The science of snowflakes

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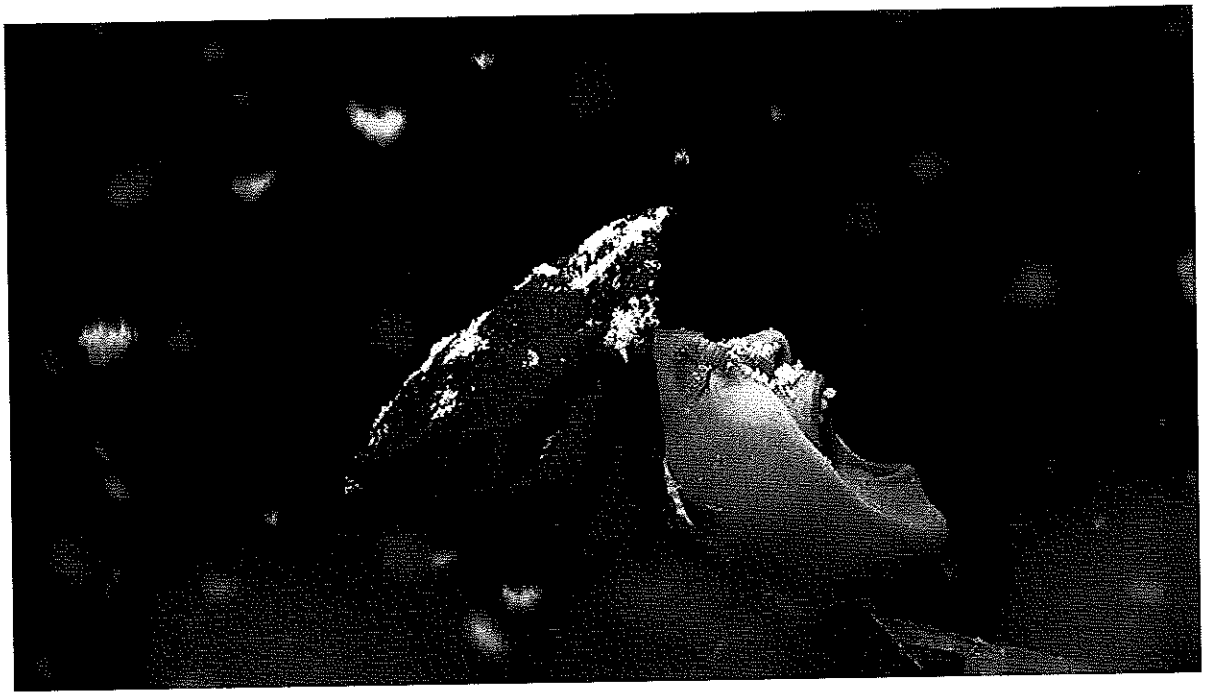
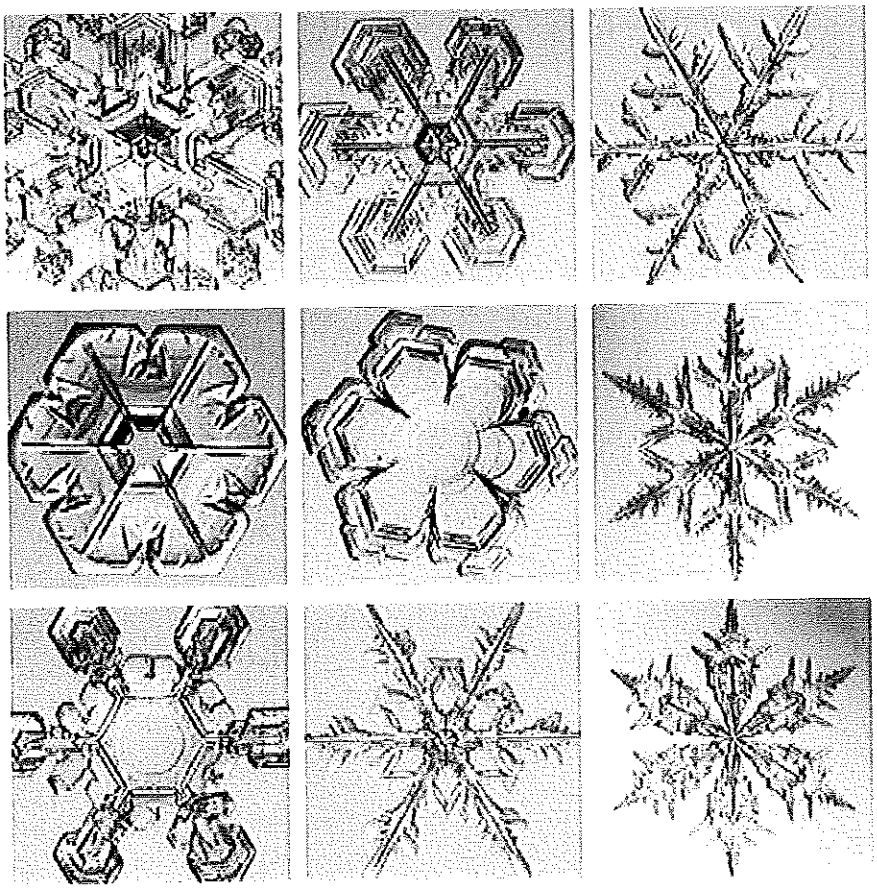


