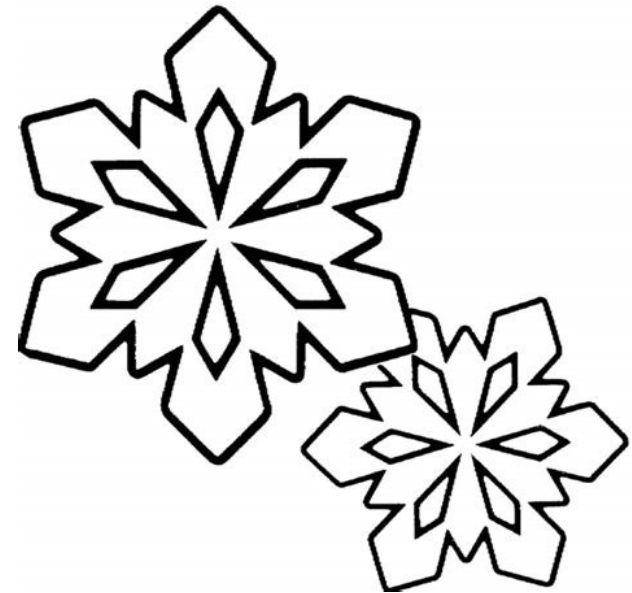


Keep Exploring!



OPERATION SNOWFALL



Name: _____

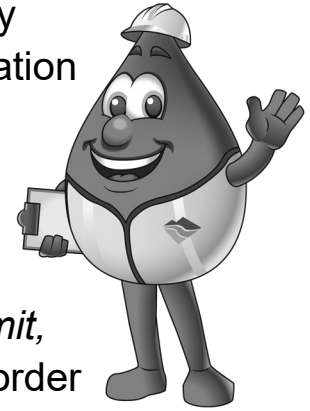
To explore other curriculum and activities developed by
Central Utah Water Conservancy District head to:
<https://cuwcd.com/education.html>

 Central Utah Water STEM Club Passport

Who is Central Utah Water?



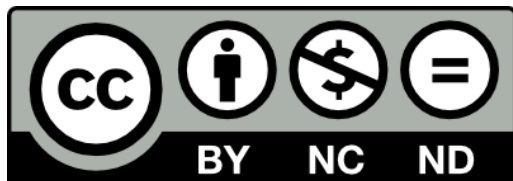
Central Utah Water Conservancy District is a government organization with the mission to move water across county boundaries. We have 8 counties located within the District (*Duchesne, Juab, Salt Lake, Sanpete, Summit, Uintah, Utah, and Wasatch*). In order to meet our mission of moving water, Central Utah Water stores water in 9 reservoirs, maintains over 180 miles of large diameter pipelines, and runs 3 regional drinking water treatment plants.



In addition to our primary responsibility to move water, Central Utah Water is the second largest producer of hydropower in the State of Utah, works to protect endangered species, supports community based water conservation projects, and is a regional leader in water education.

To learn more about Central Utah Water and our work in the community go to CUWCD.com

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Central Utah Water Conservancy District
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Further Adventures



Just because this club is done, doesn't mean you have to end the fun! H₂Joe has done his research and found you a bunch of other snow related activities and games that you can do at home.

FEMA - Winter Weather Preparedness

<https://www.ready.gov/kids/disaster-facts/winter-weather>

PBS - Snow Search Game

<https://pbskids.org/sid/games/snow-search>





National Weather Service - Winter Safety

<https://www.weather.gov/safety/winter>

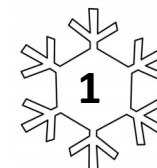
Scholastic - Snowy Science

<https://www.scholastic.com/teachers/blog-posts/alycia-zimmerman/snowy-science-four-frosty-experiments/>

Welcome to the Operation Snowfall STEM Club! Together we will be tackling 4 unique activities, each one exploring a different aspect of snow. If you work as a team to defeat all 4 challenges a special surprise will greet you at the end of the club. Lets put on our coats and explore snow!

-  **Activity 1** - Operation Snowfall
-  **Activity 2** - Studying the Snowflake
-  **Activity 3** - Mother Nature's Reservoir
-  **Activity 4** - Greatest Snow on Earth

Hi, I'm H₂Joe.
I am looking forward to
learning about snow
with you!





