Humorous Cartoons Made by Preservice Teachers for Teaching Science Concepts to Elementary Students: Process and Product

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Abstract

Elementary school science is an often-neglected subject in the current literacy-focused political atmosphere. However, reading informational trade books about science in literacy class can help children increase their science knowledge. Incorporating humor through content-related cartoons is an effective way to engage students in deeper understanding of content and creative play with language.

A master's degree student enrolled in a graduate course in instructional design acted as a consultant to a faculty member teaching a course in literacy methods for preservice elementary teachers and engaged undergraduates in creating humorous cartoons to teach science content.

The preservice teachers read science trade books designed for an elementary school audience and listed science content ideas and terms about a given topic (earthquakes, volcanoes, fossils, crystals, glacier, or caves). They noted confusing topic-related terms that were homophones, words with multiple meanings, or words that sounded very similar to other common words, thus identifying possible wordings for puns. Next, they analyzed given cartoons for science content and humor, making suggestions for their improvement. They completed partially-finished cartoons to convey science information in a funny way. Finally, they created original cartoons of their own using their choice of scenario.

A survey was administered to the preservice elementary teachers partway through the cartoon creation process to determine ways to help them. Students reported that they learned much science information from the trade books, and discovered how difficult it was to produce humor. They noted the motivating aspects of using humor in science and working within a group of peers. They found it difficult to generate creative ideas for cartoons and suggested that they be given more example cartoons and more opportunities for group brainstorming. Color cartoon scenarios made with clip art, along with idea-prompting questions, were provided and these increased productivity of humorous cartoons related to science content.

Forty-eight color cartoons with accompanying science explanations created by the authors and preservice teachers are included as an appendix. These address the science topics of earthquakes, volcanoes, fossils, crystals, glaciers, or caves. We recommend that cartoons be used as part of science teaching because of their motivating and creative aspects. [14 references, 8 tables, 1 appendix of 48 color cartoons]

Introduction

Integration of Literacy and Science

Elementary school science is an often-neglected subject in the current literacy-focused political public school arena. For example, a recent study of public schools in the San Francisco Bay area (Dorph, Goldstein, Lee, Lepori, Schneider, & Venkatesan, 2007) revealed that 80% of the elementary teachers spend less than an hour a week teaching science and 16% teach no science at all. Additionally, ten times as many teachers report they are unprepared to teach science as compared to teaching mathematics or reading. One way to help this situation is to integrate more science with the subjects that are being taught, in particular, literacy.

Reading informational trade books about science in literacy class can help children increase their science knowledge. Both fundamental and derived senses of literacy – the ability to read-/write *and* knowledge of the world – are also necessary to science education as

learning most of western science depends upon being able to read and understand text (Norris & Phillips, 2002). For example, a study by Morrow, Pressley, Smith, and Smith (1997) showed that third graders taught in an integrated science/literature program learned more science facts and vocabulary than those taught using non-science literature.

Reading and writing includes many different genres from informational texts to short stories to poetry to captioned cartoons. Incorporating humor through content-related cartoons is an effective way to engage students in deeper understanding of content and creative play with language. In a counterbalanced-design study of sixth graders studying minerals and rocks in science class, Rule and Auge (2005) showed that students were more motivated and learned more concepts when they used cartoons depicting mineral and rock characters revealing science content, than in the control condition. Similarly, Harman and Rule (2006) found that creating humorous cartoons and poetry couplets motivated high school students who were studying minerals. This article focuses on exploring and improving the process of teaching students to create cartoons.

Using Humor in Teaching

Pedagogical humor is associated with many positive psychological effects such as reduced anxiety, decreased stress, enhanced self-esteem and increased self-motivation (Berk, 1998) and many beneficial physiological effects including improved respiration and circulation along with release of endorphins in the blood (Berk, 1998). The use of humor in the classroom better engages students through creation of a positive emotional and social environment that lowers defenses, allowing students to focus and attend to the presented information (Glenn, 2002).

Garner (2003) noted that although humor can enhance learning and communication, it can sometimes become a social impediment because of its complex nature. Humor is highly personal, subjective and contextual; instructors cannot always predict how their jokes or puns will be received. Situations or punch lines viewed by some as humorous or ironic will be seen by others as trite or offensive. People have unique perceptions as to what is humorous. Garner (2006, p. 178) observed, "For humor to be most effective in an academic setting, it must be specific, targeted, and appropriate to the subject matter." Wanzer, Frymier, Wojtaszczyk, and Smith (2006), in their study of undergraduates' perceptions of humor, found that appropriate humor included course-related humor, humor unrelated to course content material, self-disparaging humor, and unintentional humor in which the instructor accidentally does something funny. Inappropriate humor categories were disparaging humor targeting students or others, offensive humor, and some self-disparaging humor. As Snotty Girdlefanny (2004, p. 24) observed, "This means being aware of sarcasm, stereotyping and other potentially offensive or hurtful tactics."

Research evidence is mounting that attests to the efficacy of humor both in promoting positive perceptions of the subject matter and instructor (Torok, McMorris, & Lin, 2004), but also in retention of information. For example, Garner (2006) found that college students who learned about research through one-hour lectures that had brief humorous stories inserted in three places scored significantly better on a content test and reported more positive opinions of the lectures and instructor than a control group who viewed the same lecture videos without the humor insertions.

Organization and Conceptual Framework of the Project

As a capstone experience prior to graduation, students in an advanced instructional design course were assigned a professor as their client. Each student then worked with his or her client as a consultant during the semester to design a unit of instruction that met a particular instructional need as defined by the client. The graduate students used a systematic approach to developing this unit (Dick, Carey, & Carey, 2005). This major project was the first time for many of the students in which they were not the subject matter experts. The emphasis for the creation of the unit was to engage the classroom students and instructor and to demonstrate effective facilitated learning (Robinson, Molenda, & Rezabek, 2008). The collaboration between authors of this paper, D. Sallis and A. Rule, is an example of the resulting benefits from incorporating a creative approach within instructional strategies.

The second author, D. Sallis, who was enrolled in a graduate course on instructional design taught by the third author, A. Donaldson, acted as a consultant to a faculty member, the first author, A. Rule, who was teaching a course in literacy methods for preservice elementary teachers. This collaboration allowed the authors to investigate the process of cartoon development for teaching with cartoons. The authors engaged undergraduates in creating humorous cartoons appropriate for upper elementary students in science class.

Method

The instructional design consultant met with the course instructor to plan the activities for preservice teachers related to science cartoons. The twenty-six preservice teachers were enrolled in a college course titled, "Methods of teaching literacy in the intermediate grades."

During the first class period, the preservice teachers worked in six small groups of four to five students each. Each group was given six science trade books focusing on the topic assigned to the group. Preservice teachers read these science trade books designed for an elementary school audience and listed science content ideas and terms about their given topic (earthquakes, volcanoes, fossils, crystals, glaciers, or caves). They also noted confusing topic-related terms that were homophones, words with multiple meanings, or words that sounded very similar to other common words, thus identifying possible wordings for puns.

During the next class period, the preservice teachers analyzed given cartoons, created by the instructor, related to their topics for science content and humor, making suggestions for improvement.

During the third instructional period, they improved two additional cartoons and completed partially-finished cartoons to convey science information in a funny way. The instructional design consultant created six partially finished cartoons that were each related to one of the six earth science topic areas. These partly-finished cartoons were pencil sketches in contrast to the clip-art cartoons made by the instructor in PowerPoint. The students were asked to complete or improve the cartoons using the science terminology and concepts with their own humor and ideas. Pun ideas were written on the back of the sketched cartoons to inspire the students.

After three instructional periods related to the project, the instructor administered a survey to the preservice teachers to determine ways to improve the process. The survey questions were:

1. What did you learn from reading the science trade books and compiling a list of concepts and vocabulary?
2. What did you learn from the cartoon activities?
3. What motivated you?
4. What aspects were most challenging?
5. What aspects helped you learn information?
6. Give suggestions for improving the activities.
7. If provided with cartoons, would you use them in your teaching?

Then the instructor and consultant discussed some improvements to the cartoon-making activities that were based on the survey results. These improvements were implemented in a final cartoon-making session. Several additional cartoon examples were provided to each group with several coming from published sources. Color images and drawings of the earth features were provided to groups so that they could trace or copy them for the cartoons. Twelve color background scenarios were also provided along with questions to help the preservice teachers generate ideas, shown in Table 1.

After students improved cartoons, completed scenarios, or sketched their own cartoon ideas, the first author, A. Rule, used PowerPoint as a drawing program and clipart and drawing tools to produce the final cartoons that are shown in Appendix A.

Table 1. Scenarios and accompanying questions

Scenario	Questions
Rides at a fair	What carnival ride would your earth feature like best? What happens when he or she gets on the ride?
Carnival games	What carnival game would your earth feature win? What prize would your earth feature want to claim?
Fashion show runway	What would be the latest fashion for your earth feature? Why is this fashion so desirable? Why is it especially suited to your earth feature?
Ice cream stand	What ice cream flavor or sundae would your earth feature want? Why does your earth feature crave it?
Shopping at a store	What unusual item would be on your earth feature's shopping list? What would your earth feature be planning to do with the item?
Billboard display	What new product would your earth feature need or want to buy? How would an ad pitch the product to your earth feature?
Visiting a doctor	Why would your earth feature need to visit a doctor? What would the doctor be confused about after examining the earth feature? What kind of diagnosis would the doctor make?
Classroom scene	What does your earth feature study in school? What does he or she excel at? What does he/she have trouble with?
Summer camp	What would your earth feature enjoy doing at a summer camp? What camp would it be? Is there a prank he/she would play?
Travel agent's office	Where would your earth feature vacation? How would he/she travel?
Olympic stage for receiving awards	In which sport did your earth feature participate at the Olympics? What happened? Why did your feature excel at this?
tombstones in a cemetery	How did your earth feature die? What was tragic about it? How was it ironic? What would the epitaph say?

Results

Survey Results

The results of the survey questions are shown in Table 2 through Table 8. Table 2 indicates that, in general, students learned a lot of new science facts through the activities. They discovered ways that trade books could be used to integrate literacy with science. They learned how informational books were designed with attractive illustrations and layouts.

Table 2. Preservice teacher responses to "What did you learn from reading the science trade books and compiling a list of concepts and vocabulary?"

Category	Example Responses	#
Specific science facts, general information about a science topic, and specific terms.	When ice breaks off and becomes an iceberg, it is called calving. That gems are made of atoms - I did not know this. There are many different types of caves - such as limestone and sea caves. Learned volcanoes and geysers are very similar minus the lava. A love wave is when the earth moves from side to side. Paleontologists look for fossils. I learned may concepts, definitions, etc in reading the books The difference between stalagmites and stalactites. It was interesting to learn about all the things that can be petrified and how they get petrified.	31
Concepts about books	Having many books on a subject is very beneficial. How to get additional ideas from the text. I also learned that with as little as 5 books we could get a ton of information Some books had very similar points If the material was accessible for students to read - if not - would the pictures be valuable? Some books' layouts were easier to use when identifying concepts of words. Some books were more informative than others. The benefits of reading children's books to enforce and build concepts like plate tectonics. The glossaries of books were very helpful.	9
Motivation	Good idea for creative learners. How to make learning funny. I learned that I could get new information because the books were interesting because they told a story about someone's life. It was more interesting and engaging to read from a trade book as opposed to a textbook. You can make reading boring textbooks fun with appropriate activities. Way to tap into multiple intelligences, talents	6
Teaching science vocabulary	Deciding what terms are most important for students to learn. Good idea for young learners to gain vocabulary. It is good to list vocabulary before started.	3
Difficulty	Science can be very confusing.	1
Connections	Science can be linked to many other subjects.	1

From the cartoon activities, as shown in Table 3, preservice teachers realized that cartoons could be used to convey science information. They noted the difficulty of producing humor while acknowledging the motivating aspects of its use. They realized that science learning could be combined with humor and they felt challenged to apply their creative thinking skills to the cartoon tasks.

Table 3. Preservice teacher responses to "What did you learn from the cartoon activities?"

