English • STEM • Environment • Social Studies • Citizenship

engage LEARNING

TEACHING GUIDE

Vol 1 • Issue 4 • Levels 3 & 4

Ages 9–13 years

Dear Educator,

We are delighted to bring you Issue 4 of **engage** magazine. We are dedicated to offering you the best in educational value. With this issue, we have updated our teaching guide. We realise that this guide is vital to the success of **engage** in your classroom.

With this issue we are improving our science instruction programme. Through the magazine, we have given students unparalleled depth in content, exposure to real scientists doing real science and connections to the real world. As important as reading about science is, it is not doing science. Starting with this issue, the teaching guide will give you an instructional plan that incorporates hands-on activities and experiments. You will find that these activities provide real-life experiences with science and will help your students become even more successful.

In this issue, you will find three new stories. The first story explores one of our five senses, sight. Students will first look at how optical illusions can trick their brain into seeing things that are not there. Then they will look at how the human eye works. Finally, they will look into animal eyes to see how their eyes are similar to and different than human eyes. They will come away with new insight into all kinds of eyes.

After looking into the eye, students will travel the world to look at different kinds of penguins. Students will learn about the various adaptations that penguins have that allow them to survive in different kinds of habitats. They will also learn about some recent research studies scientists are conducting to learn how penguins walk and stay dry.

Our last story is based on the water batteries that Sonam Wangchuk invented. You might remember him as the inspiration for the Bollywood film, *3 Idiots*. Wangchuk used basic math and science to fight the effects of global warming in Ladakh. Students will see how he used math to solve real-world problems. They will learn about the real-world applications of the math they are learning in school.

Your next issue will be available at the beginning of January 2018!

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MEET THESE STANDARDS

✓ **LANGUAGE ARTS**
- Students identify two or more main ideas from the text and explain how key details support them. Students will integrate text and diagrams to gain better understanding.
- Students will learn to become active readers by asking questions before reading and then checking to see if the text answered their questions.
- They will practise being active readers by conducting activities that help them ask questions while they read.

✓ **LIFE SCIENCE**

Students will understand that:
- Penguins are adapted for life in specific habitats.
- Energy in an animal's food is used to grow, move and keep warm.
- Students will understand how the structure and function of the human eye varies across species.

✓ **SCIENCE**
- Scientists use tools to help them observe natural phenomena.
- Students will understand that asking questions and making observations are important parts of the scientific process.

✓ **MATH**

Students will learn what surface area and volume are.

EYE TO EYE

LIFE SCIENCE OUTCOME

Students will understand how the structure and function of the human eye varies across species.

LANGUAGE ARTS OUTCOME

Students identify two or more main ideas from text and explain how key details support them. Students will integrate text and a diagram to gain better understanding.

CURRICULUM CONNECTION

This article relates to several parts of your curriculum. The story explores one of the five senses that humans have. Scientists use their five senses to observe the world. Sight is one of the most important of these senses. They use sight to make observations with which they develop theories that explain natural phenomena. The story also looks at how the human eye works and how it differs from animal eyes. Animal eyes are adapted to help different species survive in different habitats and niches within those habitats.

This story will also help students develop their nonfiction reading skills by giving them practice to identify a story's main idea.

BUILD BACKGROUND

Split students into groups of two. Have the pairs of students look into each other's eyes. Then have students draw each other's eyes. Ask students to label the exterior parts of the eye if they know what they are. They can also write down the function of each part. Tell them to return to their diagrams after they have finished reading the article and revise their labels and descriptions based on what they have read.

READY TO READ

Hand out copies of **engage** magazine and have students turn to the first story, 'Eye to Eye'.

Ask the students to turn to page 4 'Optical Illusions' and to go through the text. Notice how the article starts with a real-life incident about zebra crossings in Ahmedabad. Notice the image, and how this correlates with the text. Is there anything that strikes you about the style in which the article has been written?

(***Teacher prompt***: the article begins with a situation in an Indian city, and then develops into an understanding of a scientific principle).

The story in Ahmedabad now leads to the creation of an optical illusion and how this works through the eye-brain connection.

Have the students read the text as well as look at the images, and raise questions, which they would like to discuss. There is some written material and several images. This is a good opportunity for groups to look at the different optical illusions and raise questions. The teacher can also expect Level 4 students to inquire further and critically examine how the brain creates optical illusions. There is a QR code on the page – this is a good opportunity for the students to look at more optical illusions and discuss how they link to the text.

Some background material for the teacher to enrich the discussion:

Optical illusions and how they work continue to baffle many scientists. The information that the brain takes in can conflict with past experience or expectations. For example, the brain does not expect to see something move on a plain sheet of paper. When the brain cannot make sense of the information it receives, there may be a tendency either not to see the illusion, or else to turn the unfamiliar into something more familiar. Ask the students to reflect on why this is happening.

Optical illusions can be used as experiential exercises to:

- provide convenient windows into how the brain works;
- help people become aware of the limitations of the eye;
- show how art can be a fun tool to help people learn more about themselves.

HELPFUL LINKS

— **A large collection of visual & optical illusions** http://www.michaelbach.de/ot/

— **A kid safe zone with optical illusions for kids of all ages:** http://opticalillusions4kids.blogspot.in/

— **Beau Lotte's Ted Talk:** https://www.ted.com/talks/beau_lotto_optical_illusions_show_how_we_see

— **25 Brilliant optical illusions for kids:** http://slodive.com/inspiration/optical-illusions-for-kids/

— **Check out an elephant's legs here:** http://www.optics4kids.org/home/content/illusions/elephant-legs/

SCIENCE CONNECTION

HOW THE EYE WORKS

In order to understand how optical illusions are created in the brain, let us look at how the eye works.