A boy tries to catch snowflakes with his mouth on in Kleinmachnow, Germany, November 22, 2015. Photo: RALF HIRSCHBERGER/AFP/Getty Images



They say no two snowflakes are the same. That may be true, but even though every snowflake is different, they share some important similarities. Look at the snowflakes in the image to the right.

Do you see a pattern? It may not be immediately clear, but snowflakes all have a similar, symmetrical shape. The fancy way to say this is that they all have "six-fold radial symmetry." Symmetry is when a shape or object looks the same after you flip, slide, or turn it. If you draw six evenly spaced lines out from the center of a snowflake, you will notice that the shape on that line is repeated on the five other lines.

Why do snowflakes have this pattern? And if they all have such a similar pattern, why is it impossible for two snowflakes to be exactly the same? To answer both questions, you have to know how a snowflake forms.

The Birth Of A Snowflake

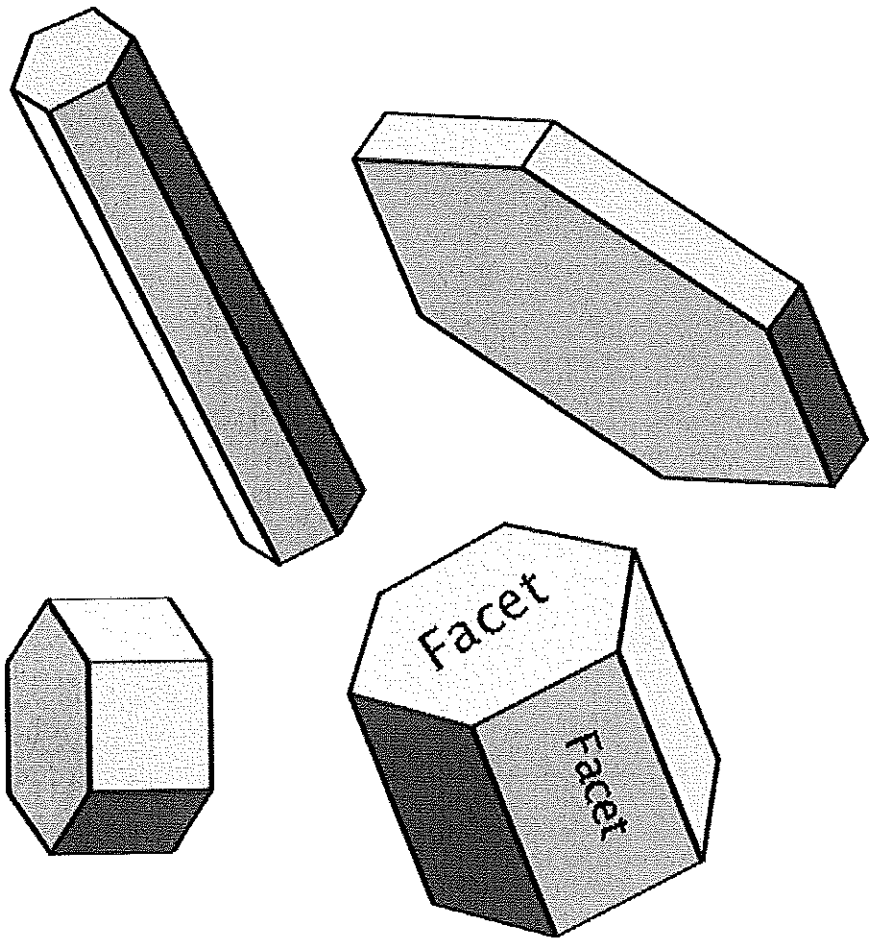
Snow is not simply a frozen drop of water that falls to the ground. Snowflakes get their unique shapes by forming slowly. They grow inside of clouds.