Category	Example Responses	#
Cartoons can be used to assist in science learning	Cartoons can help students learn about a topic Creating laughter can help someone remember things. How to use cartoons to teach science. I learned that there are a lot of informational ideas that kids can learn about science from cartoons.	9
Difficulty of producing humor	I learned that it is hard to make effective cartoons. It is hard to make serious concepts funny. It is not easy to make meaningful/teachable cartoons. It is hard to make some science concepts funny.	9
Motivation	Comedy can make science more fun. Funny things make it more motivating. If done right, it can be very motivating for students. That cartoons make the class fun.	9
Combining learning with humor	How to incorporate true facts and make it funny. It was difficult to tie in the concepts and make them funny at the same time. It was hard to improve cartoons, but it really started a discussion at our table. It's pretty easy to relate a cartoon to facts or a book.	6
Creativity	Learned to be more creative in displaying knowledge. Learned to look at things from different angles to see how to improve it. We were able to use our creative side and use what we learned to create another cartoon.	5
Differen-tiating instruction	I learned that this could be an activity for higher-level students who need a challenge. Teaching with art allows many intelligences to shine.	2
Humor	How to make them more funny. You can make just about any topic funny	2
Science Facts	Tsunamis are caused by earthquakes. You measure earthquakes with a Richter scale.	2
Group Work	Worked on group cooperation skills because we did the activities cooperatively as a group.	1
Image importance	I learned that pictures are everything.	1
Dislike for activity	It's a waste of time.	1

Table 4 shows that most preservice teachers found group interactions, humor, and classroom applications motivating, although a few did not enjoy the cartoon activities. Some became interested in the science topic after reading the elementary level trade books. Others enjoyed the novelty of the activity and the instructional consultant's visit to the classroom. Drawing the cartoons motivated one student while another noted that the class

work assignment provided the impetus to complete the activity.

Table 4. Preservice teacher responses to "What motivated you?"

Category	Example Responses	#
Group work	Fun, excitement, positive people. My group's enthusiasm. People I was with. Working in groups.	6
Humor	Creating something funny and catching would be fun. I wanted to make a funny cartoon. Making people laugh that would read it.	5
Classroom use	Motivated by knowing children could use it to learn. Trying to make the cartoons work for the classroom.	3
Lack of motivation	I wasn't very motivated.	3
Interest in science topic	Interest in the topic. To learn more about minerals.	2
Books	Looking at all of the different books.	2
Novelty	Being able to learn something new. I'd never done it before.	2
Guest speaker	The guest speaker was helpful and motivating.	1
Drawing	Drawing	1
Class work	The fact that it was required for class.	1

As presented in Table 5, preservice teachers found producing humor, improving existing cartoons, and generating ideas most challenging.

Table 5. Preservice teacher responses to "What aspects were most challenging?"

Category	Example Responses	#
Producing humor	Coming up with a funny saying. It was challenging to improve the cartoons that were already created. Making the cartoons funny. Trying to think of a new jingle for the cartoon because I did not know what would be funny. Thinking of something funny but intellectual	12
Improving the cartoons	Changing the comics! It was difficult to change them because they were so complete. The cartoon - I had a hard time improving it.	5
Generating ideas	Being creative with my cartoon. Coming up with ideas since they was new concepts.	3
Did not enjoy cartoons	It wasn't very challenging, just hard to want to think because it didn't seem worth the time. Making cartoons is just not my thing.	2
Making educational and humorous	Changing cartoons to teach and make funny at the same time. Creating it educational and humorous.	2
Time pressure	Thinking of things to write about in the allotted time	1

Most preservice teachers cited the science trade books as providing them with the most information, although a few acknowledged learning from the cartoon captions and science explanation, as detailed in Table 6.

Table 6. Preservice teacher responses to "What aspects helped you learn information?"

Category	Example Responses	#
Science trade books	Examining books on same topic. I learned better from looking at the books on the topic. Just being able to browse the books. Reading interesting literature.	17
Information from the cartoons	The caption or information given below the cartoons. The cartoons.	4
Organizing information	Making the information sheet – it wasn't the most fun, but it was the most informational.	3
Definitions	Actually being able to figure out the definition. Writing definitions.	2
Connections	Relating the main concepts to thinking of ideas.	1
Group work	Working in collaborative groups.	1

Table 7 shows the variety of suggestions preservice teachers had for improving the cartoon-making process. This is perhaps the most important information we obtained as it tells the learners' perceptions of their needs. Several suggested a non-cartoon activity instead of the cartoon-making task with which they struggled or felt saturated. We decided to provide a humorous poetry-writing activity in addition to the cartoon work. A similar number of preservice teachers suggested they be provided more cartoon examples to help them generate ideas. The need for strategies for idea-generation has come through clearly in several of the survey questions. A sentiment expressed by a few was that the cartoons based on puns were not "laugh out loud" funny and they saw them as being more appropriate for children. They also thought that more whole group brainstorming of ideas, more time to work on the project, and more information would help in cartoon generation. Some thought that more choice in the topic would help them. Other suggestions for generating ideas included providing manipulatives related to the science concepts, illustrating the process of making cartoons, and supplying punch lines or images. Providing the opportunity to see how elementary students react to this project and sharing the finished cartoons were also mentioned.

Table 7. Suggestions for improving the activities.

Category	Example Responses	#
Do another non-cartoon activity	Diorama, 3D art project instead. Have us do another literacy activity like make a poem, short story, etc. Make an activity with the books - not just with the worksheet- a little boring. No cartoons- they're not funny	8
More cartoon examples	Have funny examples to show and go off of. I think more pictures to work with would have been fun. It would have been easier to see an example when creating my own.	8
Improve the cartoons	Have better cartoons, or make them more simple to understand. I didn't like the puns that much. Make the cartoons colorful! Make the cartoons more exciting.	6
Whole group brainstorming	Brainstorm ideas before handing out all materials. More class discussion beforehand so there is a better idea of what to do. Talk about as whole class and then do group work.	4
More time	Difficult to think of things on spot, give more warning in advance.	4
More information	Supply books (for ideas) to create a full picture with info.	3
Choice of topic	Allow students to pick topic ideas. Maybe give us different subject areas.	3
Manipulatives	Include artifacts or manipulatives	3
Illustrate process of making cartoons	Give examples of how a cartoon can be made funny. It's tough to completely change a cartoon. Maybe give ideas or suggestions. Show video of how a cartoonist comes up with ideas or something like that - make more exciting.	3
Supply punch lines	Give kids "punch line" to cartoon but no picture or vice-versa.	3
Provide art helps	Cut out pictures.	2
Plan elementary student lesson	Try out the cartoons on kids to see if they understood them.	2
Recognize good ideas	Share who has the best one at the end.	1

The majority of preservice teachers, as shown in Table 8, indicated that they would use cartoons in their future elementary classrooms if they were readily available. That is one of the reasons that we decided to produce this document and make cartoons available for classroom teachers to use. Several did note their own frustration with the cartoon process and suggested that cartoon-making might be one of a choice of several activities.

Table 8. Preservice teacher responses to "If provided with cartoons, would you use them in your teaching?"

Category	Example Responses	#
Yes	Yes, definitely because they send a message and catch students' attention. Yes to help introduce the concept or get children ready to learn. Would also be good as a wrap-up. Yes - fun for students. Laughing can help student who may not be excited about topic or group work. Yes because it allows student to learn in a new way. Yes, it is very engaging for students. Yes, Sure because students are more likely to remember something that is funny.	17
Maybe	Maybe because they are motivating and funny, but very different humors. Maybe, but would not make my own. If they were more appropriate and funny, yes I would use them. Possibly, I would allow students to choose using a cartoon as an alternative because all students would not excel at it and find it frustrating.	5
No	No - because it would take more time to explain that actually learning the materials. No, I would not use cartoons unless the students were much younger. There is no way to make those cartoons funny for older kids. No, I wouldn't use this in my teaching because I didn't see the meaning in the activity. Also, this is for older students and I am going to teach K-2	3

Cartoon Production Results

Students were intrigued by the activity when first presented with instructor-made cartoons for improvement. However, several observed that they did not find the puns of the cartoons very funny. They had difficulty finding ways to improve the cartoons, but made substantial efforts in that direction. Definitely, it was easier to criticize the cartoons than to find ways to improve them.

During the third lesson, when students were given the partly completed cartoons to finish, they were somewhat confused on what to do. The consultant and instructor walked around to give groups additional directions and suggestions. The groups then became more engaged in the activity. Because students only had pens and pencils at hand, they began to work on the sketched cartoon formats before working on the clip-art cartoons.

Each group had its own dynamics depending on membership and topic area. The group that focused on crystals began working on the partly completed sketched cartoon of James Bond, spending the majority of their time drawing and finishing the concept. The crystal group probably put the most detail into their cartoons. The group that worked on fossils generated ideas for all of the cartoons they were given, however their humorous

additions did not always enhance learning the specific science concepts and terminology. Some of their jokes and puns were comedy movie lines that could be applied to many situations. The group that worked on glaciers was the only group that did not need guidance or suggestions. They came up with a number of concepts that were humorous and included the terminology they were required to use. Some of their cartoons, however, included toilet humor. To keep students engaged with the content, we suggest that the teacher set rules for appropriate humor before students begin working. The cave group had difficulty thinking of ideas, partly because they were very unfamiliar with the science of caves and partly because cave concepts are not easily related to more familiar ideas. Nevertheless, they completed the requirements of the activity. Finally, the volcano group members were very open to suggestions but generated novel ideas on their own.

After students worked on completing the partly-finished cartoons, they answered the survey questions. The next time they participated in cartoon-making activities, improvements based on the survey results and instructor-consultant observations were implemented.

Students were eager to examine the rock samples provided during the last lesson and were more enthusiastic when given the color clip-art scenarios with their accompanying questions. The questions helped groups generate humorous ideas. All groups were much more successful, completing several creative cartoons. Many groups generated original cartoons of their own.

Summary and Conclusion

Most students reported that they would use cartoons in their teaching if provided with suitable cartoons. This document provides forty-eight cartoons that are suitable for elementary and middle school students (Appendix A). Some students found generating ideas very difficult. It is clear that students need help in this process. We provided the following aids to idea-generation:

1. Trade books with interesting illustrations.
2. Time to read the books and compile a list of concepts and vocabulary. Although many students found this tedious, it is a necessary step in building background knowledge.
3. Interesting manipulatives related to the topics to increase content knowledge and motivation. We passed around fossil shells, a cast of a dinosaur footprint, several pieces of lava, large crystals, geodes, and cave rocks/stalagmites from the blast area of a new entrance to a commercial cave.
4. Examples of cartoons. Having several examples is crucial to the cartoon-generation process. Students were expecting cartoons to be "laugh-out-loud funny", rather than being based on the drier humor of puns. They need to see examples so that they do not set expectations too high for the cartoons they create themselves.
5. Color. Students definitely enjoyed and were motivated by color cartoons and the use of color markers, etc. If possible, provide color.
6. Having a list of possible puns related to the topic helped students.
7. Scenarios. Providing several possible scenes in which cartoon action could occur allowed students to apply their ideas. All groups were successful in generating cartoons when provided with scenarios. The questions that accompanied each scenario also assisted students in generating ideas.

This collaborative effort between an education professor and a graduate student in instructional design is an example of how an innovative instructional strategy can expand the strategies preservice teachers use in their teaching. The humorous cartoon-making activities were not only engaging but provided these future elementary teachers with a new perspective on effectively facilitating learning in ways beyond the traditional textbook.