Have the students read the text on pages 6-7, and pick up the following science connections:

- An object can be seen when light is reflected from its surface and enters the eyes.
- REINFORCE the Structure of the Eye, and have students label the parts accurately using the diagram overleaf. They can use the diagram in their magazines for reference.
- REVIEW the mechanism of how the eye works. For **Level 3** students, provide a diagram of the eye and have them label the parts and discuss the function of each.

For **Level 4**, review the parts of the eye. Extend thinking by asking students to find out how the eye focuses on objects that are near and far. What are some of the problems human beings can have with their vision?

IDEAS FOR REAL-LIFE CONNECTIONS

Students can conduct a survey of how many students wear glasses in their own classroom. What does corrected vision mean?

Visual acuity is measured by the ability to identify letters or numbers on a standardized eye chart from a specific viewing distance.

Visual acuity is tested one eye at a time, with the help of a standardised Snellen chart. It is a static measurement, in which the person being tested is sitting still during the testing and the letters or numbers they are viewing are also stationary.

If the ophthalmologist finds the patient cannot read the letters clearly, a pair of spectacles is prescribed, such that the person can see clearly. This is known as corrected vision.

For more information visit www.allaboutvison.com

APPROXIMATE COSTS IN INDIA

In today's context, spectacles are not the only way to correct vision. What are the other alternatives, and how do we assess variables such as cost and long-term benefits and effects when making a choice?

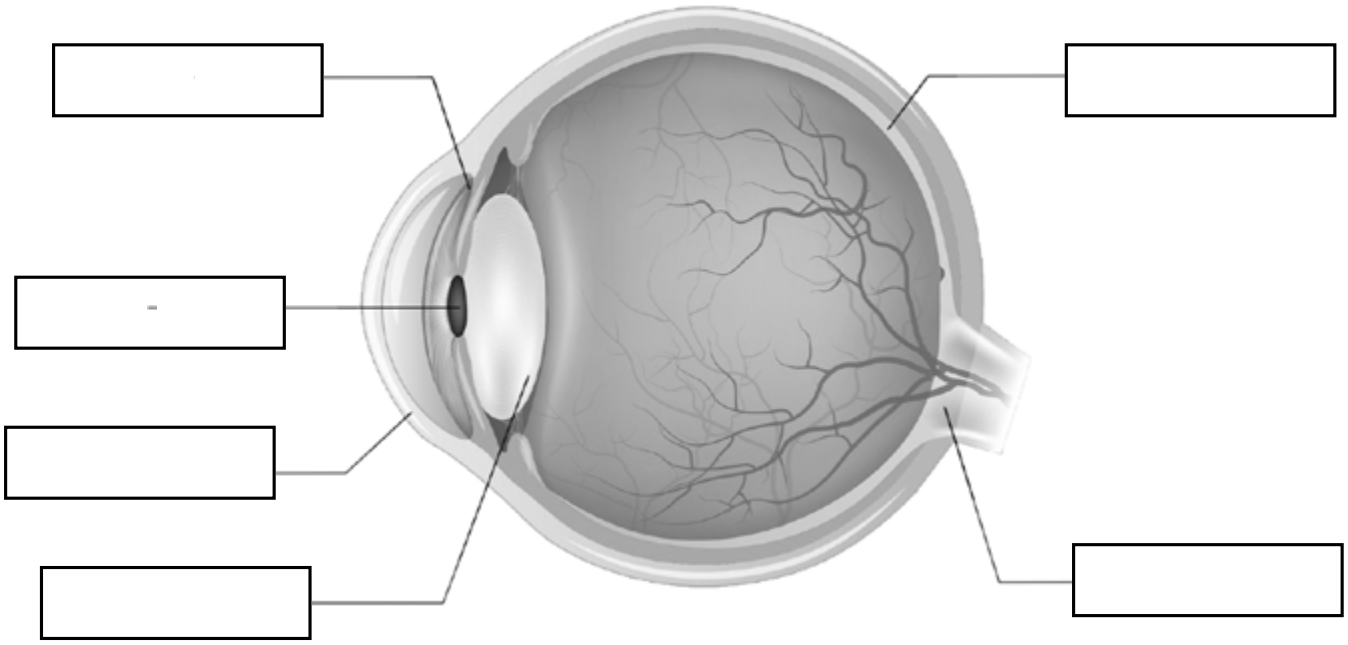
- Eyeglasses or Spectacles: Rs 1000 or more, depending on the number
- Contact Lenses: range from about Rs 250 to 2100 in India, depending on brand, quality and days before disposal
- Corrective Eye Surgery: can cost from as low as Rs 5000 to as high as Rs 1,00,000.

There are other variables as well such as personal choice. Each human body is unique, and different people adapt to procedures differently. These prompts can lead to a rich classroom discussion.

You can invite an ophthalmologist to visit the classroom to share his or her thoughts and experiences.

STRUCTURE OF THE EYE

Using the diagram as a guide, write the labels in the boxes using words from the word bank below.



Word bank:

Iris	**Pupil**	**Cornea**
Lens	**Retina**	**Optic Nerve**

CARE OF THE EYES

The teacher can encourage discussions about eye care. For example, protect the eye from dust and wind. Be aware and do not rub the eyes excessively. Our eyes give us vison, which is a gift, hence we need to be grateful, value and take care of this precious gift. Emphasize that students should be grateful for their sense of vision and be sensitive and considerate towads those who are not as fortunate. The teacher needs to be mindful in case there are any visually challenged students in the classroom, and be sensitive about their feelings.