Operation Snowfall

Over 80% of the water that falls on the state of Utah comes in the form of snow. Most of this snow falls in Utah's mountains, so that is where most of the scientific instruments that measure snow are located. Unfortunately that means that there is still a lot to learn about the snow that falls in valleys. By participating in Operation Snowfall, you help scientists fill in the gaps in their data.

For The Operation Snow I Need...

Dichotomous Key Observation Sheet

Black Felt Toothpicks

Magnifying glass (*optional*)

FUN FACT

Identical snowflakes are incredibly rare, but they do exist. The first known twin snowflakes were collected on November 1, 1986 in Colorado by the Meteorologist Nancy C. Knight.



Record Snowflake Data



OBSERVATION SHEET

Observation 1		Snowflake Drawing			
Date: _____		Time: _____			
Location: _____					
Temperature: _____		% Cloud Cover: _____			
Snowflake Type:	Plate	Stellar Crystal	Columns	Needles	
	Spatial Dendrites	Capped Columns	Irregular particles		
Other Comments:					

Observation 2		Snowflake Drawing			
Date: _____		Time: _____			
Location: _____					
Temperature: _____		% Cloud Cover: _____			
Snowflake Type:	Plate	Stellar Crystal	Columns	Needles	
	Spatial Dendrites	Capped Columns	Irregular particles		
Other Comments:					

Observation 3		Snowflake Drawing			
Date: _____		Time: _____			
Location: _____					
Temperature: _____		% Cloud Cover: _____			
Snowflake Type:	Plate	Stellar Crystal	Columns	Needles	
	Spatial Dendrites	Capped Columns	Irregular particles		
Other Comments:					





Track Storms

MONTH _____						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

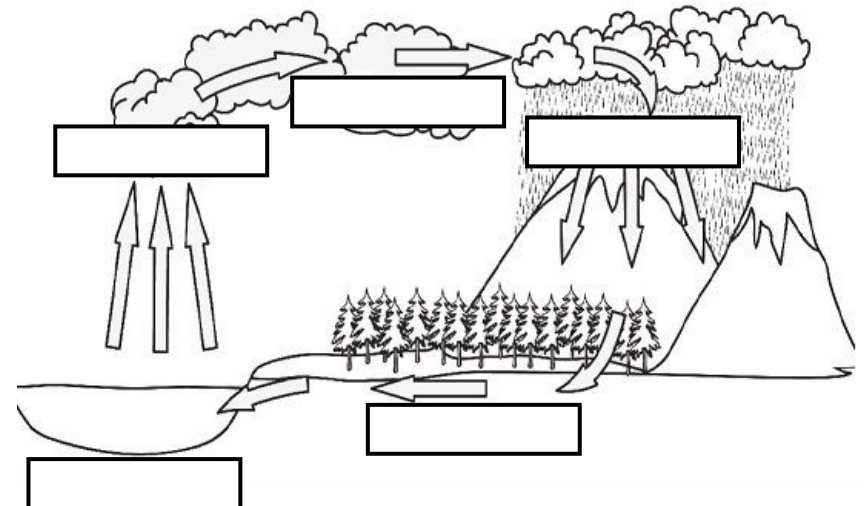


Operation Snowfall



All snow on earth is the product of the water cycle. In Utah, some of the water that falls as snow evaporated from the Pacific Ocean and was pushed by the wind across California and Nevada to get here. The rest of the water evaporated off of the Great Salt Lake and other large water bodies before falling as precipitation in our local mountains. This process is called lake effect snow!

Label this water cycle:





Operation Snowfall

The first step in participating in Operation Snowfall is to identify when a snowstorm will occur. The easiest way to do this is by looking at a weather forecast. A special type of scientist, called a meteorologist, creates these forecasts using information from places where the weather traveled from, planes, radar stations, and even satellites in space.

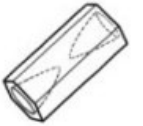
Forecasters use special words to warn us about the severity of storms.

Identify what each term means below:






Winter Storm Watch	
Winter Weather Advisory	
Winter Storm Warning	
Blizzard Warning	
Ice Storm Warning	



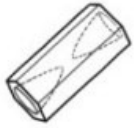
Greatest Snow On Earth



As we learned, what makes 'Greatest Snow on Earth' depends on what that snow will be used for. Write down what the best type of snow would be for each of these category of people.