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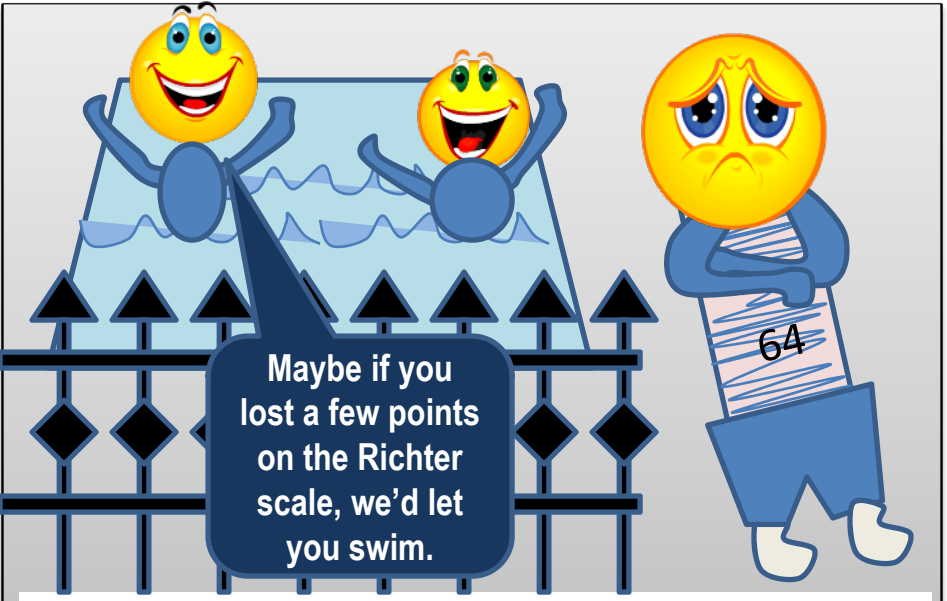
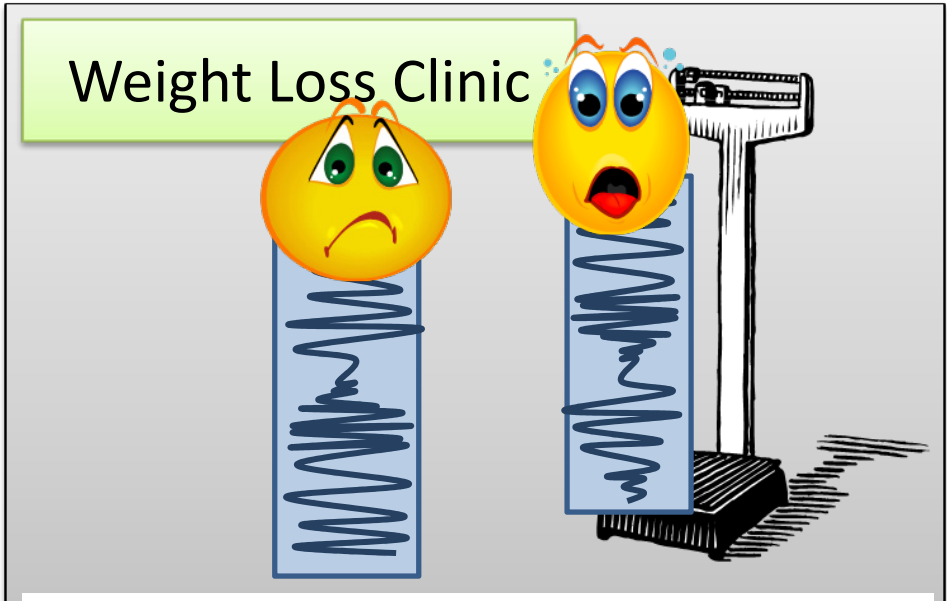
Appendix A begins on the next page.



Alaska Quake was never invited to pool parties because of tsunami danger.



Thelma and Karl Quake, both hoping to pare down to aftershock size, weighed in on the Richter Scale.

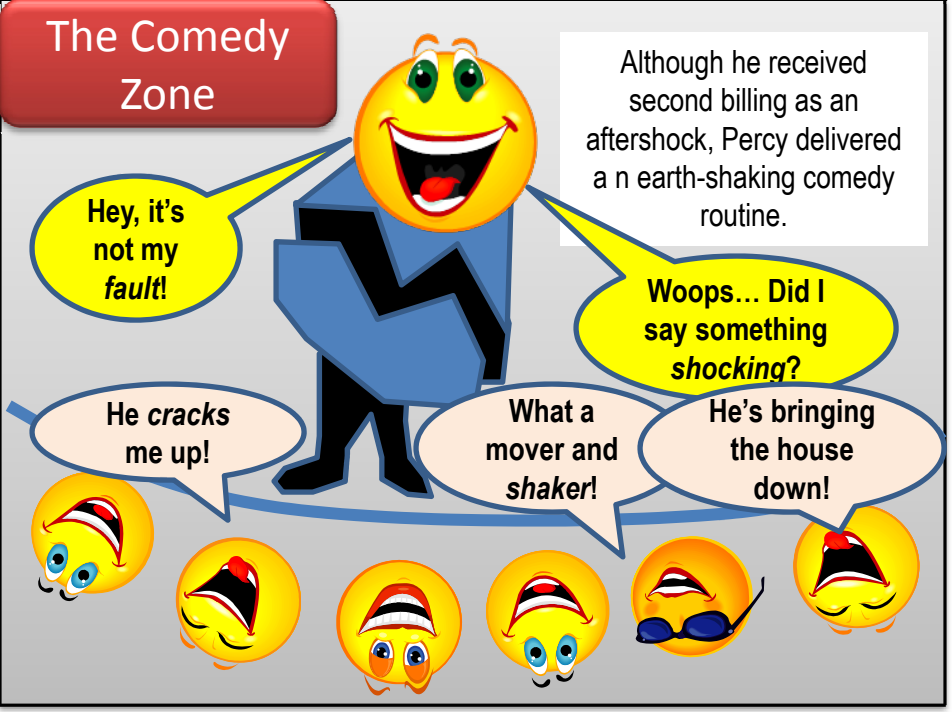
Science Information Referenced by the Cartoon

The great Alaskan earthquake of 1964 was the largest earthquake in North America and the second largest ever recorded (largest occurred in Chile in 1960). The quake caused up to 30 foot changes in ground level. It measured 8.6 on the Richter Scale. It generated a large tsunami, or tidal wave, that destroyed several coastal towns, resulting in 115 deaths in Alaska.

Science Information Referenced by the Cartoon

An aftershock is an earthquake that occurs in the same area soon after another greater earthquake. Generally, aftershocks die off quickly with time.

The Comedy Zone



Although he received second billing as an aftershock, Percy delivered a n earth-shaking comedy routine.

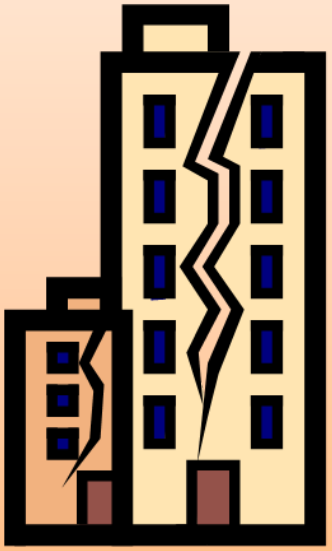
Although Victoria was vigorously rocked by Love Waves during the earthquake, she still complained of loneliness.

Science Information Referenced by the Cartoon

An **aftershock** is a small earthquake or tremor that follows a major earthquake. Earthquakes, intense **shaking** of the ground, occur when large areas of rock in the Earth's crust suddenly slide past each other. This occurs along **cracks** in the crust called **faults**. The rocks move because they are part of huge plates that move.

Science Information Referenced by the Cartoon

Love waves are surface seismic waves that cause horizontal shifting of the earth during an earthquake. They are what most people feel during an earthquake. They are named for A. E. H. Love, who mathematically predicted them in 1911.



Travel Agent

Edna Earthquake couldn't understand why the travel agent would not book her flight.

Science Facts

The Mercalli Intensity Scale for earthquakes, measures the effect of earthquakes on people. Level III is the level at which most people can feel the shaking of an earthquake. Only highly sensitive people can feel an earthquake of level II.

The Art of Break Dance

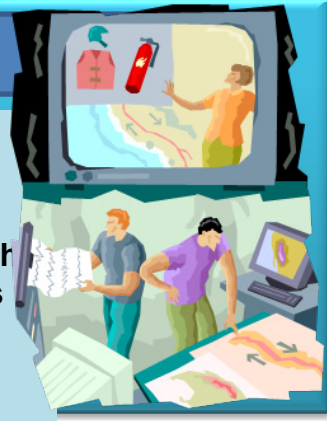
Presented by

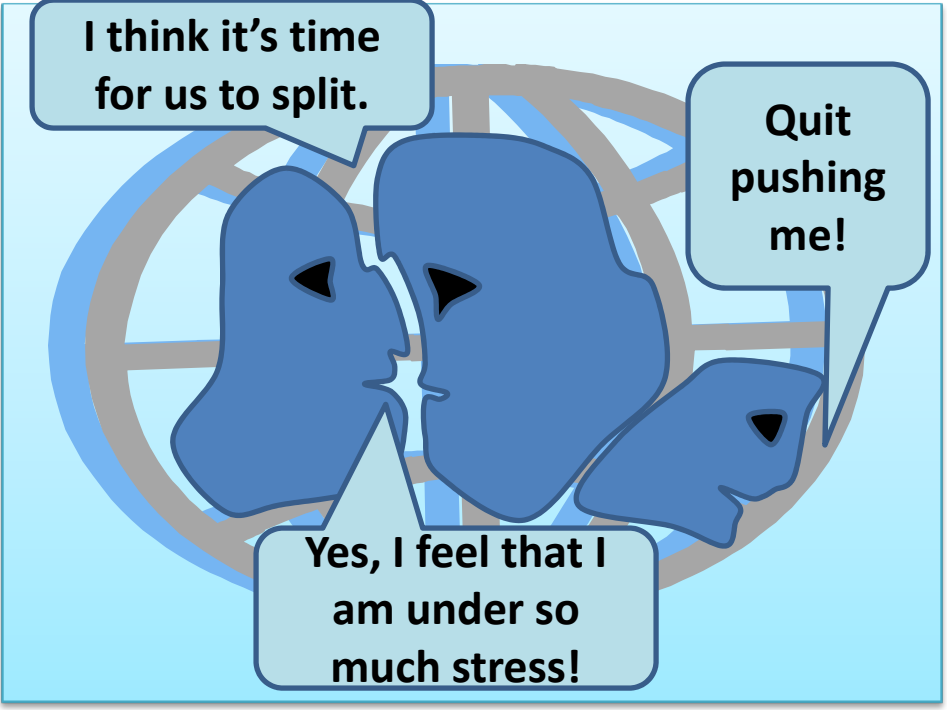
Tullulah Quake

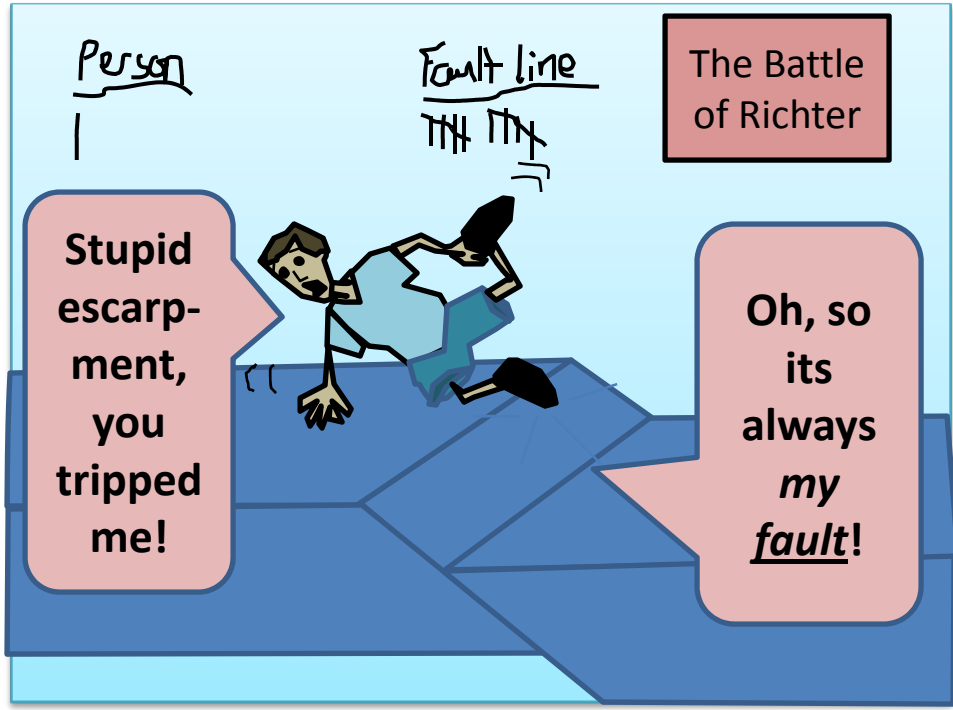
Little Tullulah Quake impressed everyone with her break dancing at school – well, almost everyone.