The birth of a snowflake begins with water vapor traveling through cold air. When a bit of water vapor comes into contact with a tiny particle or bit of floating dust it coats the particle. It then begins to condense, or change from a gas to a solid. Put another way, the water vapor turns to ice and freezes onto the particle. The result is a tiny ice crystal.

Soon, more water vapor sticks to the new ice crystal. More ice crystals form and join together to form a new, larger ice crystal. That ice crystal continues to grow and change its shape, and in time a snowflake is born.

The shape of a snowflake reflects the shape of the molecules that make up water. A molecule is the smallest part of any substance that still has the properties of that substance. For example, a molecule of water is the smallest bit of water you could have.

The molecules of different substances have different shapes. Because water molecules are six-sided, the crystals that make up snowflakes are six-sided, as well.



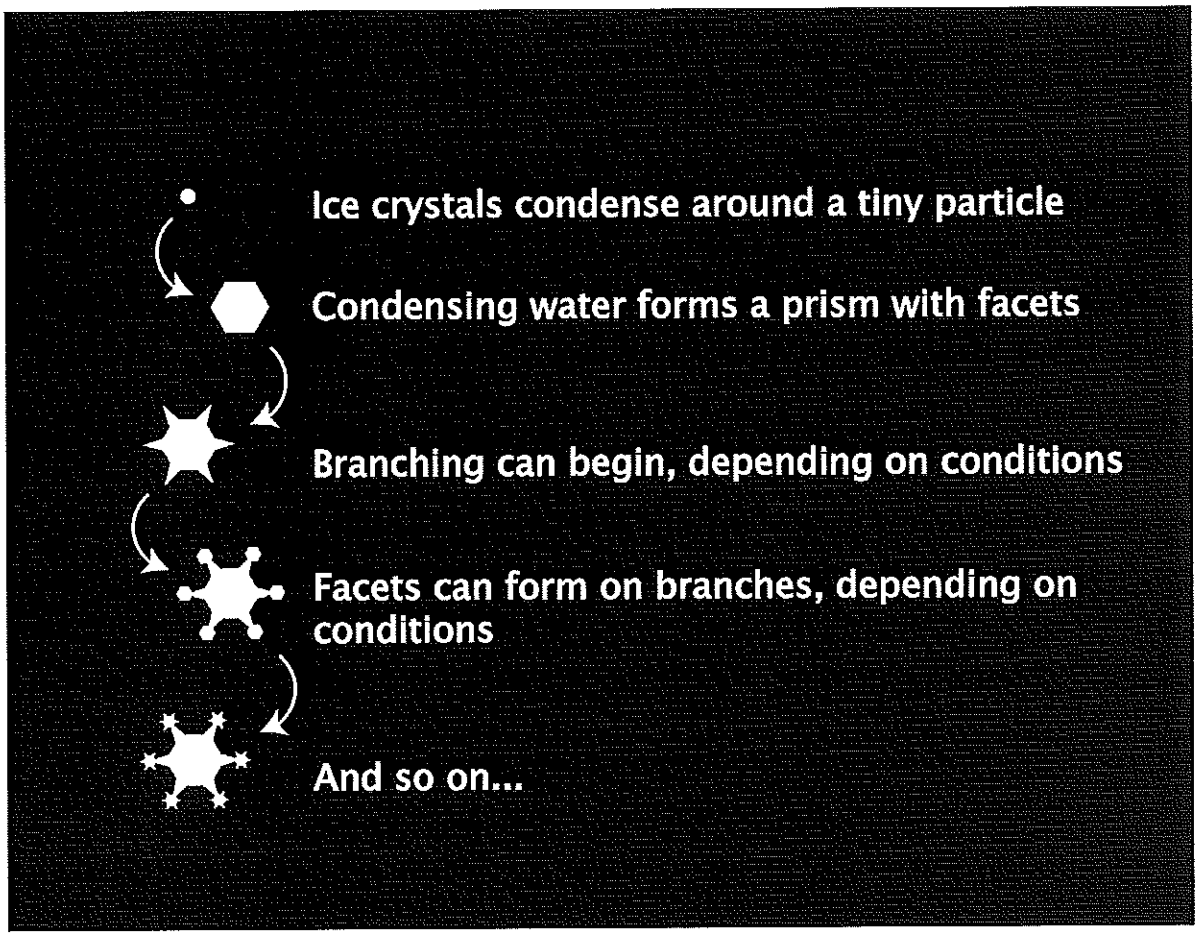
As ice crystals form they develop "facets." A facet is a flat face on a three-dimensional shape. Think, for example, of one of the surfaces of a diamond. Snowflake facets are always six-sided, and it is facets that give snowflakes their symmetry.

