Learning About MAGNETS

Presented by the
National High Magnetic Field Laboratory

Name _____

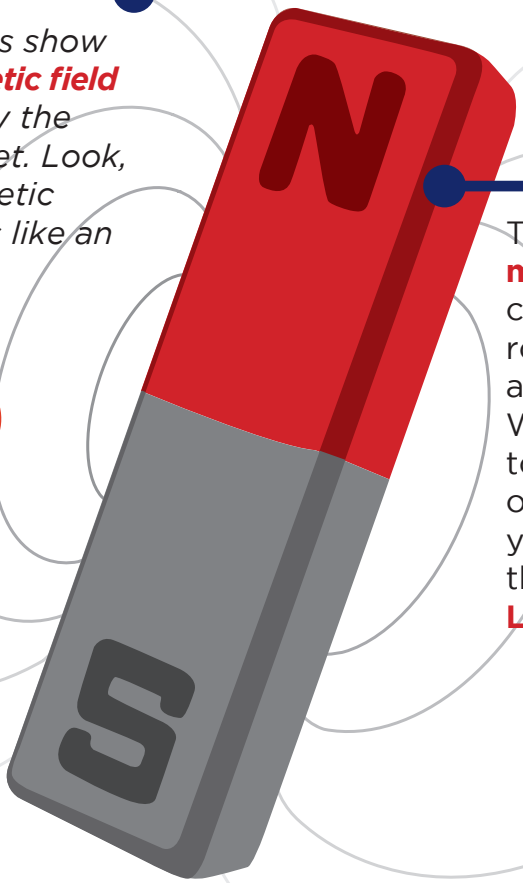
The Center for Integrating Research + Learning

What is a Magnet?

A **magnet** is a material or object that creates a **magnetic field.** This field is invisible, but it creates a force that can "attract" or "repel" other magnets and magnetic materials, like iron or nickel.

Field Lines

*These lines show the **magnetic field** created by the bar magnet. Look, this magnetic field looks like an apple!*



Permanent Magnets

This bar magnet is a **permanent magnet**. Permanent magnets can be found in the Earth as rocks and metals. Magnets have a **North pole** and a **South pole.** When you bring opposite poles together they attract each other. **Opposites attract**. When you bring like poles together the magnets repel each other. **Like repels.**

What is an Electromagnet?

Scientists at the Magnet Lab use a special kind of magnet called an electromagnet. Unlike permanent magnets that can be found in nature, electromagnets can be turned off and on using electricity.

There are three kinds of electromagnets used at the MagLab:

- **Resistive magnets** are made out of "Bitter plates" which are metal disks made out of copper and silver. When an electric current is sent through a tall stack of bitter plates, a strong magnetic field is produced in its center! Cooling holes on the Bitter plates let cold water run through the magnet so it doesn't get too hot.

In the 1930's Francis Bitter made simple magnets using this technology, hence the name "Bitter plates."

- **Superconducting magnets** are made of superconducting wire. Unlike semiconductors, these special wires carry electric current with no resistance, meaning without energy loss. Because of this special property, superconducting magnets do not give off heat like resistive magnets do. But there's a catch! To superconduct at all, they must be kept very cold. How cold? -452° F, which is colder than Pluto! Scientists do this by keeping the wires in a bath of liquid helium, the coldest substance on earth.

- **Hybrid magnets** are a combination of resistive and superconducting magnets. Scientists build a resistive magnet inside of a superconducting magnet to make one high-powered magnet!

The MagLab builds the strongest electromagnets on earth.Visiting scientists use our magnets in experiments, since they are useful for exploring the physical properties of a material, figuring out it's age or composition, mapping it's insides and more!

Will it attract?