Science Facts

Earth quakes occur when two rock masses of the earth's crust push by each other suddenly. Earthquake shaking is recorded by a seismograph that has a pen the writes jagged lines on paper as the earth shakes. Earthquakes often cause parts of the crust to break open.







Tectonic plates discuss their relationships and engage in a little "roughhousing" as they create earthquakes by sliding past each other.

The sarcastic fault line kept score of the havoc it produced.

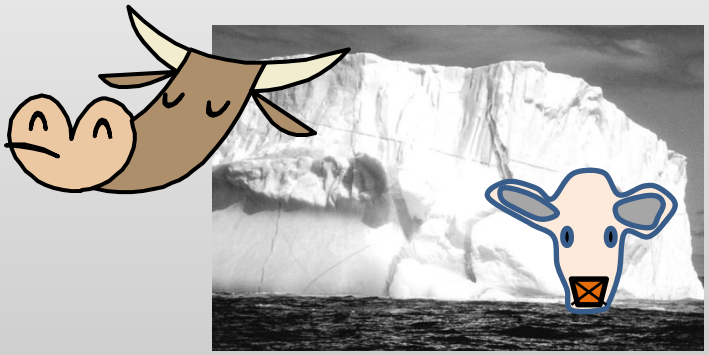
Science Facts

The Earth's lithosphere is divided into large tectonic plates that slowly move at a rate of about 2 centimeters per year. Earth has seven major plates and numerous minor plates. The boundaries between plates are associated with mountain ranges, volcanoes, and ocean trenches. When plates suddenly move past each other, they release energy in the form of earthquakes.

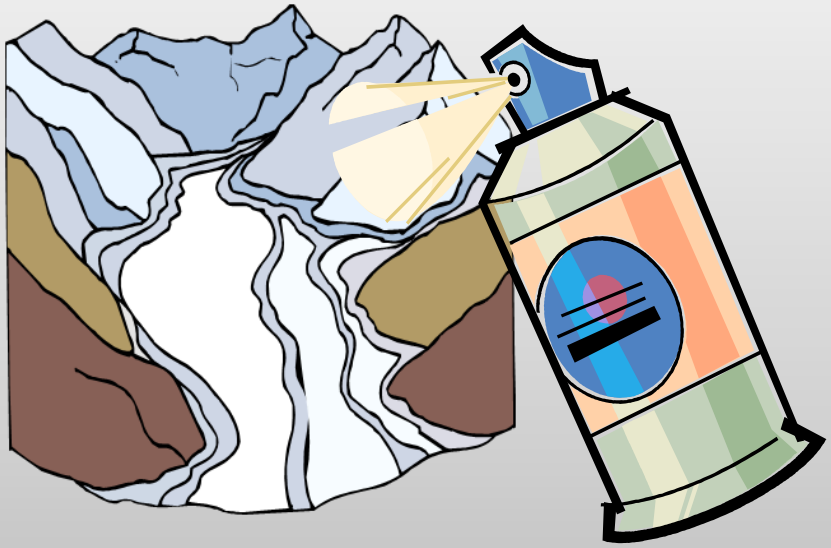
Science Facts

When blocks of earth slip past each other on a surface, that surface is called a fault. The place where this surface intersects the Earth's surface is called the fault line. An escarpment is a ridge of land that has moved upward relative to the land on the other side of the fault line.

Calving



Mother glacier noticed her offspring in recent years numbered in the thousands, while her bulk was wasting away.



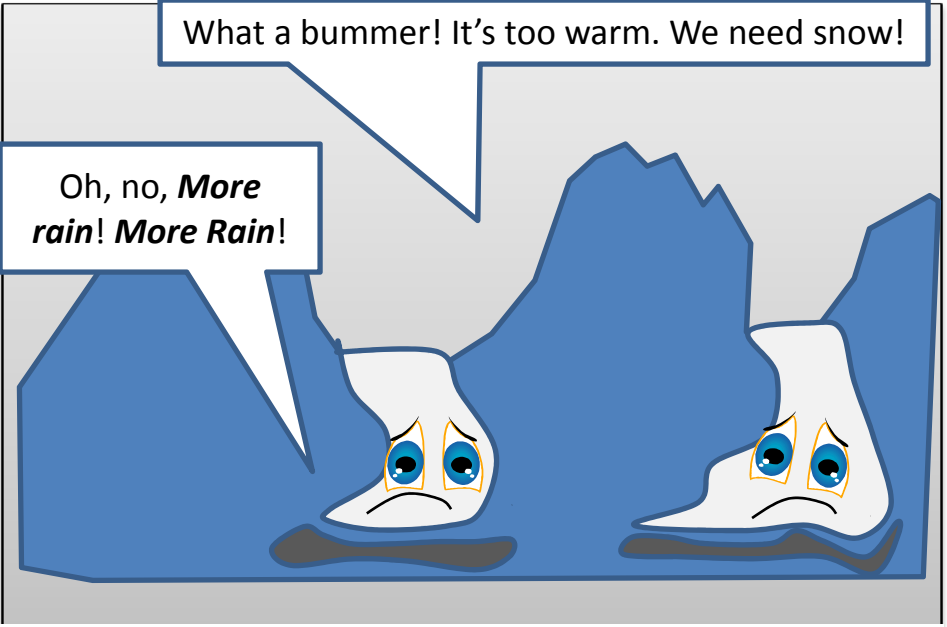
Try new Pledge for Glaciers.. Eliminate that bedrock bottom build-up and slide free and scratchless!

Science Information Referenced by the Cartoon

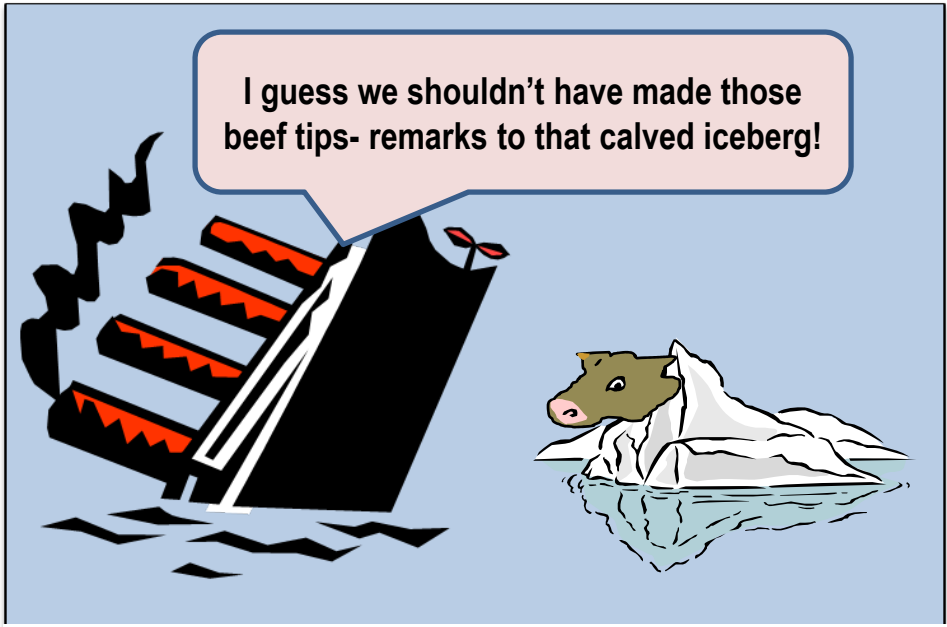
When a glacier moves along the land (or an ice cap) until it reaches the open sea, the part of the glacier touching the water often breaks off to form icebergs. This process of breaking off a large chunk of glacial ice is called **calving**.

Science Information Referenced by the Cartoon

Glaciers pick up many boulders and rocks as they move over them. Some melt water at the base of the glacier covers the rock and freezes, adding it to the bottom of the glacier in a process called **freezing on.** These rough particles then help the glacier scrape over the land and pick up more material.



Sadly, the *moraines* kept growing. It was *terminal* for the glaciers.



The *Titanic* sinks after hitting an iceberg.

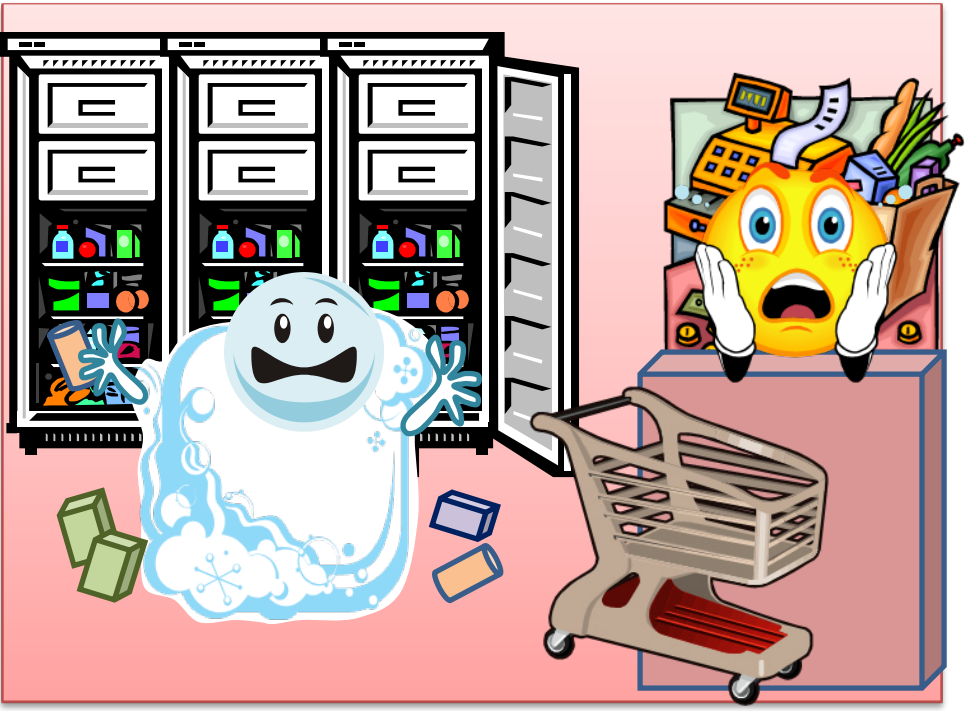
Science Information Referenced by the Cartoon

A glacier carries a load of boulders, rocks, gravel, sand and dirt on its top, within its ice, and frozen onto its bottom. When the climate becomes warmer, glaciers recede, or melt back. The melting ice drops a layer of sediment called a terminal moraine.

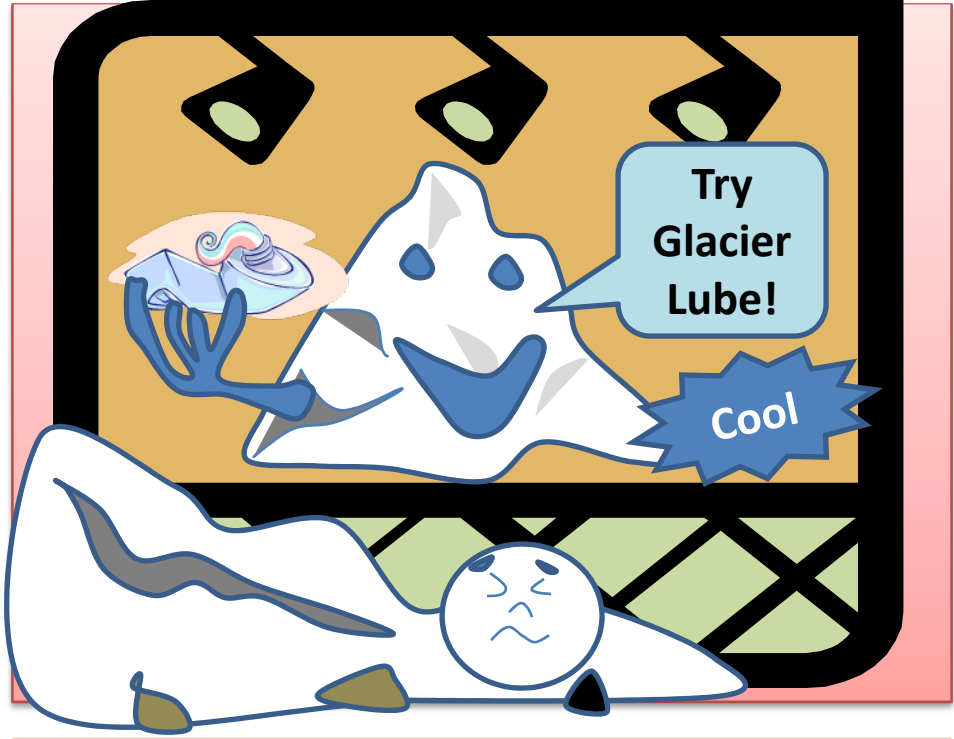
Science Information Referenced by the Cartoon

The *Titanic* was a large ocean superliner thought to be unsinkable that was sunk in 1912 when it hit an iceberg, resulting in 1500 deaths.