 Snowman Builder	
 Snowboarder	
 Cross-country Skier	
 Snow Shoveler	
 Water Manager	





Greatest Snow On Earth

In addition to the characteristics of snow, the amount of snow is important in finding the 'Greatest Snow On Earth.' Explore the globe and find out the places that have the highest and lowest amounts of annual snowfall.

Color in locations on the map that normally receive snowfall every year:



Operation Snowfall



When the snowstorm arrives, it is time to classify snowflakes using a dichotomous key and snow catching equipment. Each type of snowflake has a different amount of water in it, so this information will help scientists estimate how much water fell in the storm.

Use the dichotomous key to match the snowflake with its name:



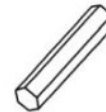
Graupel



Plate

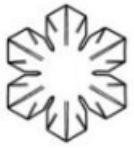


Stellar Crystal



Column





Studying the Snowflake

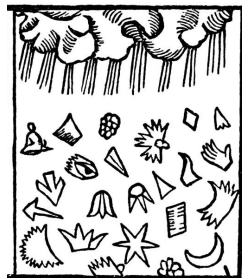
Humans have been trying to unlock the secrets of the snowflake for thousands of years. Each scientist and citizen scientist who completed research in the field helped grow our knowledge of snowflakes into what it is today.

For To Study The Snowflake I Need...

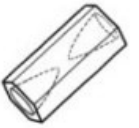
- | | |
|-----------------|----------------------------|
| Fabric or Paper | Scissors |
| Pencil/Pen | Needle |
| Thread | Camera (<i>optional</i>) |

FUN FACT

The oldest example of snowflake diagrams that we can still see today were published in Olaus Magnus's book the *Historia de Gentibus Septentrionalibus* in 1555. You can see one of his diagrams to the right of the text.



Greatest Snow On Earth



The first step understanding how to create the 'Greatest Snow On Earth' is to understand how different types of snowflakes are formed. The unique shape of a snowflake is created through a combination of temperature and the amount of water in the air. This is how Operation Snowfall can use your snowflake shape data to estimate how much water came in a storm.

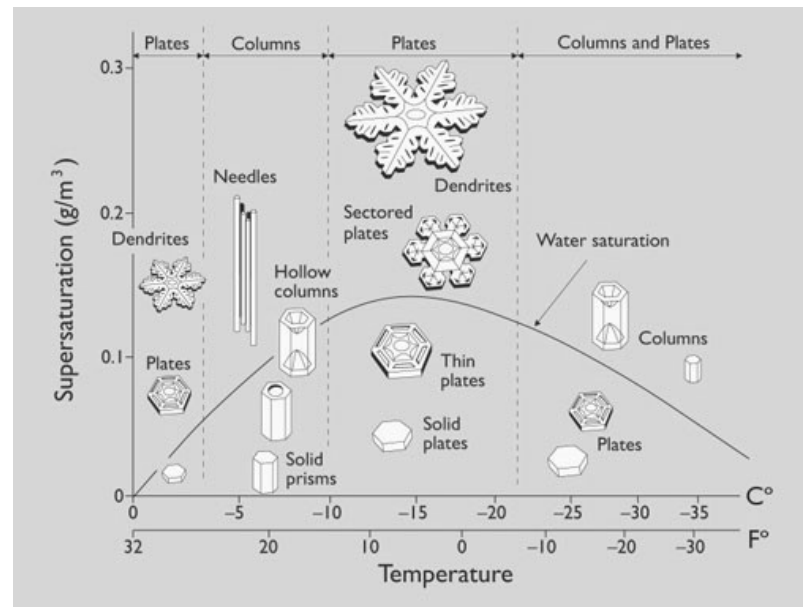
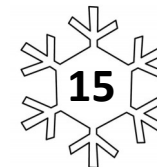
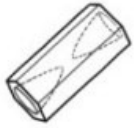


Image by Kenneth Libbrecht





Greatest Snow On Earth

Snow isn't just a wonderful way nature stores water, it is also a natural resource for recreation. But that leaves us with a couple of questions...Is all snow equally when it comes to winter activities? And is there a scientific way to find the greatest snow on Earth?

For To Study The Greatest Snow I Need...