Now ask students if they can connect the section on how the eye works to the section on optical illusions by explaining how the brain and eye work together to develop the sense of sight.

REFERENCE MATERIAL FOR THE TEACHER

HOW DO YOU SEE?

LEVEL 3

Ask students to turn to pages 6-7 in your magazine. Look at the diagram of the eye. Read the text. Now listen carefully as I explain how the eye works.

- Light falls on an object present in your line of vision. The object reflects the light, which bounces off the object and enters your eye.
- The light passes through your pupil and lens to the retina at the back of your eye.
- In the retina, an upside-down image of the object is created.
- The retina contains light-sensitive cells (called rods and cones) that change the picture into messages that your brain understands.
- The optic nerve carries these messages to your brain.
- Finally, your brain interprets these messages and creates a picture of the object for you.

LEVEL 4

- The light rays from the object pass through the conjuctiva, cornea, aqueous humour, lens and vitreous humour in that order. These structures refract the light such that it falls on the retina.
- This is called focusing. The light falls on the retina and an upside-down image is created.
- This image is received by the photoreceptors – rods and cones – on the retina. The light absorbed activates the pigments in the rods and cones and is converted into impulses that neurons carry to the brain.
- These travel as nerve impulses through a pathway to the optic nerve.
- Our vision is controlled by the occipital lobe at the back of the brain. The information is processed and we are able to see an image which is inverted back.

ACTIVITIES TO LEARN MORE ABOUT YOUR EYE

ACTIVITY 1: Binocular Vision

Human beings have what is called binocular vision. This means that we use two eyes in order to see one image of a 3D object. We can ask ourselves the question – does each eye see the same view?

To do:

Read aloud the following instructions and have students follow them as you speak:

1. Close your left eye.
2. Hold your left arm straight out in front of you, make a fist and point your index finger to the ceiling.
3. DO NOT MOVE your finger.
4. Now close the right eye and open the left. What do you observe about your finger?

Discussion*:*

— Does it look as if your finger moved? Why does this happen?

— It is because humans have 2D or binocular vision. Our eyes are approximately 5 centimeters apart and each eye sees a slightly different view. The brain then interprets the images and we see a three-dimensional image.

— Do we need two eyes in order to see 3D images? Think about it.

ACTIVITY 2: Hole in the Hand

PHOTO: http://metro.co.uk/2016/03/03/this-incredible-optical-illusion-will-make-you-see-a-hole-in-your-hand-5731464/

ASK STUDENTS: Can you always believe your eyes? Let us try and trick your brain with this simple activity.

You need:
A cardboard tube. A toilet paper or paper towel roll works well too. If not available, the students can roll up a piece of paper and make a roll. Ensure that the roll is narrow and secure.

To do:
Read aloud the following instructions and have students follow them:

1. Make sure you are in a well-lit area. Choose a non-white background to look at, a door, a wall or trees outside will work.
2. Imagine that the tube is a telescope. Keep both eyes open. Hold it in your left hand, bring it up to your left eye and look at the background you have chosen with both eyes. ASK: What do you see through the tube?
3. Raise your right hand slowly, and bring it about 10 cm away from your right eye, with the palm facing towards you.
4. Now gradually place your right hand against the tube so that the outside of your little finger is touching the tube, about halfway down its length. Look straight ahead with both eyes open. ASK: What do you see? Do you notice anything about your right hand?
5. NOTE: If the students are not able to see the hole in their hand, ask them to slide their right hand up or down the tube until they see it. If their right hand is too close to the eye, they may not see the hole.

ILLUSTRATION: https://www.scientificamerican.com/article/can-you-see-a-hole-in-your-hand/

WHY DOES THIS HAPPEN?

In this activity, your left and right eyes are looking at two different things. Your left eye is looking at a small circle of the environment. Your right eye is seeing your right hand. When your brain combines the images from the left eye and the right eye, it combines the two images and it looks like you have a hole in your right hand.

In essence, students have created an optical illusion! This links the two sections of the magazine. In the first article we read about optical illusions. In the second article we understood how the eye works. Doing the two activities above, clearly establishes the eye-brain connection!

LANGUAGE ARTS CONNECTION

SENSE PERCEPTION IN ANIMALS

Ask students to turn to 'Animal Eyes' on pages 8-9 and read the story.

Have them make a chart similar to the one shown below, of all the animals mentioned in the article. Once they have filled in each animal's name, they should add the other information.

ANIMAL	STRUCTURE	NUMBER OF EYES	POSITION
Caterpillar	Eyespot		
Leech	Eyespot		
Jellies	Eyespot		
Earthworm	Eyespot	2	Head and tail
Dragonfly	Compound eye	30,000	
Spider		8	
Lizard		3	
Sea Star		2	Arm
Scallop		100	Edge of shell
Grasshopper	Compound eye	5	2 on side of head, 1 in the middle of forehead, one behind each antenna
Horseshoe Crab		10	

After students complete their charts, ask them questions about the information presented in it. Ask them if it helps them understand the information they just read. Then ask students to read and understand the nuance of the term, nocturnal animal. Ask students to explain some of the differences between nocturnal and diurnal animals. They can use information from this issue and 'Crazy Critters' from Issue 1 of **engage** magazine.