When a glacier enters the ocean, parts break off and become icebergs, a process called **calving**.



Glacier caused quite a commotion in Aisle 3 when he started throwing items out of the freezer to make room for himself in a futile attempt to escape global warming.



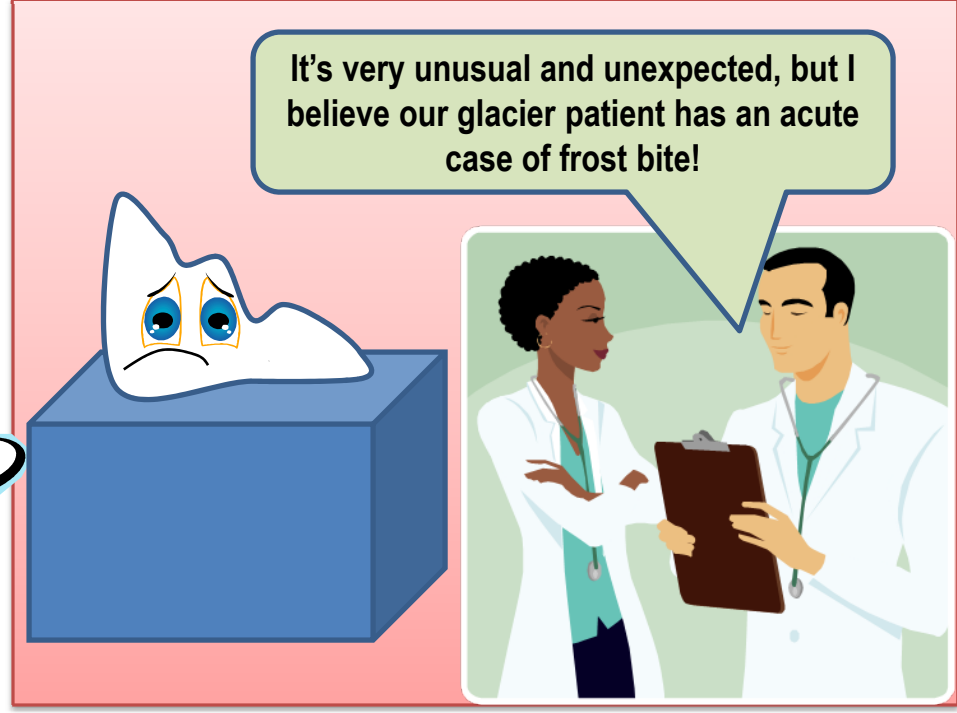
As Rocky surged near the billboard , he thought of the promise of Glacier Lube. Would it soothe the frozen-on boulders and scratches from the bedrock he rubbed over?

Science Facts

A glacier is a very large mass of ice that grows from snowfalls. Many glaciers are shrinking. Snow melt loss during the summer exceeds the amount of snow that is added in the winter. Global warming is causing most glaciers to recede and shrink in size.

Science Facts

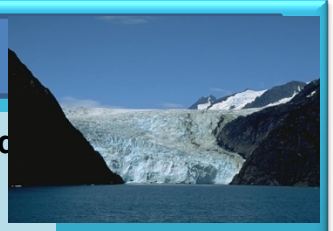
The bottom of a glacier has many boulders, rocks, and gravel frozen onto it. This allows the glacier to scour the land surface as it moves along.
Some glaciers surge, or move very rapidly, when water at the base or smooth bedrock provides easy slippage. Some glaciers have moved so quickly for a short time that dogs have barked at them!



Bobby always asked for a "Brain Freeze" glacier on a stick. Although the bar contained a lot of frozen-on sand and gravel, he felt cool eating it on a hot day.

Poor Glenn Glacier became separated from his valley and developed a terrible case of frostbite.

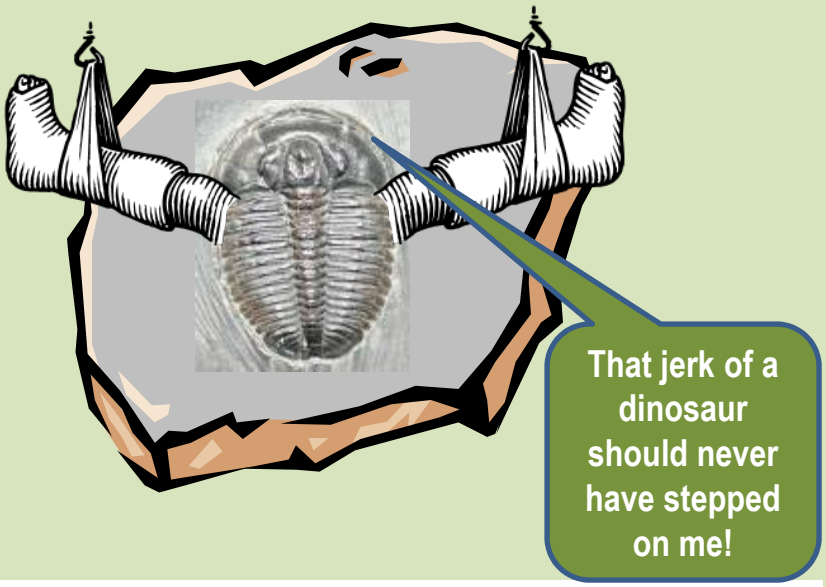
Science Facts



As glaciers move down a mountainsid or through a valley, they pick up a lot of sediment from the ground surface that freezes on to the bottom of the glacier. When the glacier melts, that sediment is dropped and forms glacial till or moraines.

Science Facts

Glaciers form from snowfalls that do not melt in the summer months. The snow slowly changes to ice and becomes more compact.

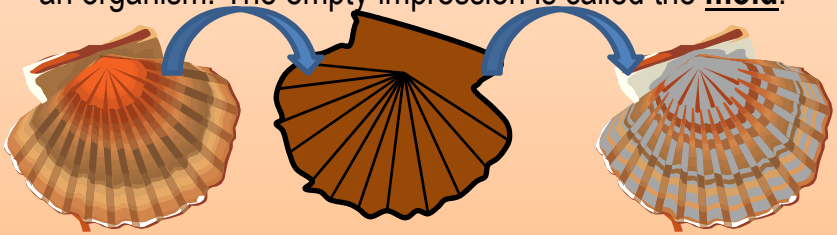


Fossil Cast

In a split second, a precious fossil becomes a chew toy!

Science Information Referenced by the Cartoon

A **fossil** is the remains, impression, or trace of a living organism of a former geologic age, such as a skeleton, footprint, or cast of an impression left by the organism. A **cast** is the resulting hard shape formed when sand or mud fills the impression or hollow space left in the sediment by the body of an organism. The empty impression is called the **mold**.



The **organism**, a scallop

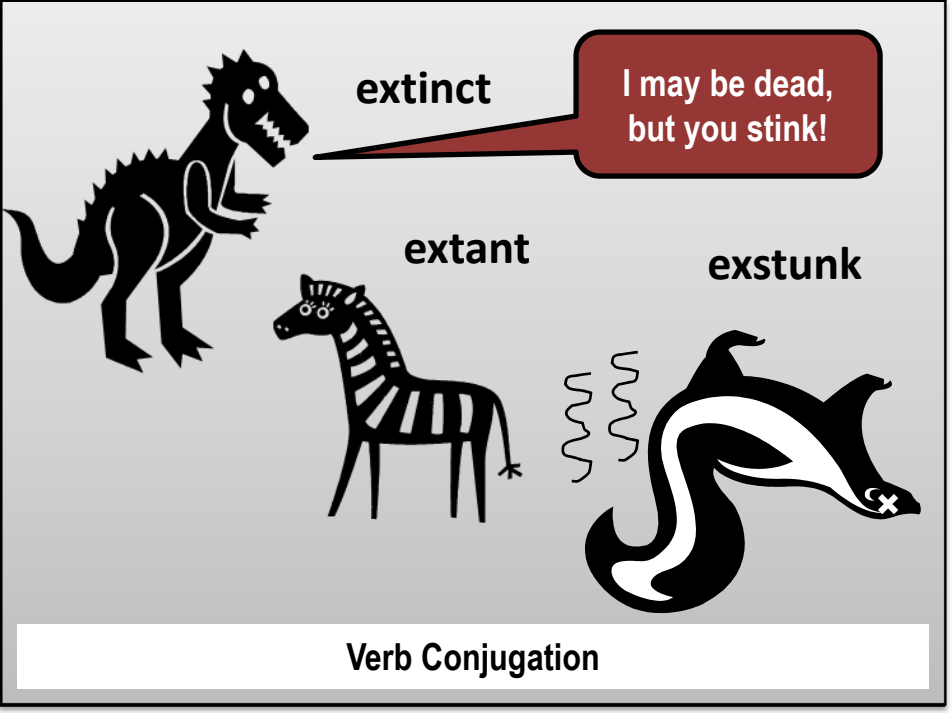
The Impression or **mold** of the organism

The **filling** of the mold, or **cast,** of the organism

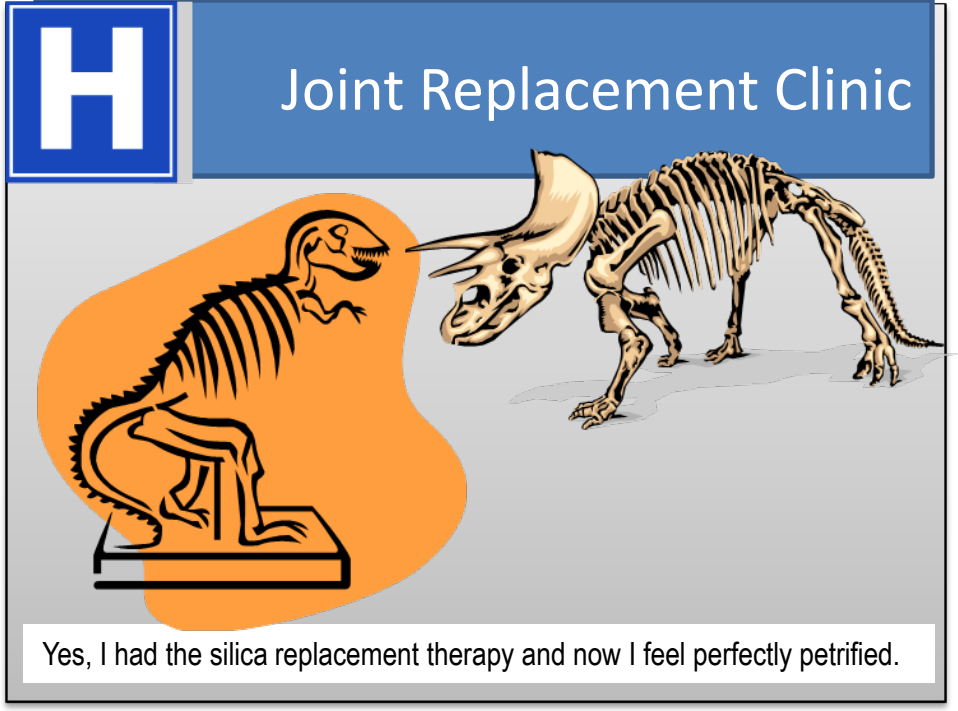
Science Information Referenced by the Cartoon

Fossilization is relatively rare because the remains of animals tend to rot away quite quickly. For remains to become fossilized, they must be buried quickly by sediment and contain some hard parts, such as bones, that can become mineralized.

Scientists who study fossils are called paleontologists.



Verb Conjugation



Yes, I had the silica replacement therapy and now I feel perfectly petrified.

