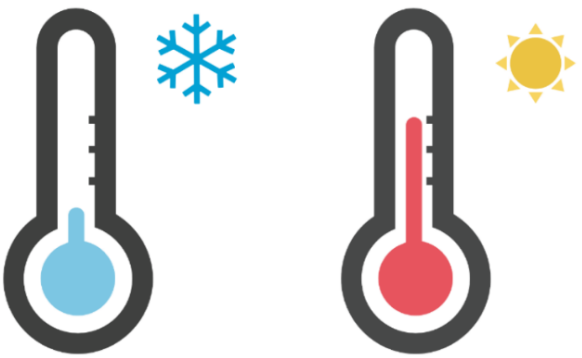
Frozen!

This week's Pop-up Science edition deals with freezing cold, the absolute temperature, and why molecules move faster in warm water than in cold.

Last week you learned that everything around us is made of molecules, and that molecules are made of atoms. But why did the molecules of food coloring migrate faster in warm water than in cold water in our participatory experiment on Monday?

Water consists of many molecules that move back and forth. The more energy the molecules have, the faster they move. Heat is also a form of energy! This means, that hot water has more energy than cold water. Molecules in hot water therefore move faster than in cold water. Therefore, the food coloring is distributed faster in hot water!

By the way, this is also the case when you make a cup of tea. The tea ingredients dissolve faster in hot water. This also applies to sugar. In cold water, it takes much longer for the tea ingredients and the sugar to dissolve. However, stirring with a spoon speeds up the dissolving process in both warm and cold water. The reason is that the molecules are additionally set in motion.



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A. Read the following text and underline the most important pieces of information.

The cold-loving quantum computer

Developing new drugs on the computer, calculating fast travel routes, creating climate models, designing new materials. Anyone investigating such things collects a lot of data! With calculations using this data, predictions can be made, or products can be developed. The human brain could never calculate with this amount of data. It would simply be too much. Even super-fast computers need a lot of time to make some of these calculations. In the future, however, quantum computers could manage to do certain difficult calculations in a flash!

A quantum computer can calculate a greater amount of data than a "normal" computer. The two computers also differ in the way they calculate. Imagine that you want to bring your aunt, uncle, grandma and grandpa and your cousins a pack of cookies on Saturday. But they all live very far away from each other! So, what would be the best route that your parents could take by car to save as much time and fuel as possible? If a "normal" computer would start this calculation, it would go through all sequences and all routes one after the other. It would then compare all the possibilities and choose the fastest and cheapest method. With many possibilities, this can take a very long time! A quantum computer, on the other hand, calculates everything simultaneously. You can imagine it as if the quantum computer had many little helpers who all check the possible routes simultaneously. So it immediately recognizes which route is the optimal one.

For a quantum computer to work well, it needs very low temperatures near absolute zero. This is the coldest possible temperature at which molecules stop moving completely. It is set at 0 Kelvin (K). 0 Kelvin equals −273.15 degrees Celsius (°C)!

Special knowledge: "Normal" computers calculate with bits. These can take on the values 0 and 1. A quantum computer calculates with so-called qubits. A qubit can also take on all values between 0 and 1.

You can imagine that a normal computer can only tell whether a coin is lying on a table with its head or its tails up. With a qubit the coin can stand on the edge and turn! It has not yet been decided whether heads or tails will lie on top.

B. Try to answer the following questions.

Tick the correct answers.

1. The human brain can calculate as fast as a quantum computer.

   ☐ true ☐ false

2. A "normal" computer calculates different possibilities one after the other and then compares them. A quantum computer can do certain calculations simultaneously.

   ☐ true ☐ false

3. What is the temperature of absolute zero?

   ☐ 0 K = –100 °C ☐ 0 K = –273,15 °C ☐ 0 K = –327,15 °C

4. Why do the molecules of food coloring from our participatory experiment on Monday migrate faster in warm water than in cold water?

   ☐ The statement is wrong! Molecules in hot water do not migrate faster, but slower!

   ☐ Molecules in cold water move faster than in warm water. This also means that the coloring is distributed faster in hot water!

   ☐ Molecules in hot water move faster than in cold water. This also means that the paint is distributed faster in hot water!

