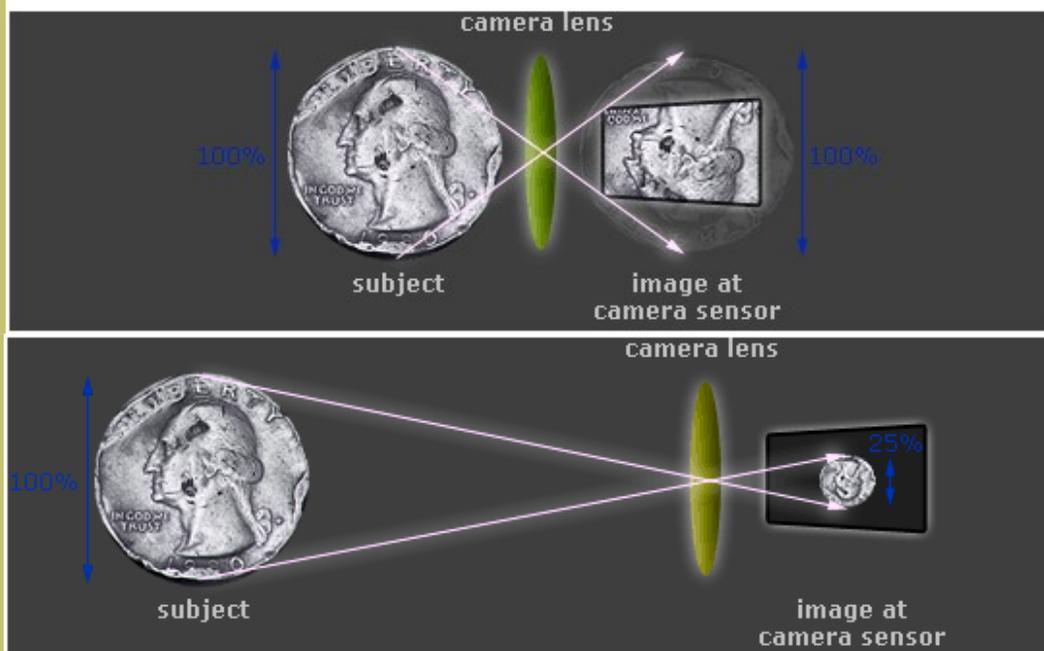


- Move the paper under the cover (but not indoors where they can melt). Be sure that you have plenty of light. Find the focus by moving your cellphone **macro lens** closer or further from the snowflake. Snap the image.
- For more ideas about capturing snowflakes or modifying how the image looks, see the Apply section.

REFLECT:

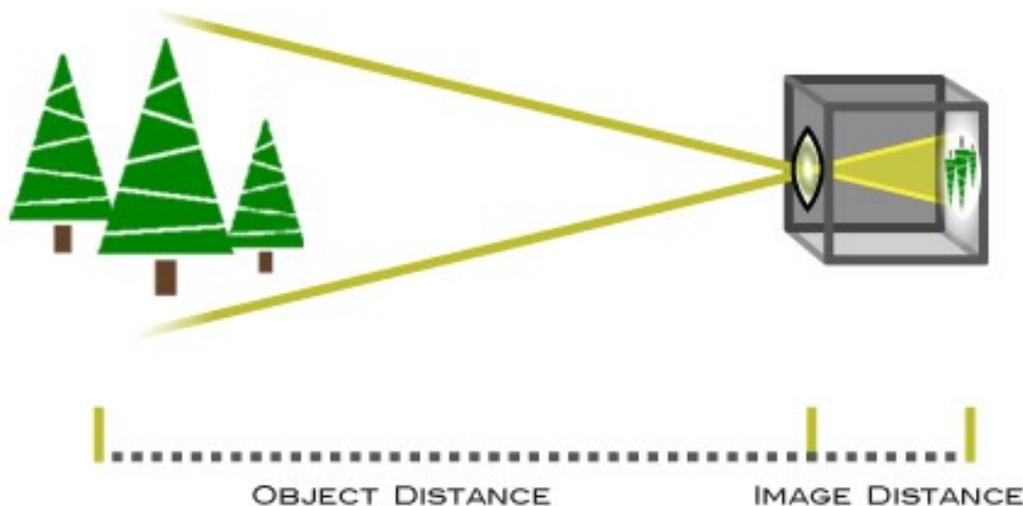
Concepts Behind the Activity

Macro Lens magnifies an image at 1.0X, or the life size of that image. The frame of your camera captures the actual size of the image. Most lenses shrink the image to fit in the frame of your camera.