ACTIVITY 3: See What They See

Ask students to pick and research one of the nocturnal or diurnal animal's physical ability to see in the habitat in which it lives. Give a 3-4 minute presentation on the animal. Describe how the animal sees the world, why this is so, how it helps the animal, and maybe how predators and prey take advantage of any weakness in the animal's ability to see or sense their presence. Tell students to use pictures to illustrate their findings. Students do not have to do a PowerPoint presentation, but given the colour and nature of the images, ask for the assignment in electronic form.

SUGGESTIONS: Snake (pit viper), dog, cat, bee, bat, albatross, shark, elephant, ant, butterfly, moth, fly.

Some websites about how animals see:

— http://morgana249.blogspot.in/2014/07/10-examples-of-how-animals-see-images.html

— http://www.gizmodo.in/science/New-Software-Lets-You-See-the-World-Through-Animal-Eyes/articleshow/48389112.cms

— http://www.brighthubeducation.com/elementary-school-activities/72518-op-art-lesson-plan/

ACTIVITY 4: Create Op-art

Remind students about the optical illusions we read about in the magazine on pages 4-5, and revisit the background material on pages 6-7 on how the brain makes sense of what the eye sees in the physical world. Tell the students that we are now going to explore this further by doing some simple experiments in class.

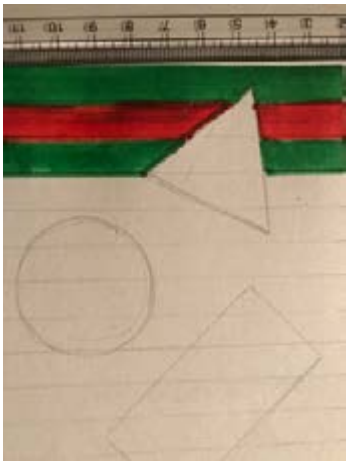
You need:

- white paper (9" x 12" works well)
- ruler (1" wide)
- markers or crayons
- pencils & erasers
- shape templates (circles, triangles, squares, rectangles), cut from cardboard. Or you can use objects like bangles, biscuit tin lids, box tops of different shapes and sizes, tupperware lids, building blocks, etc.

To do:

1. Place the paper in landscape format. Use pencils to trace the width of their rulers to create vertical lines from the top to the bottom across the entire height of the short side of the paper.
2. Select three different shapes from the objects listed above. Arrange these shapes on the paper, and lightly trace the shape across the vertical lines.
3. Select two different coloured crayons or markers. It is essential to follow instructions when colouring to ensure that there is no confusion. Colour the first vertical line in one colour. If a shape falls on this line, leave it white.
4. The lines need to be coloured in two different colours, hence for the first time, leave the alternate line white.
5. Continue colouring the alternate lines in the first colour, leaving the shapes blank.
6. Now colour the second set of lines in the second colour, again leaving the shapes blank.
7. Continue the process, and then colour the shapes on the lines in the complementary colour.
8. The art work can be modified based on level. Older students should be able to create an illusion with five to seven shapes, and younger children could create an illusion on smaller paper with one to two shapes. Older students can also be introduced to a wider variety of shapes (hexagons, diamonds, stars, octagons, etc.). Paints instead of markers or crayons can also be used.

Within five minutes, have students think about all the occupations that humans do, which would require them to protect the eye. List these on the board,



A sample created by Shruti Poddar

and then talk about all the ways to protect the eye. This can move into discussions about construction workers, laboratory research assistants, data entry operators, cinema operators, and how they can look after their eyes. Bring the discussion back to the students own lives and experiences, whether in school or at home and talk about how we can value and protect our eyes.

EXTENSION: In the higher grades, students can be given a photo assignment entitled, "Seeing the extraordinary in the ordinary". Ask them to view the world through a camera. The project is to take one or two pictures of ordinary everyday objects or scenes, but to turn the lens in such a way that they capture a completely different angle or perspective. Does this change the way we look at the same object? This can become a very interesting class assignment, which can also develop collaborative skills, if you choose to give it as a group project with common themes.

PENGUIN PUZZLES

LIFE SCIENCE OUTCOME

Students will understand that:

— Penguins are adapted for life in specific habitats.

— Energy in an animal's food is used to grow, move and keep warm.

— Scientists use tools to help them observe natural phenomena.

LANGUAGE ARTS OUTCOME

Students will learn to become active readers by asking questions before reading and then checking to see if the text answered their questions.

CURRICULUM CONNECTION

This story uses penguins to help students connect to the curriculum you already teach. Students will learn that penguins have specific adaptations that help them survive in specific habitats. They also have adaptations that help them get the energy they need to survive in their habitats. Finally, the story builds on a connection first established in 'Eye to Eye', that humans have eyes that help them make observations. In 'Penguin Puzzles', students will read about how scientists use tools to improve observations.

The story also helps students develop their nonfiction reading skills by giving them practice in asking questions. Readers who ask questions and actively search for the answers to their question as they read are active readers. Studies show that active readers have higher comprehension levels than passive readers.

BUILD BACKGROUND

Begin by explaining that the article is organized around a specific topic, penguins, and we learn new facts through reading. We may already know about penguins from articles we have seen in the newspaper, or by visiting a zoo or aquarium. You can build background by having students research stories on the internet.

Have students use a KWL graphic organizer to find out how much they already know about penguins and what they want to learn.

K – What I know about penguins	**W –** What I want to know about penguins	**L –** What I have learned about penguins

Guiding Questions:
Before reading the story, work with students by filling in the first column.

After completing the first column, continue by having students read the headline, 'Penguin Puzzles,' the captions and the subheads. Then ask students to write the questions they think the article will answer in the second column.

Tell students that they will complete the third column after they finish reading.