Colored Pencils

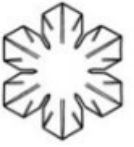
Thermometer

FUN FACT

Professor Jim Steenburgh at the University of Utah has dedicated his career to trying to find the best snow on earth. He has traveled around the world, but thinks he may have found it here in Utah!



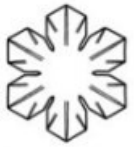
Studying the Snowflake



First way that humans used to describe their snowflake observations, was by using music and poetry. The oldest that exists to today is in Han Ying's Han Shi Waizhuan, which includes a song to teach students to pay attention to the hexagonal symmetry of snowflakes. This song is at least 2135 years old.

Create a short poem that describes your own observations about snowflakes:

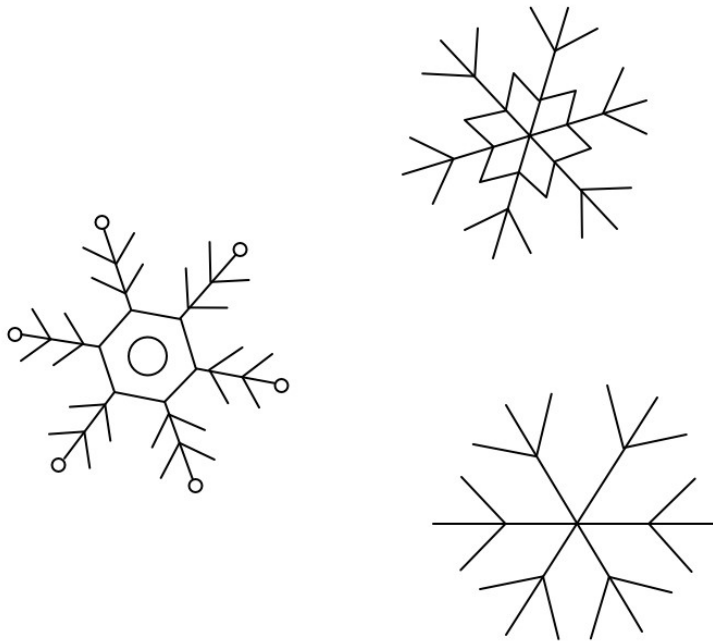




Studying the Snowflake

The next system that humans used to record the shapes of snowflakes was through art. Because paper was so rare and precious, the shapes of snowflakes were preserved by embroidering that pattern into a piece of fabric.

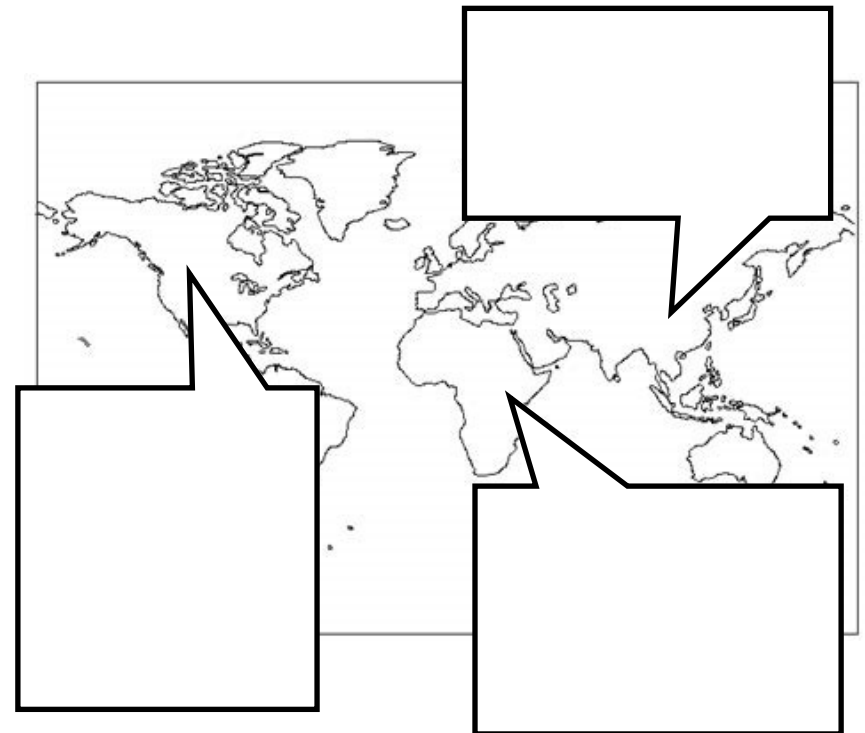
Using a Pen or Pencil trace one of the snowflakes onto a piece of paper or fabric then use a needle to embroider your design:



Mother Nature's Reservoir



As our globe changes and human communities grow, Mother Nature needs help so that she can meet our demand for water. Around the world different communities have engineered solution that can make sure that the water stored in snow pack is available when it is needed most.