Science Information Referenced by the Cartoon

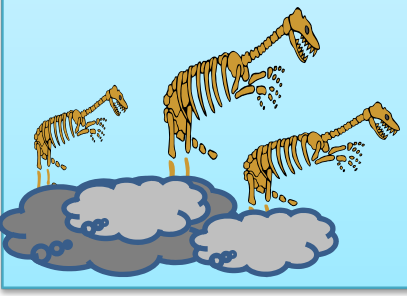
An **extinct** species (kind) or organism is one that has completely disappeared or died out. No members of this type of organism are now living. We can learn about extinct organisms from **fossil** evidence. An **extant** organism is one that is still existing as a living organism on Earth.

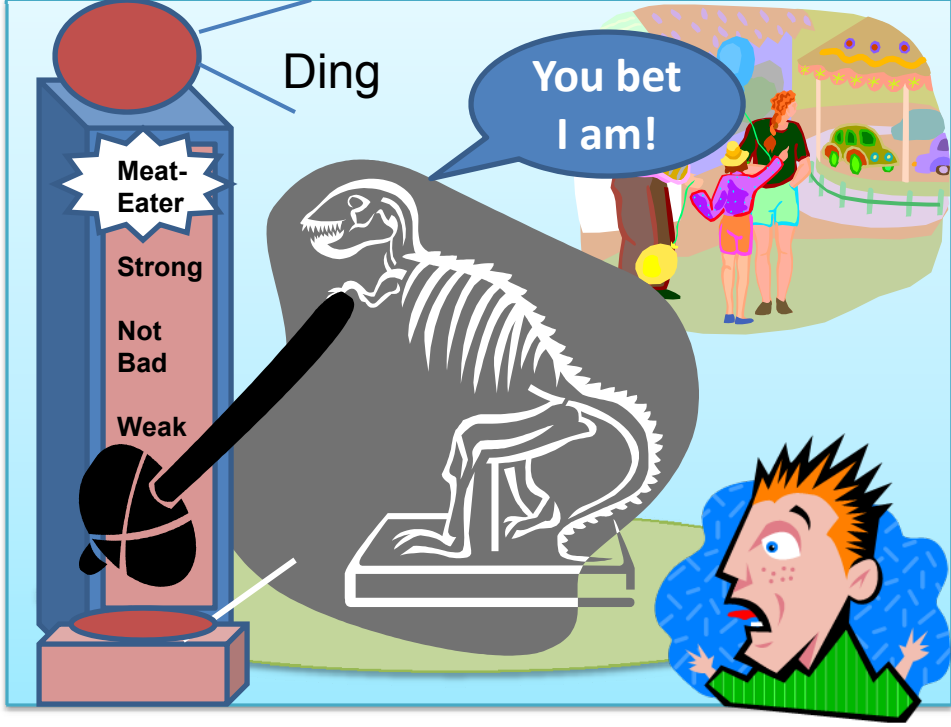
Science Information Referenced by the Cartoon

When an animal dies and is buried by sediment, the flesh rots away, leaving bones. Ground water sometimes moves through the bones, depositing minerals in them, turning them to stone. They are then said to be **petrified** – turned to stone.

Camp Fossil

"Where We Put a Little Meat on Your Bones!"





Rex enjoyed Camp Fossil. He had never been treated so well in millions of years. Although he always chose steak, he wondered about the small mammals that the omnivores ate.

One day, a T-Rex named Sue, bent on proving his manhood, escaped from the Chicago Field Museum and rang the bell on the strength tester at Navy Pier.

Science Facts

Dinosaurs lived during the Mesozoic Era, 65 -250 million years ago. Many dinosaurs were meat-eaters (carnivores), but others were herbivores (plant-eaters). Some were omnivores, meaning they ate both plants and animals. Some dinosaurs ate small mammals that lived at the same time.

Science Facts

Sue is the largest, most complete skeleton of a Tyrannosaurus Rex ever discovered. The sex of this dinosaur is unknown. The skeleton was unveiled at the Chicago Field Museum in 2000. The fossil was found in 1990 in South Dakota in the Black Hills by Sue Hendrickson.

Rex was anxious to see the Old Homeland and so made haste to the airport to catch the next flight.

Fossil fish discussing their problems.

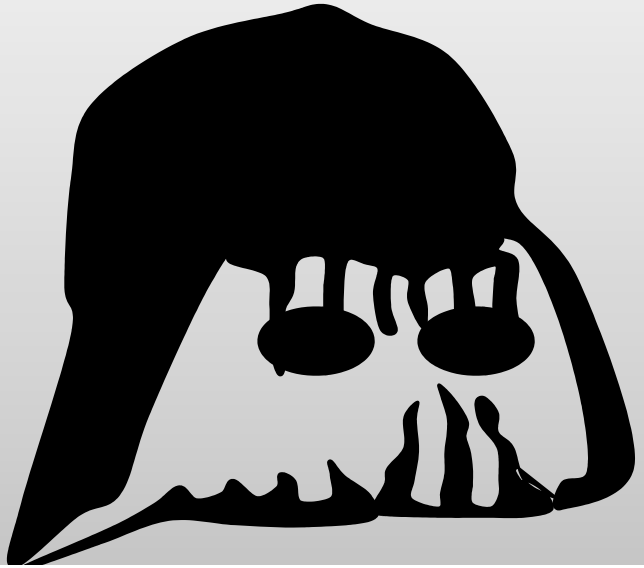
Science Facts

The dinosaurs in the fictional book and movie, Jurassic Park, were created with dinosaur DNA from blood in mosquitoes preserved in fossil amber. Although considered science fiction when the book was first published, the idea of extracting and using DNA from fossils is becoming more plausible.

Science Facts

Many fossil fish skeletons are found in Wyoming in the Green River shale formation from about 50 million years ago. The climate in this area at that time was like that of the present day Gulf Coast, rather than the current desert scrubland.

The stalagmites sang their song day and night, year after year as the water dripped from the cave ceiling.



All the other caves avoided Darth Vadose Cave: his mouth was adorned with sinister stalactites accompanied by the sound of air rushing in and out.

Science Information Referenced by the Cartoon

Stalagmites are cave formations that form on the floor of a cave. Water dripping from the ceiling contains dissolved minerals that are left behind when the drop dries. These build up to form a pillar-like limestone rock, called a stalagmite. The process of forming stalagmites is usually very slow, they can take thousands of years to grow.

When the stalactite on the ceiling meets the stalagmite on the floor, they join to form a column.

Science Information Referenced by the Cartoon

Rainwater seeps into the ground, finding its way through cracks into the bedrock below. If this rock is limestone, the weak acid in rainwater begins to dissolve the limestone along these cracks. These cracks become larger and eventually form caves. All this happens when the cracks are underwater. A cave that is filled with water is said to be in the **phreatic zone**. Later, the water drains away (often because of uplift of the land) and the cave fills with air. It is now in the **vadose zone.** Now cave formations like stalactites and stalagmites begin to form.

Warning! This Cartoon is *beary* funny!

The Three Bears

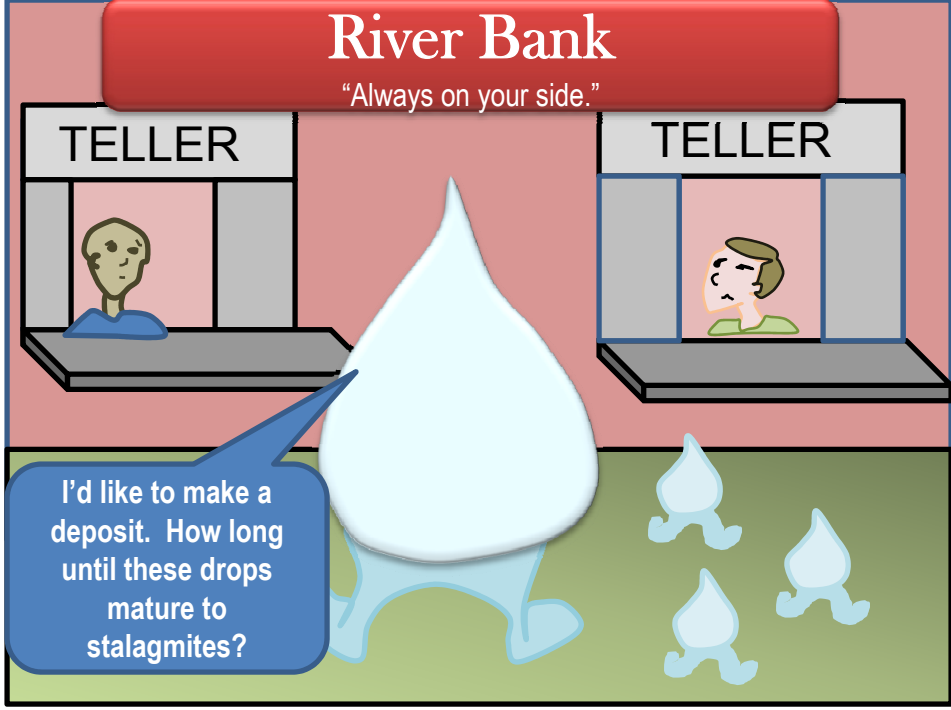
Arghh! The acidic rainwater is eating my fur!

Baby bear's grotto

Mama bear's cave

Papa bear's cavern

Water trickled along cracks in the limestone, dissolving holes of different sizes, just perfect for the three bears.

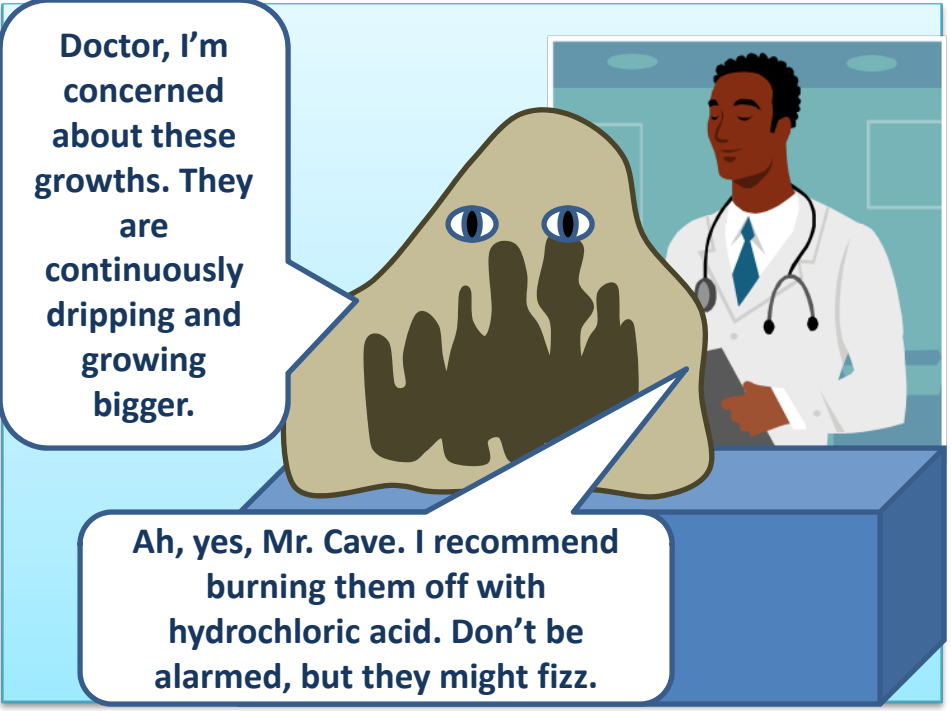


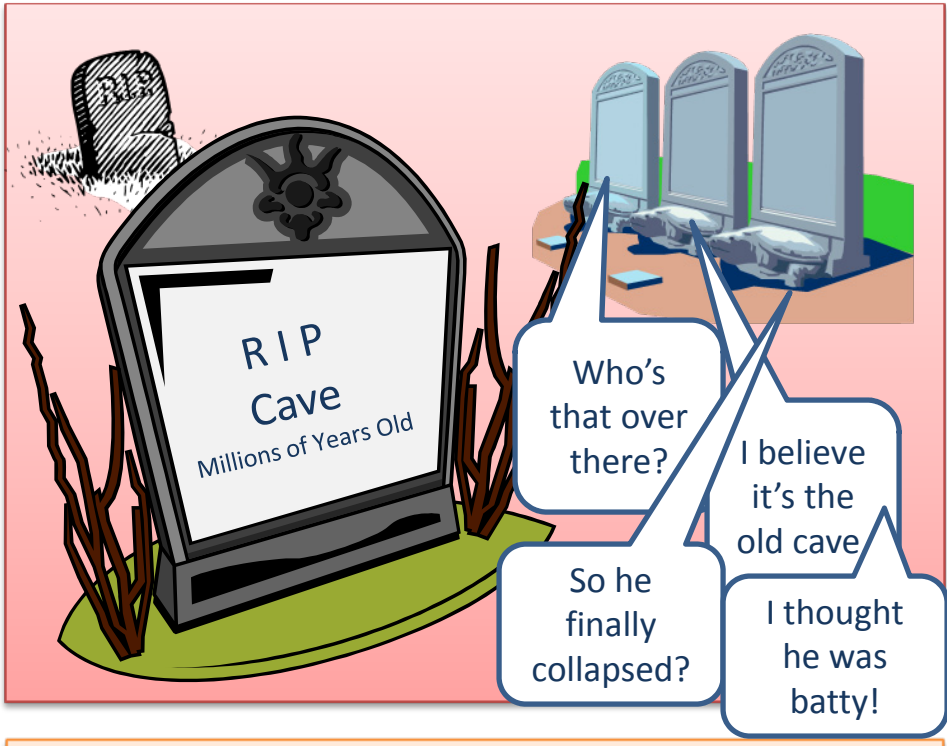
Science Information Referenced by the Cartoon

Rain water falls from the sky and soaks into the ground. This water is slightly acidic. As it moves along cracks in the rocks underground, it dissolves minerals like calcium carbonate (calcite) in limestone, leaving holes. As time goes on, the cracks widen. Some of them are large enough to be called grottos (small caves), caves, or caverns (huge caves).