Conduct the reading by splitting the students into pairs and having them take turns reading the story aloud to each other. Tell students that they can help each other with difficult concepts and words.

After students have finished reading, complete the third column by listing what students learned from the story. Check their responses against what they wanted to learn in the second column. Ask students how they can learn the answers to any remaining questions.

LANGUAGE ARTS CONNECTION

ACTIVITY 1: Write a Diamante

Explain to students that the diamante was invented only 40 years ago. It was created by an American poet named Iris McClellan Tiedt in 1969.

A diamante – pronounced 'dee-uh-MAHN-tay' – is an unrhymed seven-line poem. The beginning and ending lines are the shortest, while the lines in the middle are longer, giving diamante poems a diamond shape. "Diamante" is the Italian word for diamond, so this poetic form is named for its diamond shape.

Also known as a "diamond poem" because of its shape, it is a wonderful way to get children to write and also create a collage spread. This form creates a wonderful visual display in the classroom.

The activity can also be done in groups for **Level 3**, and individually for **Level 4**. Write on the board the steps on how to write a diamante. Then have students follow the steps to write their own diamante.

Line One:	A noun
Line Two:	Two vivid adjectives that describe the noun in line one
Line Three:	Three interesting "-ing" action verbs that describe the noun
Line Four:	Four nouns, two which are associated with line one and two with line seven
Line Five:	Three interesting "-ing" action verbs that describe the noun in line seven
Line Six:	Two vivid adjectives that describe the noun in line seven
Line seven:	A noun

Here is an easy way to visualize the diamente:

Noun 1
Adjective, Adjective
Verb, Verb, Verb
Noun, Noun, Noun, Noun
Verb, Verb, Verb
Adjective, Adjective
Noun 2

Penguin
Clumsy, playful
Waddling, swimming, diving
Seal, slope, ocean, water
Sliding, singing, dancing,
Black, white, colourful,
Emperor

You already teach that a variety of organisms live on Earth and that these organisms have specific adaptations that help them survive. In this story, students will learn that different kinds of penguins live in different habitats and have different physical and behavioral adaptations that help them survive. Students will also learn that penguins are part of a food web.

Have the students use the information they read in 'Penguin Puzzles' to classify the following penguin adaptations as behavioral or physical. Ask students to justify their responses.

- tuxedo like appearance or counter shading
- ability to swim
- migration to different places
- water does not stick to the feathers
- a male penguin holding an egg on top of his feat
- snow and ice do not bother penguins
- thick feathers with grooves and barbs
- waddling
- wide feet

EXTEND the learning by asking students to choose penguin not discussed in 'Penguin Puzzles,' research it and then present to the class five adaptations that help it survive in its natural habitat. Explain to students that their presentation must be presented using the following format:

1. They need a title that uses alliteration. Explain that alliteration consists of two or more words that have the same Choose a catchy title, which is alliteration – penguin puzzles, careful camels or rascal raccoons
2. Find a picture of the penguin and the environment where it lives
3. Describe two adaptations – one must be structural and the other behavioural.

For **LEVEL 4**, increase the complexity of the research and increase the number of adaptations. Watch the film, **March of the Penguins** https://www.youtube.com/watch?v=A2vt8RJRna0

Turn to page 19 in the magazine, and perform a simple experiment to see how a penguin stays dry..

ACTIVITY 2: How a Penguin Stays Dry

Penguins spend much of their time in water. See how they stay dry.

You need:

- plastic bag
- water
- blue food colouring
- oil
- duct tape

To do:

1. Pour water into the plastic bag, filling ¼ full.
2. Add the colouring so the water looks like blue ocean water.
3. Add oil to the bag so that a layer forms on top of the water.
4. Seal the opening of the bag with duct tape.
5. Gently shake the bag to mix the oil and water.
6. Place the bag on a desk and watch what happens.

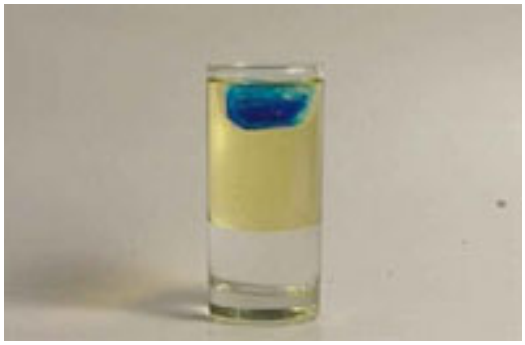
What happens:

The oil separates from the water. Because oil and water do not mix, the oil on a penguin's feathers causes melting snow to roll off. Now, you might try sticking your finger in the oil and then sticking your finger in water. What happens?

ACTIVITY 3: Ice and Oil

We know what happens when oil and water are mixed. They form two separate layers, since both are immiscible with each other. Have you thought about what happens when oil and water are frozen together? Try it.

Put equal amounts of oil and water in a transparent container. To make it more interesting, add food colouring to the water. Put in a freezer. You will find that the mixture has frozen in two layers, but now the layers are reversed. The water is now on top of the oil. Why does this happen? The water expands when it freezes, and therefore is now lighter than oil.



Have a discussion about what the students have learned with reference to how a penguin stays warm. However, both the Antarctic (where penguins live) and the Arctic have several other animals as well. Let us now look at different materials, which we commonly use as insulators, and understand how other animals stay warm.

ACTIVITY 3: How Do Arctic Animals Stay Warm?

A warm, fuzzy project from www.sciencebuddies.org (*January 19, 2017*).