A lens magnification has two components: object distance and image distance. The object distance is how far the object is from the lens. The image distance is how far the image is in focus behind the lens, called the **focal point**. The camera film or image sensor is at the image distance. In a macro lens, the object distance is very close. As the lens gets closer to the object, the larger the object appears.

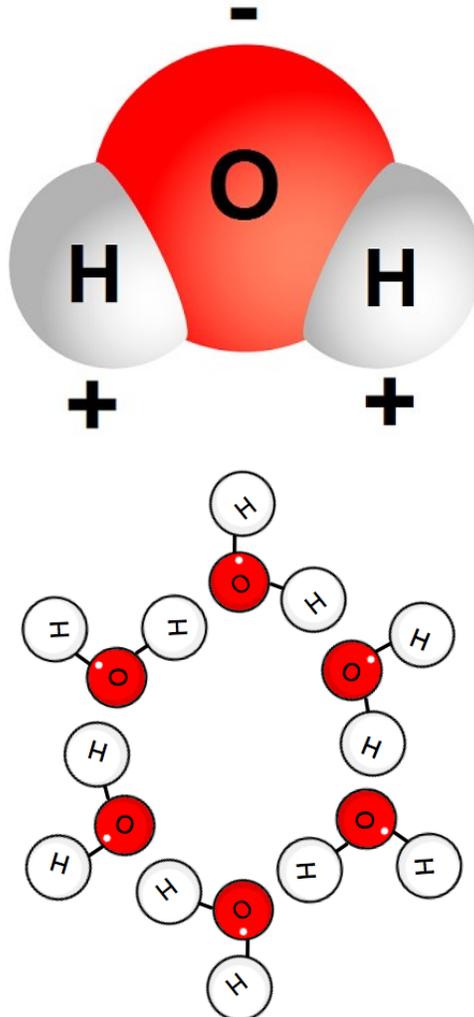
LENS FOCAL LENGTH



Snowflake Science is really cool!

The science behind how snowflakes form depends on the polar nature of a water molecule. H_2O has a very uniform structure as it freezes, usually forming in a **hexagon** shape. Notice in the diagram that the hydrogen (H) atoms are positive and the oxygen (O) atom is negative. The negative and positive sides of water molecules are attracted, and the positive/positive and negative/negative sides repel. This polar nature of water is fundamental in how water acts in all phases.

When water starts to freeze, the molecules slow down. This gives the negative oxygen and the positive hydrogen time to align. As water freezes, it takes this very uniform shape. It is the same shape regardless if water is freezing as an ice cube or a snowflake. This six-sided structure is the basis for a snowflake. If there is enough moisture, the snowflake begins to grow the branches, each from one of the hydrogen atoms that point out from the center. It takes a bit of dust in the cloud to start the snowflake growing.