As snowflakes form, they usually develop arms that shoot out from the center in a symmetrical way. Snowflakes always have six arms, each of which looks exactly the same as the others. However, the shape of these arms varies greatly from snowflake to snowflake.

As snowflakes grow, they can branch out in different directions. This branching happens because water vapor will condense on the first thing it touches. If there is a small bump on a flake's surface, the vapor will condense there instead of traveling any further. Now the bump is bigger and even more likely to "catch" water vapor at that point. The process repeats itself and a branch is formed!

How It Takes Shape

Tiny changes in temperature and in the amount of water in the air change the way that a snowflake takes shape. The temperature at which a crystal forms is what determines its general shape. That's why we see long, needle-like crystals at 23 degrees Fahrenheit, and very flat, plate-like crystals at 5 degrees Fahrenheit.



Imagine a growing snowflake in a cloud. As the snowflake blows back and forth, it experiences all sorts of changing conditions. There are different temperatures and moisture levels in different parts of the cloud. The order in which it experiences those changes and how long each set of conditions lasts determines its final shape and pattern.

The complicated shape of a single arm of the snowflake is determined by the atmospheric conditions experienced by the entire ice crystal as it falls. A crystal might begin to grow arms in one manner. Then, minutes or even seconds later, slight changes in the surrounding temperature or moisture level cause the crystal to grow in another way. Although the six-sided shape is always maintained, the ice crystal may branch off in new directions. Since each arm of the snowflake experiences the same conditions, they look identical.

How likely would it be for two snowflakes to experience the exact same conditions all the way down to the microscopic level? Astronomically unlikely! That's why you'll never find two truly identical snowflakes.

Summing It Up

A snowflake begins to form when an extremely cold water droplet freezes onto a pollen or dust particle in the sky. This creates an ice crystal. As the ice crystal falls to the ground, water vapor freezes onto the primary crystal, building new crystals – the six arms of the snowflake.

The ice crystals that make up snowflakes are symmetrical because they reflect the internal order of the crystal's water molecules as they arrange themselves to form a six-sided snowflake.

Individual snowflakes all follow slightly different paths from the sky to the ground and, as a result, they encounter slightly different conditions along the way. Therefore, they all tend to look unique.

Quiz

1 Fill in the blank.

In the opening paragraphs, the author.....

(A) uses visual imagery to illustrate the questions that will be answered about snowflakes.

(B) reminds the reader what it was like to look closely at and try to catch snowflakes as a child.