Science Information Referenced by the Cartoon

Stalagmites are cave formations that grow from the floor of a cave when drops of water fall, evaporate, and leave behind a small trace of calcite. As time goes by, the calcite deposit grows to form a cave formation.



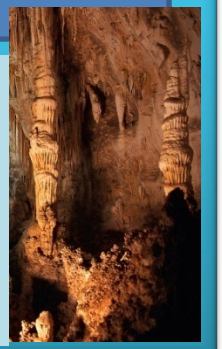


Clarence Cave did everything to rid himself of his cave formations, but to no avail. Finally he resorted to having them surgically removed.

Poor old cave couldn't handle the pressure of the overburden and caved in.

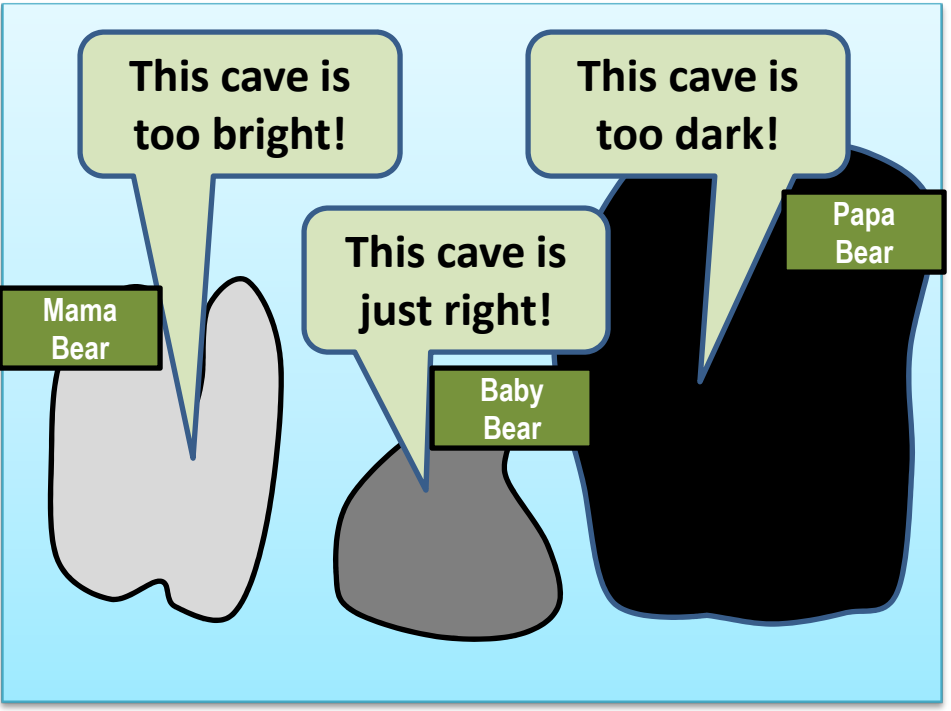
Science Facts

Cave formations, stalactites (hanging from ceiling) and stalagmites (growing from floor) grow when dripping water evaporates and leaves behind calcium carbonate, the mineral calcite. A common test for this mineral is to see if it fizzes in dilute hydrochloric acid.



Science Facts

The caverns and tunnels of a cave develop when the cave is filled with water. Much later, perhaps because of uplift of the area, the cave becomes filled with air. Sometimes a cave collapses at this time because without the water pressure inside it, it can't support the weight of the overlying rock – the "overburden."



Goldilocks visits the Three Bears' Caves and falls asleep in Baby Bear's twilight-lit grotto.

Poor Carlsbad Cave was ushered out of the Upscale Pet Store when she requested 27 bats for her cavernous home.

Science Facts

Most caves are too dark for plant life except near their entrances. Many caves contain animals specially adapted to the dark cave environment: blind fish and blind salamanders.

Science Facts

Carlsbad Cavern is a National Park in New Mexico. The extensive cave houses sixteen species of bats, including the rare Mexican Free-tailed bat.
Bats often roost in caves during the day and fly outside during the evening to catch insects or feed on fruits and flower nectar.

I call ***my*** old geezer "Old Faithful" because he is just like the famous *geyser*. Every hour or so he erupts and lets off steam about some issue he was watching on television.

The old geyser gives the little geyser advice on being faithful.

Science Information Referenced by the Cartoon

A geyser is a hot spring that intermittently sends up fountainlike jets of water and steam into the air. Geysers appear in volcanic areas. The ground water of a geyser system circulates deep underground where the rocks are hot from the volcanic magma. When steam builds to a certain point, the geyser erupts and spills hot water and steam at the surface.

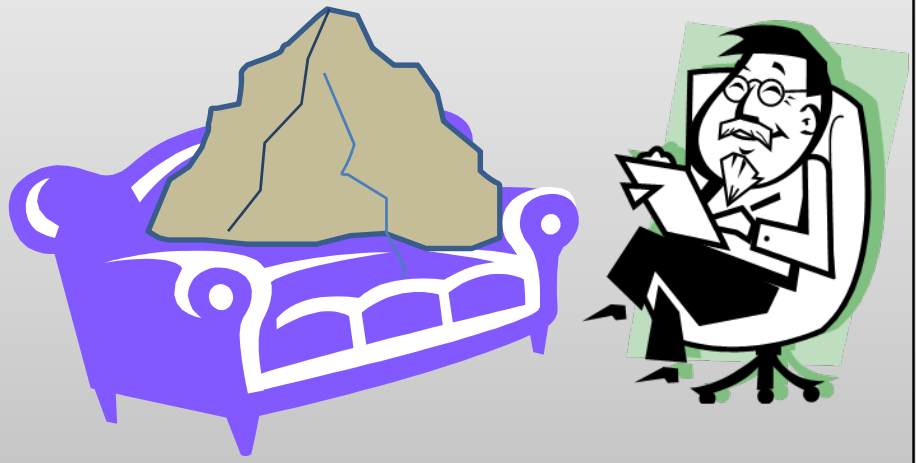
Science Information Referenced by the Cartoon

Some geysers erupt regularly, every few minutes, hours or days. Old Faithful is a famous geyser in Yellowstone National Park that erupts about every 90 minutes. Other geysers are not predictable. It depends upon the system of underground cracks that feed water to the hot rock layers far below.

A scene from Yellowstone National Park.

While the other dormant volcanoes continued to sleep, Mount St. Helens felt a rumbling deep within her and awakened. She remembered the extinct volcano's sage advice: "Stay active!"

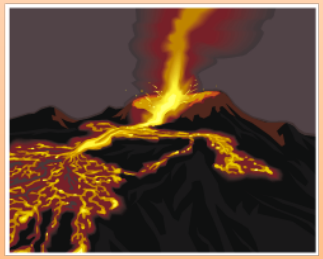
Mt. St. Helens, a dangerous composite cone volcano, visits Dr. Freud.



Uh-huh… Yes, well, Helen, err… Someone of your temperament, who lets it all build up without venting steam… well, could suddenly EXPLODE!

Science Information Referenced by the Cartoon

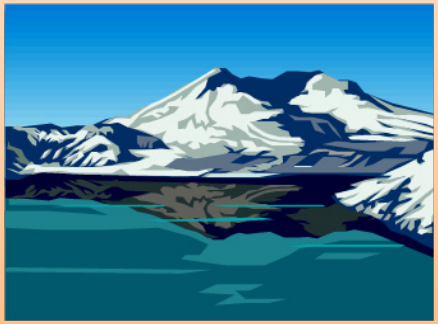
Volcanoes can be classified as active, dormant, or extinct. **Active volcanoes** are those that have erupted in recent times, or which are likely to erupt. A **dormant volcano** is a volcano which is not currently active (that is, not erupting nor showing signs of unrest), but is believed to be still capable of erupting. **Extinct volcanoes** are those that are cut off from their sources of molten rock and will therefore never again erupt.

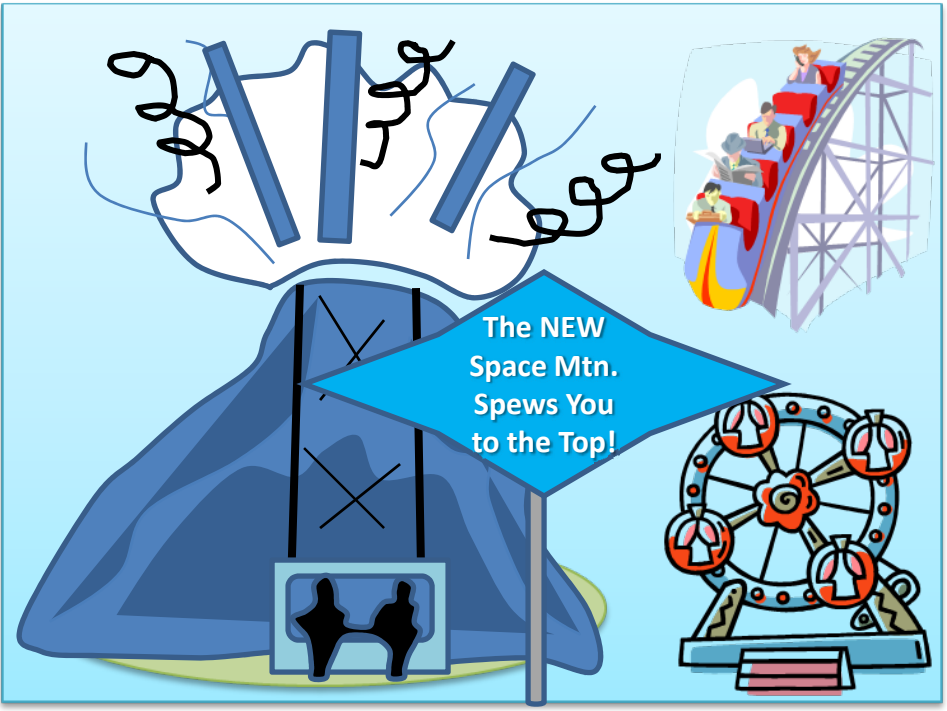


Science Information Referenced by the Cartoon

The most explosive volcanoes are called **composite cones.** This type of volcano has very thick lava that prevents gas and steam bubbles from reaching the surface. Eventually the gas builds up until the volcano explodes violently. Mount St. Helens was this type of volcano and exploded, blowing off part of its top and killing many people in the area.

Mount St. Helens showing the missing top part of the mountain that blew off during the eruption.





Vesuvius' dad , an engineer, installed innovations on the Space Mountain ride at the fair. However, only volcano folks could tolerate the excessive heat, fierce shaking, and explosive finish.

Rocky resented being sent to anger management camp and frequently erupted after lunch, especially when served peas or guacamole.