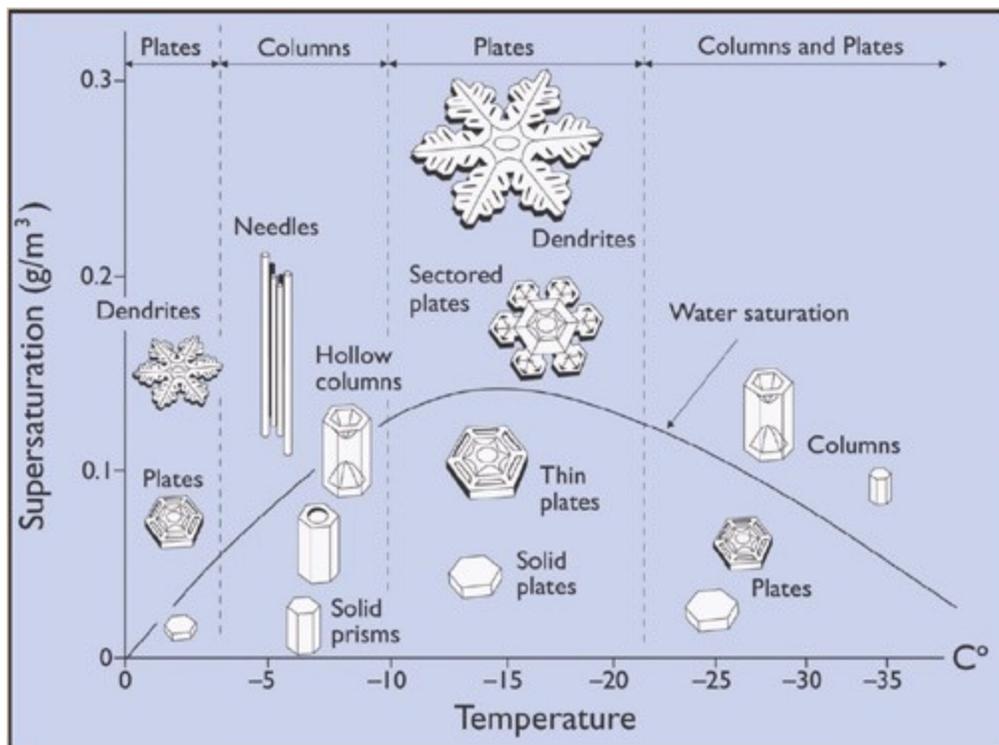


about their problems.

47. Imagine yourself in exotic places.
48. Hang around bookstores and libraries.
49. Play harmless practical jokes on April Fool's Day.
50. Join one of the 4-H clubs in your county.
51. Take photographs at the school talent show.
52. Make money by setting up your own business—paper route, lemonade stand, etc.
53. Create an imaginary city using a computer.
54. Do 3-D puzzles.
55. Keep track of the top 10 songs of the week.
56. Read about famous inventors and their inventions.
57. Make play-by-play announcements at the school football game.
58. Answer the phones during a telethon to raise money for orphans.
59. Be an exchange student in another country with the 4-H International Programs.
60. Write down all your secret thoughts and favorite sayings in a journal.
61. Jump out of an airplane (with a parachute, of course!).
62. Plant and grow a garden in your backyard (or windowsill) in the gardening project.
63. Use a video camera to make your own movies.
64. Get your friends together to help clean up your town after a storm.
65. Spend your summer at a computer camp learning lots of new computer

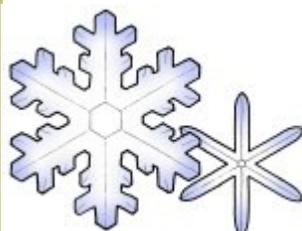
programs.

66. Build bridges, skyscrapers, and other structures (like robots) out of LEGOs.
67. Plan a concert in the park for little kids.
68. Collect different kinds of rocks.
69. Help plan a sports tournament.
70. Be DJ for the school dance.
71. Learn how to fly a plane or sail a boat.
72. Write funny captions for pictures in the school yearbook.
73. Scuba dive to search for buried treasure.
74. Recognize and name several different breeds of cats, dogs, and other animals.
75. Sketch pictures of your friends.
76. Pick out neat stuff to sell at the school store.
77. Answer your classmates' questions about how to use the computer.
78. Draw a map showing how to get to your house from school.
79. Make up new words to your favorite songs.
80. Take a hike and name the different kinds of trees, birds, or flowers.
81. Referee intramural basketball games.
82. Join the school debate team.
83. Make a poster with postcards from all the places you went on your summer vacation.
84. Write down stories that your grandparents tell you about when they were young.