Gather a few items and try out the insulating capacities of various materials.

You need:

- ziplock sandwich bags (four)
- small plates (four)
- ice cubes
- small feathers (craft feathers are fine)
- quarter pound of butter (one stick) at room temperature
- ruler
- preparation

To do:

1. Fill one sandwich bag with a layer of feathers about two centimetres thick and close the bag.
2. Fill another sandwich bag with a two-centimetre-thick layer of butter and close the bag. If the butter was not at room temperature, leave the bag and butter out for a while before you perform the test.
3. Trap air into a third sandwich bag. Try to make it as thick as the other bags. (Closing the bag a little over halfway first, then blowing into it and closing the remainder works well; because the air you trap this way is warmer than room temperature, it is best to leave the bag out for awhile to adjust.)
4. Leave a fourth sandwich bag empty.
5. Place a layer of ice cubes on four small plates.
6. Place one bag on top of the ice cubes on each plate.
7. Let one hand rest on the empty bag, the other on the feathered bag. Avoid pressing down on the bags. Which one feels colder?
8. Remove your hands and wait a moment until both hands feel warm again. Now, place one hand on the empty bag and the other on the bag filled with fat. Which one feels colder now, the empty bag or the bag with the layer of fat?
9. Before you go on, which one do you expect to feel colder, the empty bag or the bag with air—or would they both feel as cold?

Feel the bags. Which one feels colder? Was your prediction correct?

In a moment you will compare the layers of feathers, fat and air. Which one do you think will feel warmest and which one will feel coldest? The one that feels warmest creates the best thermal barrier and thus, is the best thermal insulator. Scientists call materials that prevent heat transfer "thermal insulators."

Perform the test. Make sure to let your hands adjust to room temperature before comparing. Were you able to tell which bag felt warmer or is the difference too small to detect?

For a more detailed test, leave the bags on the ice cubes for 15 minutes and feel again. Are you able to detect a difference now?

Do your predictions and your test results agree?

EXTRA: Do you think adding several layers will create a bigger thermal barrier? To test this, you first must let your bags warm up again. Take them off the ice and leave them at room temperature for awhile. Then place a stack of two bags on ice cubes and measure how long it takes before the top feels cold. Does it take longer than with the single layers?

OBSERVATIONS AND RESULTS

The empty bag probably felt a lot cooler than the filled ones. The materials in the bags are good thermal insulators—they do not let heat travel through them easily. Stacking two bags on top of each other creates an even stronger barrier, so it probably took longer before the top bag felt cold.

The bag with butter (a fat) probably felt colder than the bag with air or feathers, leading to the conclusion that heat transfers faster through fat than via an equally thick layer of stationary air. Feathers insulate because they trap air, so there was probably little difference between how the bag of feathers and the bag of air felt.

CLEAN-UP

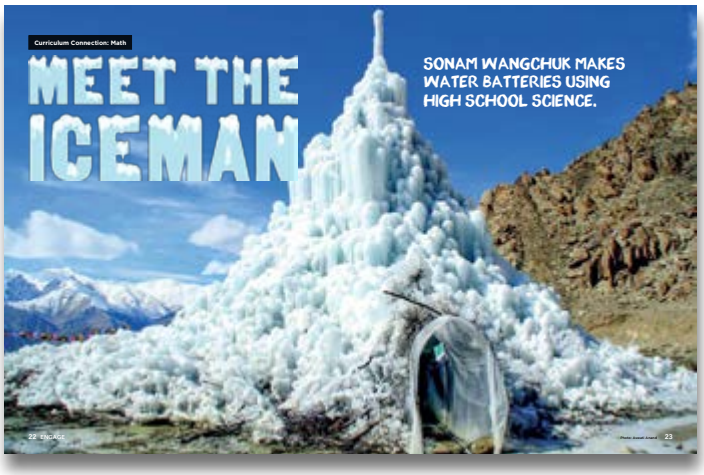
So long as you used a clean bag, you can reuse the butter for cooking. Also reuse your feathers and other bags as you can.

MEET THE ICEMAN

MATH OUTCOME
Students will learn what surface area and volume are.

SCIENCE OUTCOME
Students will understand that asking questions and making observations are important parts of the scientific process.

LANGUAGE ARTS OUTCOME
Students will practise being active readers by conducting an activity that helps them ask questions while they read.



CURRICULUM CONNECTION

You already teach students basic equations, surface area and volume. In this story, students will learn how scientists use basic math to solve real-world problems. This story also demonstrates that science and math have real-world connections that can improve people's lives. It also shows how a scientist uses the scientific process.

In 'Penguin Puzzles', students practiced their ability to ask questions about a text. In 'Meet the Iceman', students will continue to learn how to ask questions and become active readers.

BUILD BACKGROUND

Begin the lesson by using a large map of India to show where Ladakh is located. Explain to students that the word 'Ladakh' is made up of two words – 'La' meaning mountain pass and 'Dak' meaning country. Ladakh is a cold desert in India, lying in the Great Himalayas, on the eastern side of Jammu and Kashmir. Point out each geographic feature as you mention it. If appropriate for upper-level readers, you can point out other geographic features. Continue by telling them that Ladakh is enclosed in the north by the Karakoram Mountains and in the south by the Zanskar Mountains. Several rivers flow through Ladakh. The most important river is the Indus. The rivers form deep valleys and gorges. Several glaciers are found in Ladakh. The Gangri glacier is an example. The altitude in Ladakh varies from about 3,000 m in Kargil to more than 8,000 m in the Karakoram.