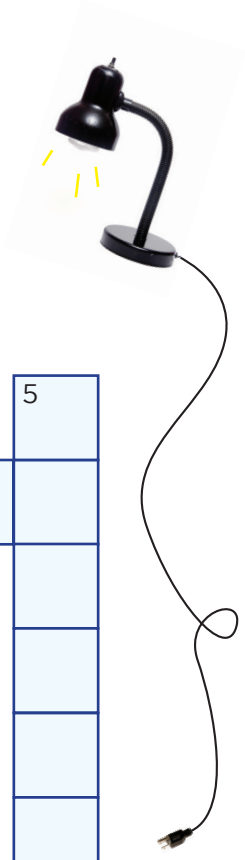
Matching with Magnets

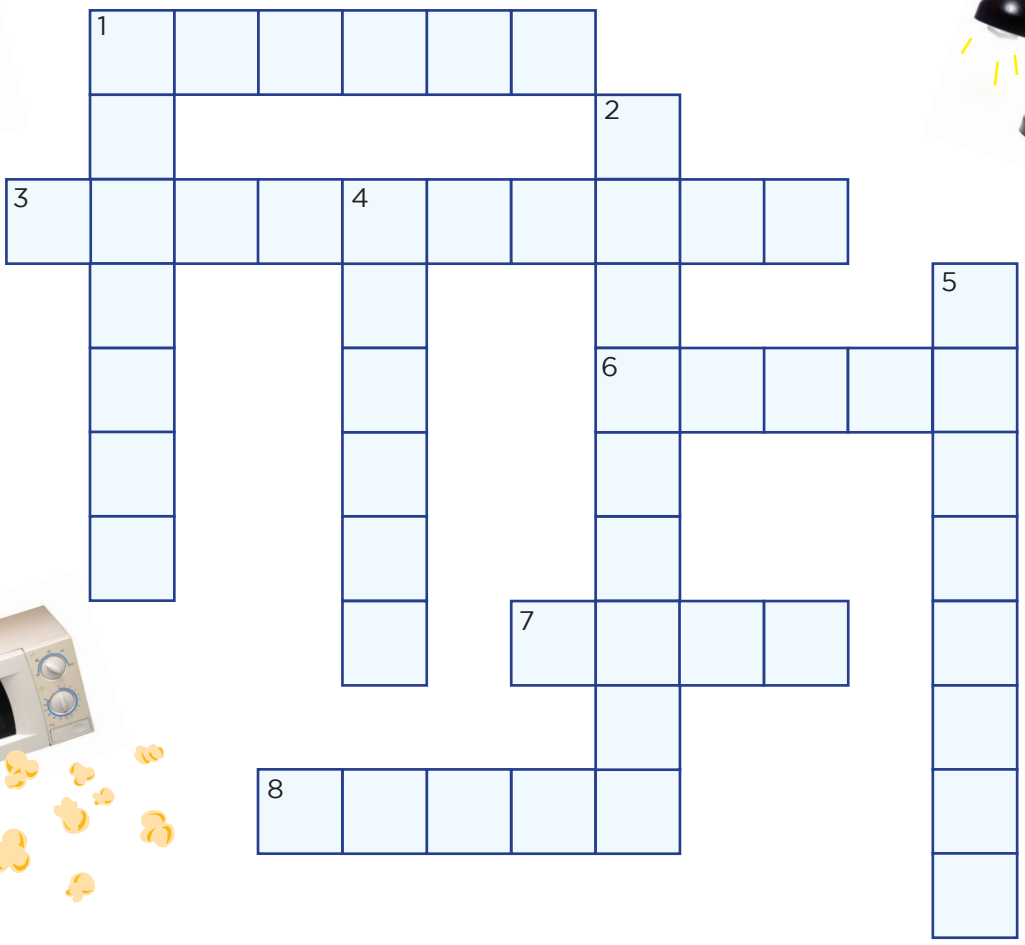
Draw a line from the magnet to the objects that are magnetic.

Magnets at Home

Crossword Puzzle

The clues at the bottom will help you uncover magnets found in houses. The answers will fit into the crossword puzzle below.





ACROSS

1. Where you store milk & eggs.
3. Used to watch movies & shows.
6. Used to listen to music.
7. Used for light.
8. Used to call people.