5. **Special question:** What are the units of a quantum computer called?

   ☐ bits ☐ qubits ☐ zeros and ones

C. Build an ice cube crane!

The aim of this experiment is to lift an ice cube from a glass of water using a thread. The ice cube must not be touched with your hand! For this experiment we need a kind of "magical glue". But which substance can serve as glue?

For the experiment you need:

- An ice cube
- A glass of water
- A small wooden stick
- A piece of thread
- Some sugar, salt, pepper or chewing gum

Here is how it works:

1. Tie a piece of thread to the wooden stick to build a small crane.
2. Place the ice cube in the glass of water. The ice cube will float on the surface because water expands when it freezes. The density of the ice cube is therefore lower. Because of this the ice cube can float on the water surface.
3. Before you start the experiment, answer the following question:
   ➔ With the help of which ingredient can you lift an ice cube out of the glass of water without touching it with your hands? What do you think? Circle the answer!
   - With sugar.
   - With pepper.
   - With salt.
   - With chewing gum.
4. Put the end of the thread on the ice cube. Put some of the substance on the ice cube and the thread. Hold the wooden stick with the thread in your hand.
5. Wait for 45 seconds.
6. Try to lift the ice cube carefully out of the water with the crane. With the right substance, the ice cube will stick to the thread and you can lift it out of the water! Which substance serves as a magic glue?

_____ serves as a magic glue! The reason is that this substance causes the ice to melt. Shortly afterwards, however, it freezes again. This is because melting the ice consumes energy. It draws heat from its surroundings. The environment of the substance and the thread cools down until everything including the thread freezes to the ice cube!

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D. Word search

Can you discover all the hidden words in our word search this time?

QUANTUMCOMPUTER	KELVIN	CELSIUS
ABSOLUTEZERO	HOT	TEMPERATURE
COMPUTINGPOWER	QUBITS	FREEZINGCOLG
DATA	MOLECULES	ENERGY

Circle each word. Have fun!

Y	Q	V	S	K	M	V	K	Q	G	Z	Z	G	M	H	E	Q	V	N	C
H	K	G	D	Q	Q	G	L	O	C	G	N	I	Z	E	E	R	F	Y	C
J	W	C	R	O	C	O	M	P	U	T	I	N	G	P	O	W	E	R	E
N	Q	D	A	Z	O	A	M	I	Z	Y	H	I	Z	C	E	H	Y	C	Z
Q	Q	I	P	D	R	G	W	K	Z	A	I	C	V	G	Q	F	K	E	W
Y	B	U	S	B	E	G	S	K	K	T	E	W	R	Q	X	A	G	Q	H
P	U	J	A	T	Z	I	U	T	E	D	Y	O	A	Z	F	H	U	L	F
E	D	S	E	N	E	B	Y	R	R	L	R	G	S	G	G	K	N	E	I
Y	Z	Q	I	A	T	R	K	X	L	E	V	Q	Y	I	X	F	U	W	P
R	T	D	I	F	U	U	Y	V	Y	I	K	I	M	Q	P	F	K	G	O
D	O	A	Y	X	L	S	M	U	R	D	L	I	N	A	S	Z	Y	U	S
R	U	H	C	F	O	F	G	C	D	R	E	S	A	T	A	D	J	M	Y
D	M	H	H	W	S	S	D	U	O	E	L	S	G	A	N	U	E	M	Q
R	I	O	W	W	B	U	U	T	E	M	P	E	R	A	T	U	R	E	C
R	U	T	S	B	A	I	B	I	W	D	P	U	F	L	X	O	V	L	L
R	J	M	Z	J	R	S	T	I	B	U	Q	U	T	I	O	T	H	A	C
M	O	L	E	C	U	L	E	S	R	Z	S	U	T	F	D	Q	P	R	G
I	F	H	D	Q	K	E	F	B	N	B	M	W	I	E	U	A	I	P	O
H	L	R	W	N	Y	C	G	B	R	K	U	E	N	E	R	G	Y	J	X
N	I	K	D	X	N	U	V	O	S	E	T	Y	U	W	F	C	H	H	P

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