Due to the high altitude, it can be freezing cold and dry in Ladakh. The air is so thin that the sun's heat can be felt intensely. In summer the temperature during the day can rise to 21° and the night temperature falls to . In winters the temperature is usually about 7°. The rainfall in this region is as low as 10 cm annually. This is because it lies in the rain shadow of the Himalayas. The area experiences freezing winds and burning sunlight. Consequently, if you sit in the sun with your hand in the shade, you will experience sunstroke as well as frost bite at the same time.

After introducing the geography of Ladakh, hand out copies of the map of India with Ladakh marked, included with this guide (*overleaf*). Ask students to label the geographic features that you discussed. Also have them mark where they live with a label.

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MAP: https://upload.wikimedia.org/wikipedia/commons/thumb/4/40/India-LADAKH.svg/2000px-India-LADAKH.svg.png

Disclaimer: The outline map of India shows the administrative boundaries of the states and union territories of India. They are for illustration purposes only. All efforts have been made to make this image accurate. However Engage Learning Pvt Ltd and its directors do not own any responsibility for the correctness or authenticity of the same.

READY TO READ

- Hand out copies of engage magazine and have students turn to the story 'Meet the Iceman' on pages 22-23.
- Have students preview the text and write down questions they would like answered as they read.
- Explain that good readers ask questions and then go back to see of the text answers their questions.
- Conduct a shared reading session where the students do an activity called jigsaw reading.
- Discuss the questions and ask students whether their questions have been answered after conducting the '**After Reading Extension Activities**'.

Jigsaw Strategy

Ten simple steps to conduct the jigsaw collaborative activity in the class

1. Divide students into 5- or 6-person jigsaw groups. The groups should be diverse in terms of gender, ethnicity, race, and ability.

2. Appoint one student from each group as the leader. Initially, this person should be the most mature student in the group.

3. Divide the article into 5 segments. For example, divide this reading into: **i)** The Heartbeat of Ladakh **ii)** A Changing Climate **iii)** A Problem Solver + Legendary Glaciers **iv)** High School Science **v)** A Stupendous Stupa + More Stupas

4. Assign each student to read and understand one segment. Mark out which illustrations go with which segment.

5. Give students time to read over their segment at least twice and become familiar with it. There is no need for them to memorize it.

6. Form temporary "expert groups" by having one student from each jigsaw group join other students assigned to the same segment. Give students in these expert groups time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group.

7. Bring the students back into their jigsaw groups.

8. Ask each student to present her or his segment to the group. Encourage others in the group to ask questions for clarification.

9. Float from group to group, observing the process. If any group is having trouble (e.g., a member is dominating or disruptive), make an appropriate intervention. Eventually, it's best for the group leader to handle this task. Leaders can be trained by whispering an instruction on how to intervene, until the leader gets the hang of it.

10. At the end of the session, give a short oral quiz about the article.

AFTER READING EXTENSION ACTIVITY

Apply the scientific method steps to the article as outlined below. This will develop critical thinking skills in the students.

The Scientific Method:

Many a time, the method for scientific experiments consists of exercises with step-by-step instructions. The approach to science education that we are trying to bring through engage is to use the inquiry philosophy. This allows students to construct a question and then gives them the choice to follow with different methods in order to determine an answer to the inquiry.

Big Idea: Scientists ask questions and use the scientific method to create experiments, which can be tested and validated.

Tell students: Let us first review how Sonam Wangchuk used the scientific method.

Steps of the Scientific Method:

1. Ask a Question: The scientific method starts when you ask a question about something that you observe: How, What, When, Who, Which, Why or Where?

2. Do Background Research: Rather than starting from scratch in putting together a plan for answering your question, you want to be a savvy scientist using library and Internet research to help you find the best way to do things and insure that you don't repeat mistakes from the past.

3. Construct a Hypothesis: A hypothesis is an educated guess about how things work. It is an attempt to answer your question with an explanation that can be tested. A good hypothesis allows you to then make a prediction:

"If _____[I do this] _____, then _____[this]_____ will happen."

State both your hypothesis and the resulting prediction you will be testing. Predictions must be easy to measure.

4. Test Your Hypothesis by Doing an Experiment: Your experiment tests whether your prediction is accurate and thus your hypothesis is supported or not. It is important for your experiment to be a fair test. You conduct a fair test by making sure that you change only one factor at a time while keeping all other conditions the same.

   You should also repeat your experiments several times to make sure that the first results weren't just an accident.