DOWN

1. Where ice is made.
2. Used to pop popcorn.
4. Cleans messy carpets.
5. Ring when you visit a friend's house.

Marie Curie

Basic Research Pioneer

In 1903, Marie Curie was awarded a Nobel Prize in Physics for her studies on the nature of radioactivity. In 1911, she won another Nobel Prize in Chemistry, for the discovery of two radioactive elements, Polonium and Radium. She is the first woman to win a Nobel Prize and the first person to win two prizes.

Marie Curie was a "basic" researcher. Since many people did not understand what radiation was or how it worked, she performed observations, measurements and experiments to learn more about it.

- **Basic Research** is the study of the world around us to acquire knowledge for knowledge's sake. It's only goal is to further understanding of materials or phenomena, thus establishing theories or facts.

- **Applied Research** is scientific study aimed at meeting specific human needs using the knowledge gained through basic research.

The Magnet Lab is a place where scientists from around the world come to conduct basic research. Visiting scientists conduct experiments using our high-powered magnets along with variable temperatures, pressure and light to learn more about how certain materials work.

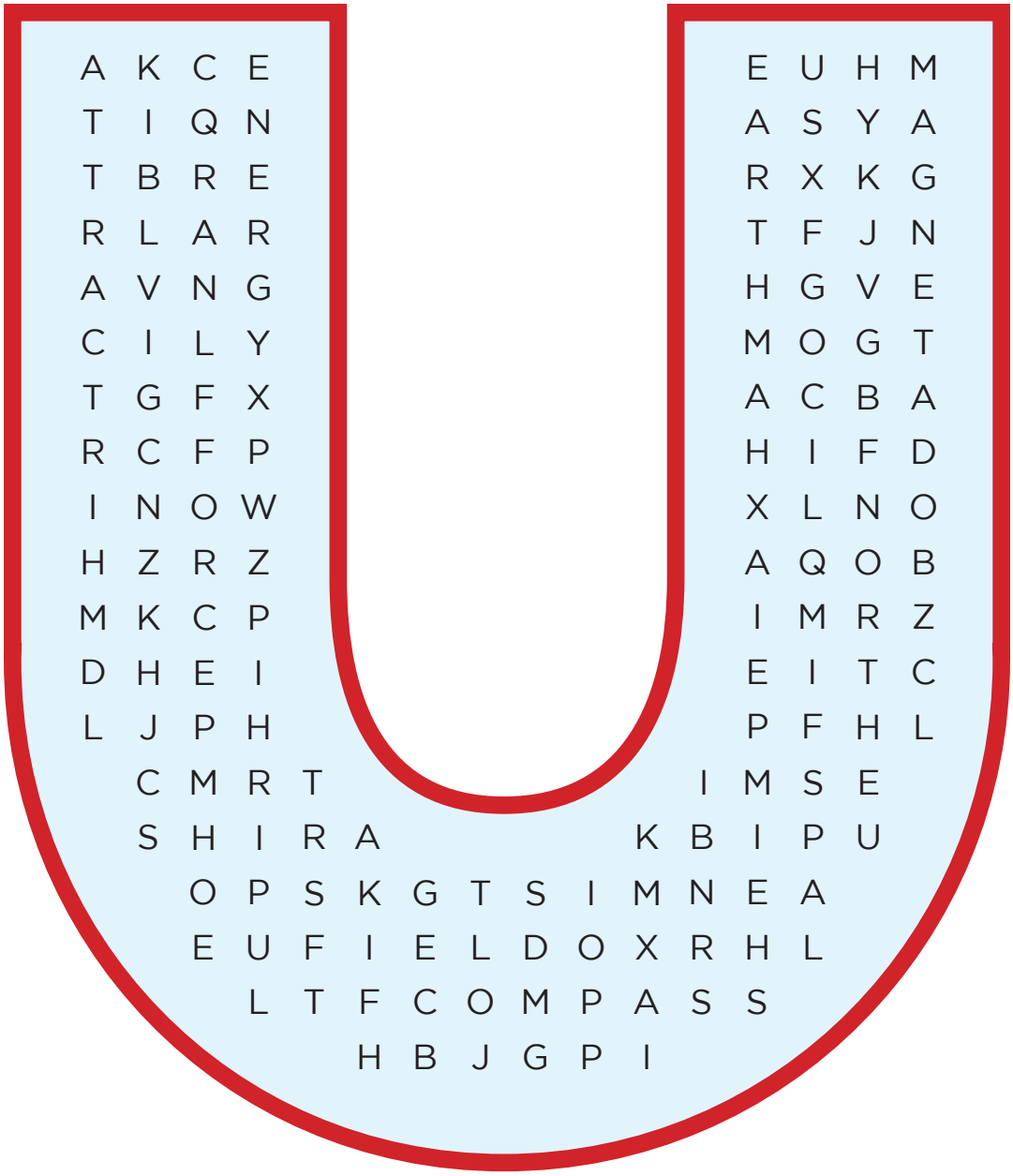
Circle the kind of research used in each of the following scenarios:

1. Building a better microchip. *BASIC or APPLIED*
2. Studying properties of superconductors. *BASIC or APPLIED*
3. Mapping the surface of a virus. *BASIC or APPLIED*
4. Measuring the strength of metal. *BASIC or APPLIED*
5. Developing a cancer drug. *BASIC or APPLIED*

Attractive

Word Search

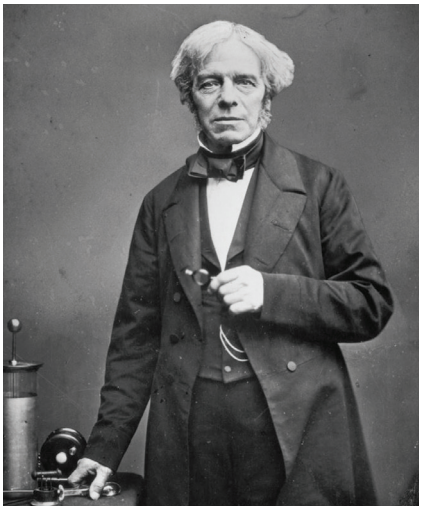
There are 10 words hidden below. Can you find them all?



ATTRACT
COMPASS
EARTH
ENERGY
FIELD
FORCE
MAGNET
NORTH
REPEL
SOUTH

Michael Faraday

Pioneer of Electromagnetism



Michael Faraday's basic research explored many of the principles and invented some of the techniques that make the Magnet Lab's research possible.

Faraday, an Englishman born in 1791, had very little education as we think of it today, and he discovered an interest in science by chance. While an apprentice at a printing press, he began to read the scientific texts that were passing under his hands. He was particularly interested in magnetism and chemistry. Impressed with 300 pages of notes the 21-year-old Faraday sent him after a lecture, a prominent chemist at The Royal Institution of Great Britain hired Faraday on as a secretary. Faraday went on to hold the senior chemist's post, receiving several important scientific honors and making several discoveries in chemistry.

He's most famous, however, for his investigation into the relationship between magnetism and electricity. Riffing on the ideas of his contemporary Hans Christian Oersted, whose discovery of **electromagnetism** made waves across Europe, Faraday constructed a simple **motor**. It became the structural basis for much of today's electromagnetic technology.