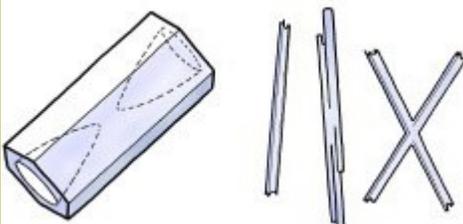


KENNETH G. LIBBRECHT/BASED UPON EXPERIMENTS BY U. NAKAYA

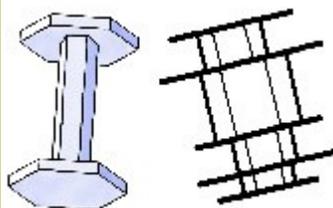
Snowflakes come in some basic forms.



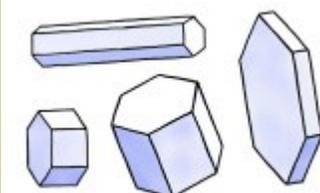
Stellar Dendrites: stellar = star and dendrite = crystal tree-like. Stellar dendrites are quite large and common, probably the most recognized snowflake. The best specimens usually appear when the weather is quite cold, around -15°C (5°F).



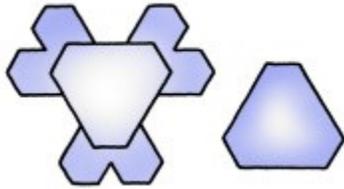
Columns and Needles: These small, but easy to miss crystals are common. They appear when the temperature is -6°C (21°F). Hollow columns have conical hollow regions in both ends. The especially long, slender columnar crystals are “needle crystals.”



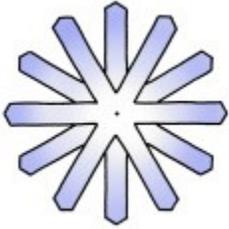
Capped Columns: Not common but easy to find. The basic shape looks like an axel with two wheels and they can form additional plates. These form when traveling through different temperatures while they are growing. The first column forms at -6°C (21°F), and then the plates grow on the ends of the columns at -15°C (5°F).



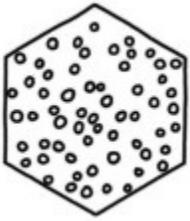
Diamond Dust Crystals: These are tiny snow crystals that look like sparking dust in the sunlight. They are the smallest snowflakes that form in the most bitter cold weather. Diamond dust is a phenomena that is seen most frequently in the interior of Antarctica.



Triangular Crystals: These are very unusual snowflakes, but until recently, no one had a good explanation why. Drs. Libbrecht and Arnold have support that suggests they are formed by blowing winds. They have successfully replicated triangular crystals in their lab. They noted that these flakes actually have six sides—3 short and 3 long, but the overall symmetry is triangular.



Twelve-branched Snowflakes: These are formed when 2 snowflakes collide in mid-air. Surprisingly, they are not rare, and you can easily find them if you keep an eye open for them!



Rimmed Snowflakes and Graupel: Snowflakes grow inside clouds made of water droplets. Water droplets freeze on the growing snowflake when they collide. These droplets are called **rime**. The snowflake can have no **rime**, a few droplets, or completely covered with **rime**. Blobs of **rime** are called graupel or soft hail.

Irregular Crystals: These are the most common snowflakes by far. They are small and clumped together, and they show little symmetry seen in the other types of flakes.

APPLY:

Extensions to the Activities

- With practice, you can start taking beautiful images of snowflakes. Instead of using black construction paper, try using a dark fabric in black or other colors (dark blue, dark grey, dark green, dark red, etc.) Be sure to keep a high contrast between your snowflake and the background color.
- Try using glass instead of fabric. Some of the most beautiful images taken are on glass. What about a mirror? Collect the flakes on your construction paper or cloth, and with a small paintbrush, move them from the cloth to the glass. Remember to bring the temperature of the glass or mirror, paper or cloth, and the paintbrush to outside temperature first.
- What can you do with your snowflake images? Print them and make a frame for them to decorate your room or give them as presents to family or friends.
- Go on a snowflake treasure hunt. Can you photograph one of each of the snowflake types?
- Did you know that you can preserve snowflakes in superglue? Awesome! Here's how:
 - Materials:
 - * tube of thin liquid superglue—not the gel type
 - * glass microscope slides and cover slips
 - * small paintbrush, the smaller the better
 - * piece of dark construction paper or dark cloth
 - Directions:
 - * Place everything outside in a protected area for at least one