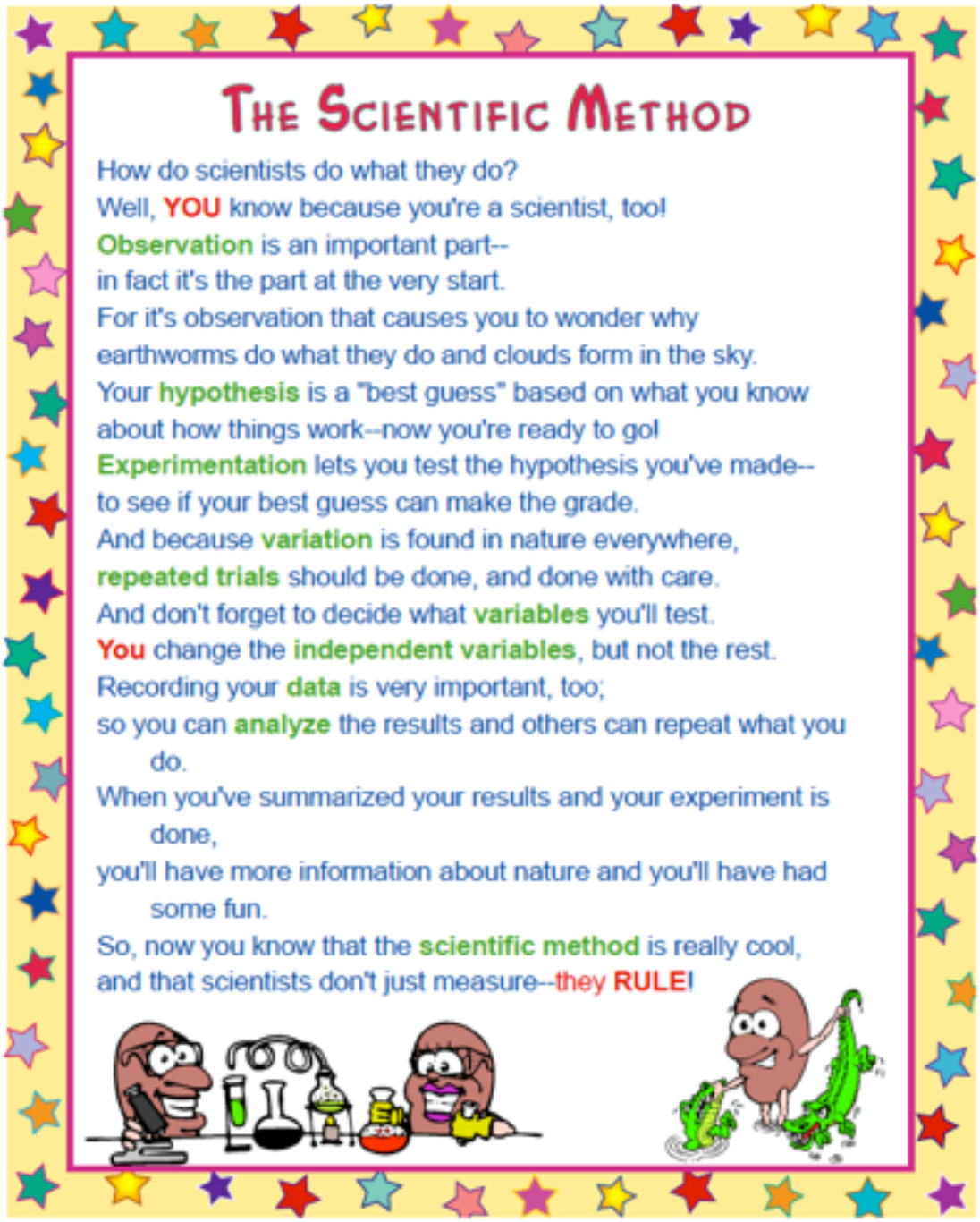
5. Analyze Your Data and Draw a Conclusion: Once your experiment is complete, you collect your measurements and analyze them to see if they support your hypothesis or not.

   Scientists often find that their predictions were not accurate and their hypothesis was not supported, and in such cases they will communicate the results of their experiment and then go back and construct a new hypothesis and prediction based on the information they learned during their experiment. This starts much of the process of the scientific method over again. Even if they find that their hypothesis was supported, they may want to test it again in a new way.

6. Communicate Your Results: Professional scientists publish their final report in a scientific journal or by presenting their results on a poster or during a talk at a scientific meeting.

Applying the scientific method to the reading

Step	What did Sonam Wangchuk do?
1. Ask a question	
2. Do background research	
3. Construct a hypothesis	
4. Test the hypothesis	
5. Analyze the data and draw conclusion	
6. Communicate results	



The University of Georgia
Savannah River Ecology Laboratory

Applying the learning to science

STUDENTS UNDERSTAND THAT:
Progress in science relies on conducting careful investigations, recording data, and communicating results in an accurate manner. Use the scientific method for the following activity.

Step	What will you do?
1. Ask a question	
2. Do background research	
3. Construct a hypothesis	
4. Test the hypothesis	
5. Analyze the data and draw conclusion	
6. Communicate results	

Instructions for the teacher

Research question: Does the amount of salt affect the melting time of frozen water? The story in the magazine is about freezing. What are all the factors that determine the temperature at which a substance can freeze. We can do this by freezing a mixture, and then measuring how long it takes for the different mixtures to melt.

During the discussion of ice ask students if icebergs were made of salt water or fresh water. When the class is unable to agree on an answer (there will be disagreement), invite them to devise a lab that can be done in class or at home.

1. Have the class gather seven empty water bottles and fill each with one cup water and various amounts of salt.
2. Bottle One remains salt free as the control bottle.
3. Students add one tsp salt to Bottle Two, two tsp salt to Bottle Three, three tsp salt to Bottle Four, four tsp salt to Bottle Five, five tsp salt to Bottle Six, and finally six tsp salt to Bottle Seven.
4. The water is kept in a freezer until it freezes and the students begin their observations in the classroom by making sketches and noting the time the lab began.
5. The bottles are placed outside and the time it takes for the ice to melt is measured.
6. The ice is checked every hour.
7. Help the students to see that the more salt added to the water, the less solid the water froze and the quicker it melted.

Analyzing Data

Students should conclude that the initial lab revealed that the more salt added to the water, the less solid the water froze and the quicker it melted. They realize that icebergs are not made of salt water because if they were they wouldn't last long in the warmer temperatures. Bottle seven had the most salt added and the water in that bottle did not freeze as solid as the other bottles. It also takes less time for the ice to melt in bottle seven.

What other ways could they find to test whether or not there is salt in an iceberg?