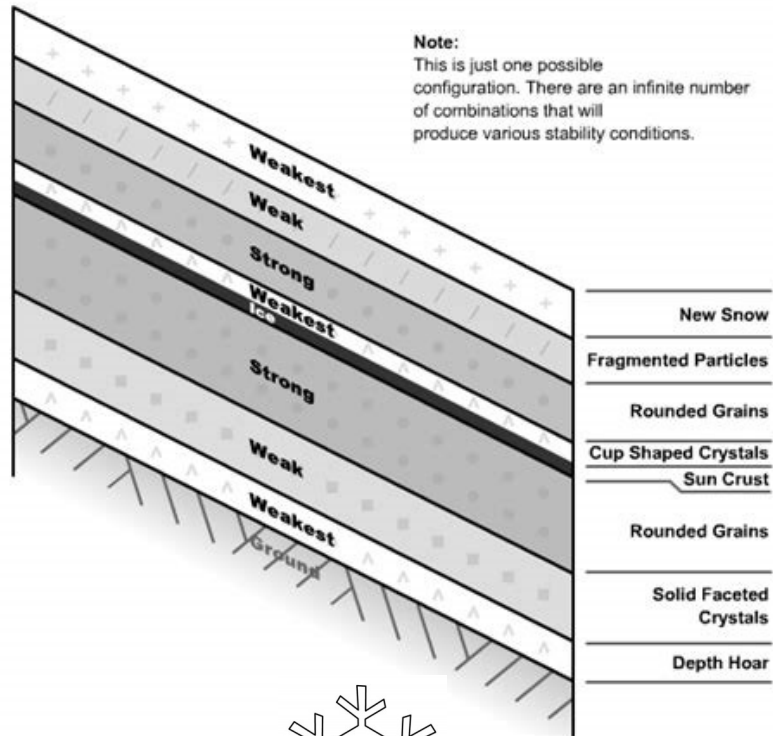




Mother Nature's Reservoir

Snow doesn't just give us water. It also gives us a history of recent storms that have hit the area. By digging down a hole in the snowpack, researchers can gain a better understanding about the types of storms that affect mountainous areas, as well as determine avalanche risk.

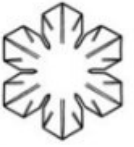
EXAMPLE OF LAYERS IN SNOWPACK:



Note:
This is just one possible configuration. There are an infinite number of combinations that will produce various stability conditions.



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Studying the Snowflake

The method that most snowflake scientists use to record is photography. Around the turn of the century two citizen scientists techniques that allowed them to take photos of snow through a microscope. The first of these photos were taken by Andrei Andreevich Sigson in Russia, the second and more famous photos were taken by Wilson Alwyn Bentley in Jericho, New York.



Sigson captured snowflakes using a piece of felt, then dropped the single snowflake he wanted to photograph onto a silk net.



Bentley captured snowflakes using a turkey feather, then placed the single snowflake he wanted to photograph on a piece of black velvet.



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Mother Nature's Reservoir

While we have a lot to learn from individual snowflakes, we can unlock even more information when we look at the snow pack as a whole.

For Mother Nature's Reservoir I Need...

- Measuring Cups Snow or Shaved Ice
- Bowl Heat Source
- Scale (*optional*)

FUN FACT



It is estimated that 1.7% of all water on our planet is stored in the forms of ice and snow. That is a whopping 68.7% of all freshwater in our planet. The best places to find these frozen water is high in mountains and at our planet's poles.



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Mother Nature's Reservoir

The water held in snow is critical for life in many communities around the world. This water needs to be measured so that communities downstream can make plans on how they can use that water wisely.

There is more than one way for scientists to measure the amount of water in snow. Let's compare two of these methods.

Melt Method	Weight Method



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