POWER WORDS

- convex:** having an outline or surface curved like the exterior of a circle or sphere
- dendrite:** a crystal or crystalline mass with a branching, tree-like structure
- focal point:** as light passes through a **convex** lens, they bend and meet (the image is in focus at this point behind the lens)
- hexagon:** a six-sided polygon
- macro lens:** able to reproduce a life-sized image of an object on the recording medium
- polar:** having electrical or magnetic polarity, or poles
- rime:** frost formed on cold objects by the rapid freezing of water vapor in cloud or fog

FASCINATING FACTS

Scientists can now grow identical snowflakes in a lab. By placing two crystal seeds next to each other and growing them under the exact same conditions, Dr. Libbrecht found that he could create two snowflakes with nearly the same intricate shapes and patterns.



JOKES

- Q: What does the snowman have for breakfast?
A: Snowflakes!
- Q: What did the pirate say when he got his peg leg stuck in an iceberg?
A: Well, shiver me timbers!

THANKS

Stephanie Conley for her help with Careers Questionnaire!

CITATIONS

<http://www.its.caltech.edu/~atomic/snowcrystals/class/snowtypes4.jpg>

https://www.youtube.com/watch?v=Sb_xrEXlhHE

<http://www.snowflakebentley.com/bio.htm>

<http://www.noaa.gov/stories/how-do-snowflakes-form-science-behind-snow>

<http://www.snowcrystals.com>

<https://www.420magazine.com/forums/do-it-yourself/305072-diy-cheap-macro-lens-camera-phones.html>

<https://www.cnet.com/how-to/diy-macro-lens-for-your-phones-camera/>

<https://www.cnet.com/how-to/diy-macro-lens-for-your-phones-camera/>

<http://astrocampschool.org/author/alisa/page/6/>

<https://byjus.com/physics/macro-lens/>

<https://www.nikonusa.com/en/learn-and-explore/a/tips-and-techniques/understanding-focal-length.html>

Reeves, Diane Lindsey and Clasen, Lindsey (2007) Career Ideas for kids who like Science 2nd Edition. Checkmark Books, New York NY; Pp7-26.

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hour. They need to be chilled, so that the snowflake will not melt when it lands.

- * When snow is falling, collect some flakes on your construction paper or cloth.
- * Use your macro lens for a better view. When you see an outstanding crystal, gently pick it up with the paintbrush (it's easier than it sounds) and place it on a clean glass slide.
- * Carefully add a good-sized drop of cold superglue right on top of the crystal, and place a cover slip on top of that.
- * You may trap an air bubble or two with the snow crystal. That's okay. The image on the right is a superglued snowflake with an air bubble.



- What other images can you take with your macro lens?
 - What does a coin or dollar bill look like close-up?
 - What does the inside of a flower look like?
 - How about a leaf? Ultra-cool is the bottom side of a leaf from the plant *Tradescantia zebrina*. The underside of the leaf is purple. The leaf has tiny holes called stomata on the bottom to allow carbon dioxide to enter and oxygen to exit. The stomata are green in a sea of purple!
 - Ever think getting close up to insects or spiders? You now can!
 - Ever take a close up of a parent's eye?
 - What about your fingerprint?
- How does lighting affect the image? Use your macro lens in different levels of light. Does the image look better at the first light? Last light? Middle of the day light? How about using a light bulb? What is you use a filter to color the light (like a red filter or blue filter).
- How do lenses work? To really see the differences in lenses, use your macro lens from the laser pointer, and any hand lens you have around your house.
 - Stand sideways by a window. Hold up a piece of paper and place the lens between the paper and the window. Be sure that you don't block the light between the window, the lens, and the paper.
 - Move the lens backwards and forwards until you find the focal point of that lens. You will see the window and the outside (in the image to the right, you can see the trees in my front yard). For the macro lens, think about how close you have to hold the cellphone camera to have your image in focus. How close do you need to hold it to the paper for the image to be clear?
 - How far is the lens from the paper? That is the focal distance for for each lens. The shape of the lens determines the focal distance.