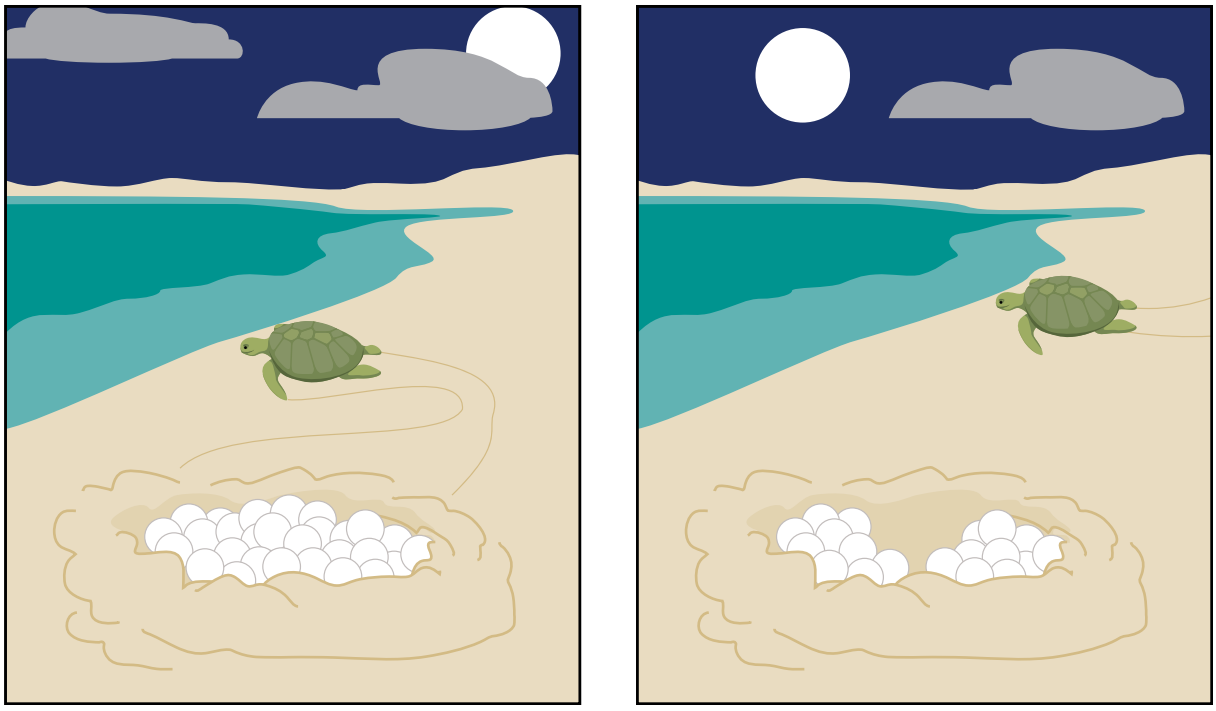
A few years later Faraday discovered **electromagnetic induction**, which allowed for the invention of important everyday products such as standard electric motors and power transformers. This discovery led to the construction of a device called the **electric dynamo**, which was improved upon and refined to become today's **power generator**. Since Faraday was self-educated, he never received any training in complex math. Theorists and mathematicians later outlined the principles that made his inventions and ideas work.

Turtle Beach

Spot the Differences

Some animals use the **Earth's magnetic field** to find their way around the earth, the same way humans use a compass. When it's time to lay their eggs, female loggerhead turtles use it to find the beaches they were born on.

There are two beaches below. They are identical except for 5 differences. Find and circle all 5 differences.



Did you know...