(C) explains the reasons for the symmetrical six-sided shape of all snowflakes.

(D) describes weather conditions that contribute to the formation of snowflake shapes.

2 Which of the following sentences provides the answer to the following question from the introduction [paragraphs 1-3]?

And if they all have such a similar pattern, why is it impossible for two snowflakes to be exactly the same?

(A) That's why we see long, needle-like crystals at 23 degrees Fahrenheit, and very flat, plate-like crystals at 5 degrees Fahrenheit.

(B) The complicated shape of a single arm of the snowflake is determined by the atmospheric conditions experienced by the entire ice crystal as it falls.

(C) As the ice crystal falls to the ground, water vapor freezes onto the primary crystal, building new crystals -- the six arms of the snowflake.

(D) Individual snowflakes all follow slightly different paths from the sky to the ground and, as a result, they encounter slightly different conditions along the way.

3 Look at the image of the nine snowflakes near the top of the article and the graphic in the middle of the article.

Which idea from the article do BOTH images show?

(A) Water droplets form snowflakes by freezing onto pollen or dust.

(B) Atmospheric conditions can cause ice crystals to branch in changing directions.

(C) A facet is a flat face on a three-dimensional shape.

(D) Snowflakes all have six symmetrical sides but come in different forms and sizes.

4 Look at the graphic at the bottom of the article. Which detail from the article is NOT shown in the graphic?

(A) Snowflakes get their unique shapes growing inside of clouds.

(B) Snowflakes begin forming when water vapor coats a tiny particle.

(C) The ice crystals continue to grow larger and form facets.

(D) The ice crystals that make up snowflakes are six-sided.

Writing Prompt: Today you will pretend you are a snowflake. Write about an aduenture you would go on.

Name : _____ Score : _____

Common Multiples

Sheet 1

List out the first two common multiples for each pair of numbers.

1) 3, 4

Multiples of 3 : _____

Multiples of 4 : _____

Common multiples : _____ and _____

2) 2, 5

Multiples of 2 : _____

Multiples of 5 : _____

Common multiples : _____ and _____

3) 12, 8

Multiples of 12 : _____

Multiples of 8 : _____

Common multiples : _____ and _____

4) 4, 6

Multiples of 4 : _____

Multiples of 6 : _____

Common multiples : _____ and _____

5) 5, 3

Multiples of 5 : _____

Multiples of 3 : _____

Common multiples : _____ and _____

Name : _____ Score : _____

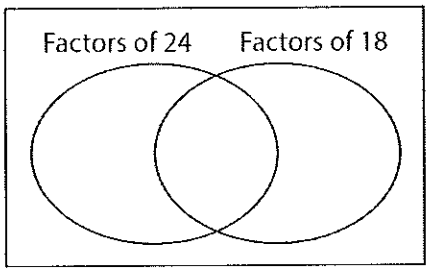
GCF - Venn Diagram

Easy: S1

Find the greatest common factor for each pair of numbers using Venn diagram.

1) 24, 18

a) Complete the venn diagram.

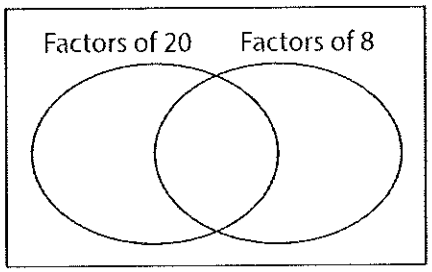


b) Common factors are _____

c) GCF(24, 18) = _____

2) 20, 8

a) Complete the venn diagram.

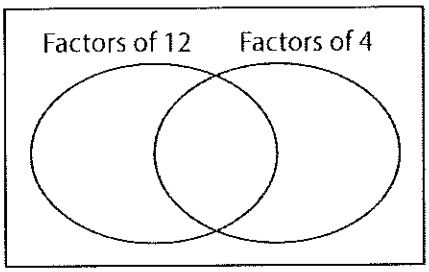


b) Common factors are _____

c) GCF(20, 8) = _____

3) 12, 4

a) Complete the venn diagram.