Science Facts

Vesuvius is the name of a famous volcano in Italy near the ancient town of Pompeii. Volcanic eruptions are accompanied by earth tremors as lava moves underground. The temperature of lava is 500 to 1100 degrees Centigrade. Many volcanoes explode when they erupt.

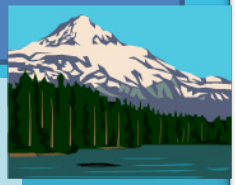
Science Facts

Volcanic eruptions come in many different types. In cold climates, volcanoes may erupt under ice sheets or glaciers. These can cause catastrophic floods. Phreatic eruptions occur when cold water comes in contact with rocks layers heated by magma. Steam and broken pieces of rock shoot out from such an eruption, but no molten magma.

Mount Hood set his alarm clock to "vibrate" so that his fellow mountains would have some warning of his eruption.

Mt. St. Helens, in a desperate attempt to find relief from her inner rumblings, visits Dr. Evil.

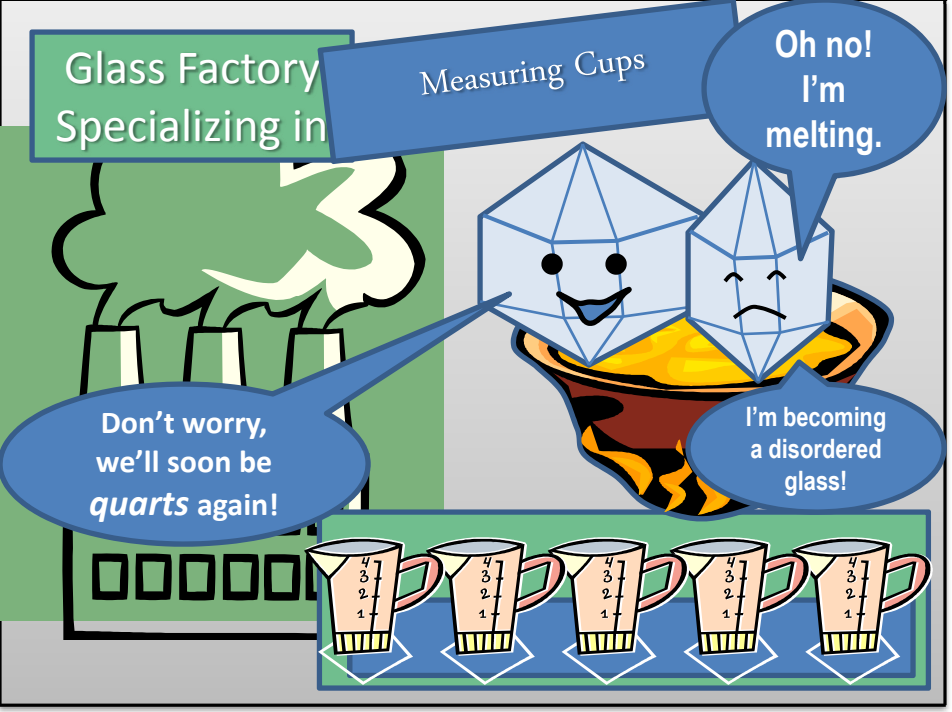
Science Facts

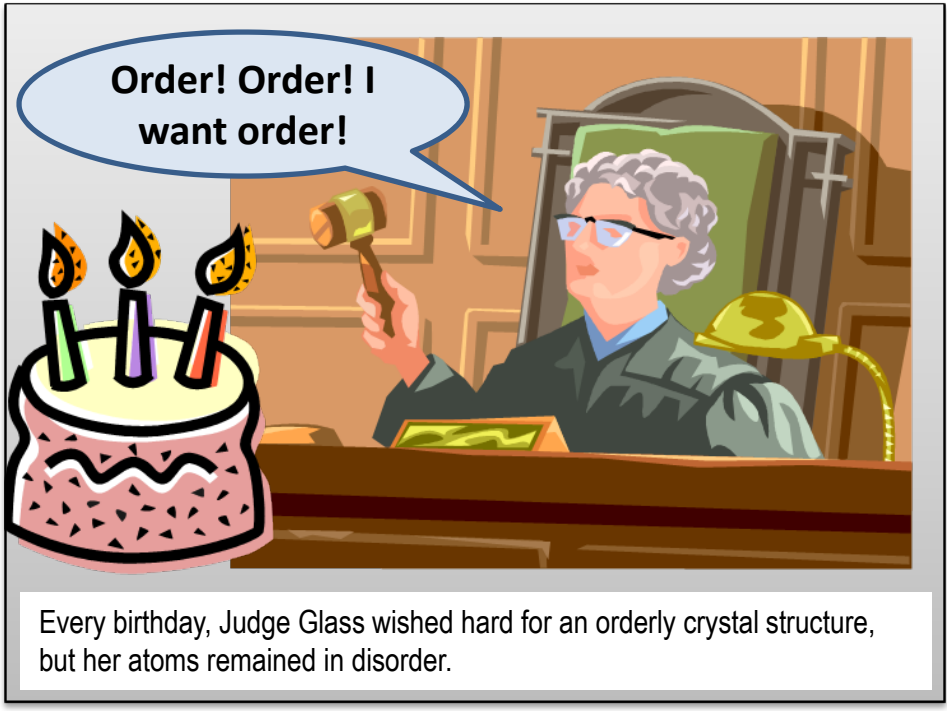


Most volcanic eruptions are preceded by earthquakes caused by the movement of magma to near the Earth's surface. Mount Hood is located in Oregon and is considered the most likely volcano to erupt in that state. There is a 3-7% chance that it will erupt within the next 30 years.

Science Facts

Mount St. Helens is an active stratovolcano or composite cone located in Washington State. Its 1980 eruption was the largest and deadliest eruption seen in the United States. Fifty-seven people were killed and 47 bridges were destroyed.

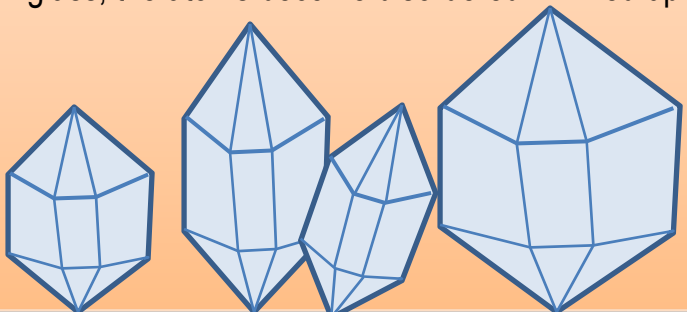




Every birthday, Judge Glass wished hard for an orderly crystal structure, but her atoms remained in disorder.

Science Information Referenced by the Cartoon

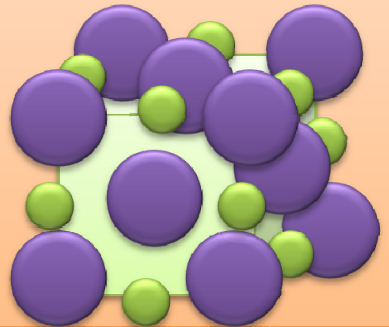
Quartz is the most common mineral on the surface of the earth. It is the hard, clear mineral that comprises most sands. Its composition is silicon dioxide, SIO_2. The silica and oxygen atoms are arranged in an orderly pattern in quartz. Quartz is the mineral that is mined for the manufacture of glass bottles, windows and other items. When quartz is melted to make glass, the atoms become disordered – mixed up.



Six-sided crystals of quartz

Science Information Referenced by the Cartoon

Crystals show beautiful geometric shapes because their atoms are arranged in a repeating pattern. But not all solids are crystallize with well-arranged atoms. Glass is a solid that has atoms that are not arranged in patterns. Glass is formed when crystallize substances like quartz are melted. The heat causes the atoms to jump around and lose their pattern.



Example of atoms in order

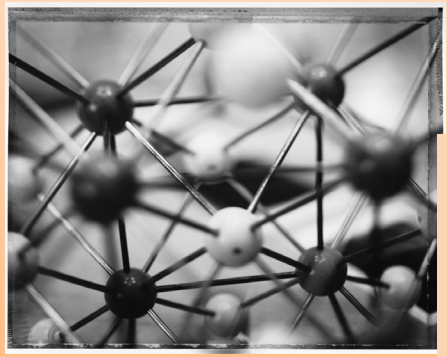
Few people are aware of the mineral kingdom holiday called Crystalmiss, when crystals vacation in Florida.

Science Information Referenced by the Cartoon

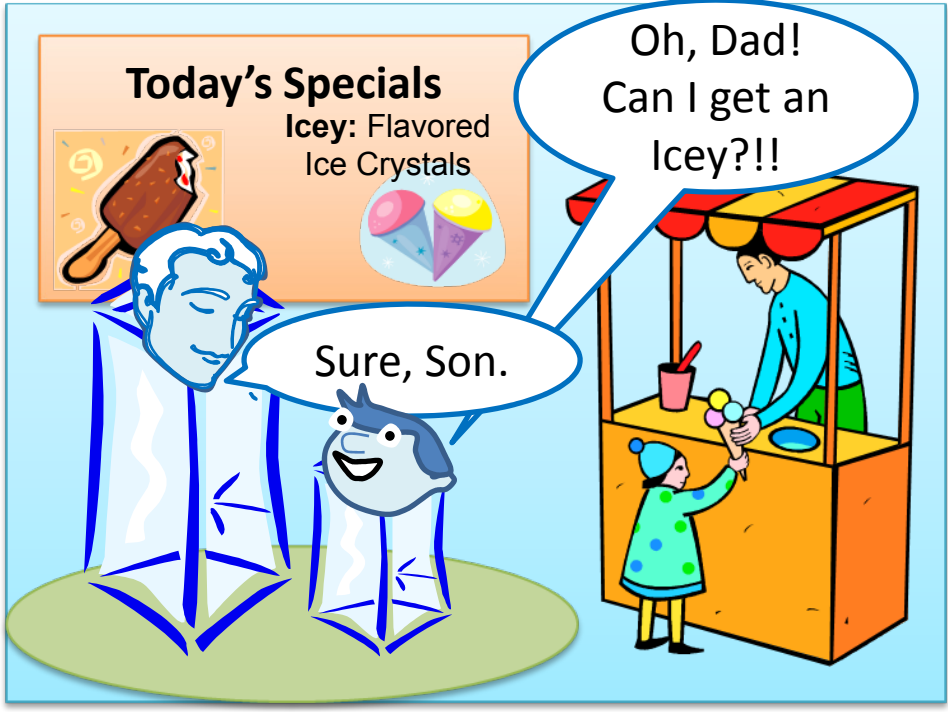
There are many edible substances that commonly show crystal shapes, such as salt, sugar, and ice. People like to own mineral crystals (diamonds, rubies and other gems) and wear them in jewelry.

Science Information Referenced by the Cartoon

When atoms join together, they "bond." Crystals are made of atoms bonding in a regular pattern. These patterns show geometric arrangements such as hexagons, rectangles, and squares.



A model of atoms bonded together



Krystal modeled the latest in Blingwear at the Paris show, proving that she was no longer a "diamond in the rough," but a high fashion, multi-faceted gem.

When Otto and his dad went to the fair, Otto always begged for his favorite treat, flavored ice crystals, although he felt like a cannibal consuming them.

Science Facts

Diamond crystals have an octahedral shape. They have rough surfaces and do not shine very much. Jewelers cut new flat faces on these crystals and polish them to create sparkling diamond gems.

Science Facts

Ice, frozen water, is a crystalline solid. The hydrogen and oxygen molecules in ice are arranged in a repeating pattern. All crystals have an orderly arrangement of atoms.

Krystal couldn't bear to break any of the balloons of the balloon-popping booth at the fair. The disorder of missing balloons upset her tremendously.

Krystal wondered what it would be like to have increased reflection symmetry and so wandered into the House of Mirrors. It was here she met her long lost twin!

Science Facts

Atoms in a crystal structure are arranged in a pattern that repeats. If some of the atoms are removed, the pattern will no longer be perfect and will be tending toward disorder.

Science Facts

Many crystals display mirror or reflection symmetry in which the atoms are arranged as if they had been reflected in a mirror. Often, two similar crystals that grow from the same point are related by mirror symmetry. These crystals are called twins.