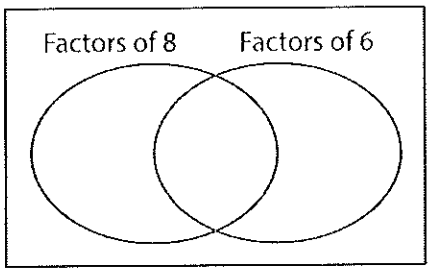


b) Common factors are _____

c) GCF(12, 4) = _____

4) 8, 6

a) Complete the venn diagram.

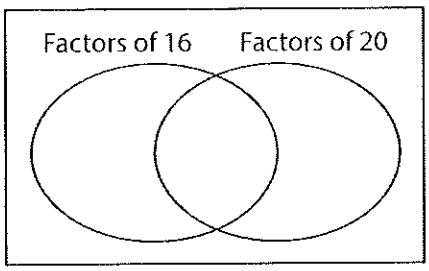


b) Common factors are _____

c) GCF(8, 6) = _____

5) 16, 20

a) Complete the venn diagram.

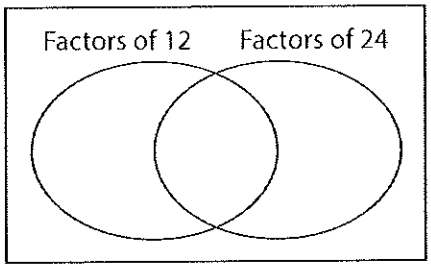


b) Common factors are _____

c) GCF(16, 20) = _____

6) 12, 24

a) Complete the venn diagram.



b) Common factors are _____

c) GCF(12, 24) = _____

Name : _____ Score : _____

Translating Phrases

ES1

Translate each verbal phrase into an algebraic expression.

1) The product of 5 and q is greater than 30 _____

2) Twice the square of b is equal to 8 _____

3) The difference of 23 and thrice of y is not equal to 15 _____

4) The total of p,q and r is lesser than or equal to 25 _____

5) One added to the quotient of m and 3 is less than 2 _____

6) The difference between n and 5 is 18 _____

7) The quotient of x and 4 is greater than or equal to 6 _____

8) The sum of z and 7 is not equal to 9 _____

9) The cube of t is less than 12 _____

10) One-fourth of the sum of 6 and 2 times c is 3 _____

Name : _____ Score : _____

Translating Phrases - Linear Expression

ES1

Translate each verbal phrase into an algebraic expression:

1) The sum of x and 2 _____

2) t divided by 8 _____

3) The product of 9 and m _____

4) Subtract 5 from c _____

5) Combine y and 7 _____

6) Three-sevenths of h _____

7) 3 multiplied by d _____

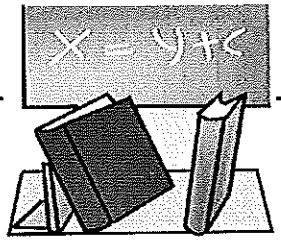
8) One-quarter added to n _____

9) b decreased by 10 _____

10) One-half of k _____

Name: _____

Basic Algebra



Evaluate each expression.

$a = 3$,	$b = 5$,	$c = 6$

1. $a + 5$ _____ **2.** $15 - c$ _____

3. $4b$ _____ **4.** $\frac{18}{c}$ _____

5. $20 - a$ _____ **6.** $11b$ _____

7. $\frac{45}{b}$ _____ **8.** $a - 2$ _____

9. $a + b + c$ _____ **10.** $\frac{c}{a}$ _____

$p = 12$,	$q = 2$,	$r = 30$

11. $q50$ _____ **12.** $\frac{r}{q}$ _____

13. $p + 4 + 6$ _____ **14.** $p - 7$ _____

15. $10r$ _____ **16.** $\frac{r}{10}$ _____

17. $\frac{p}{4}$ _____ **18.** $r - p$ _____

19. $r - q$ _____ **20.** $\frac{48}{p}$ _____

Now try this: Write five of your own algebraic expressions on the back of this paper. Have a friend solve them.