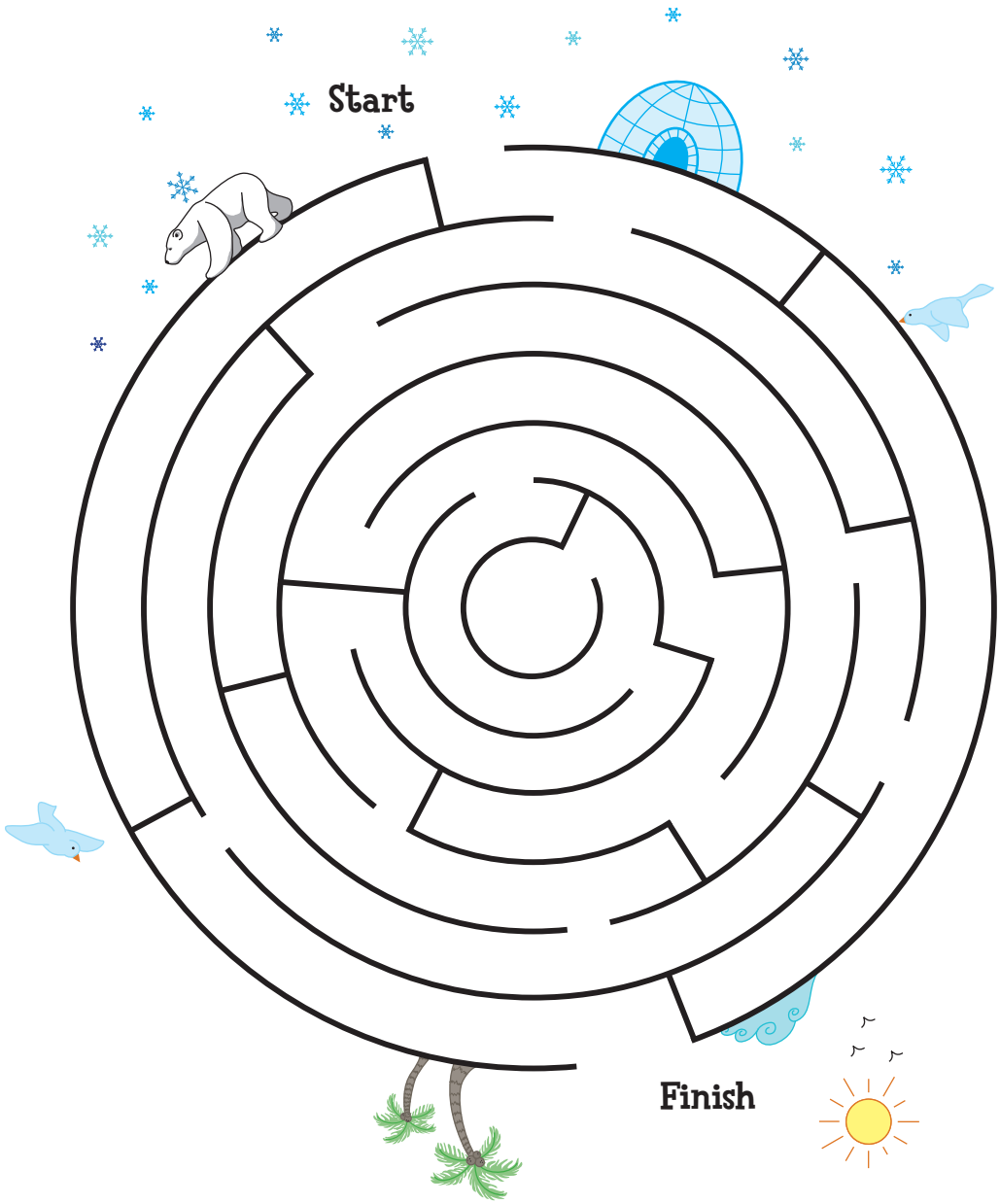
Mother turtles leave their eggs on the beach and return to the water. The sand keeps the eggs warm until it's time for the eggs to hatch. When eggs are laid on busy beaches, scientists help the baby turtles by moving their eggs to safer places on the beach. When the turtles hatch and make their way to the water, scientists help them get there safely.

Birds in Flight

Migration Maze

Birds use the **Earth's magnetic field** to find their way when they migrate. Many birds migrate to warmer places during the winter to escape the cold.

Find your way from the cold winter to the warm weather in the maze below.



Find the Pattern

Dancing Bees

Bees communicate by dancing and singing to each other. When a bee finds a good place to find pollen, it gathers around other bees and dances to tell them how to get there. Once the bees leave and fill up on pollen, tiny compasses in their bodies help them get back home using the **Earth's magnetic field**.

Below are some dancing bees, but it seems they have forgotten the last moves! Help them finish their dance by drawing the next bee in the space provided.

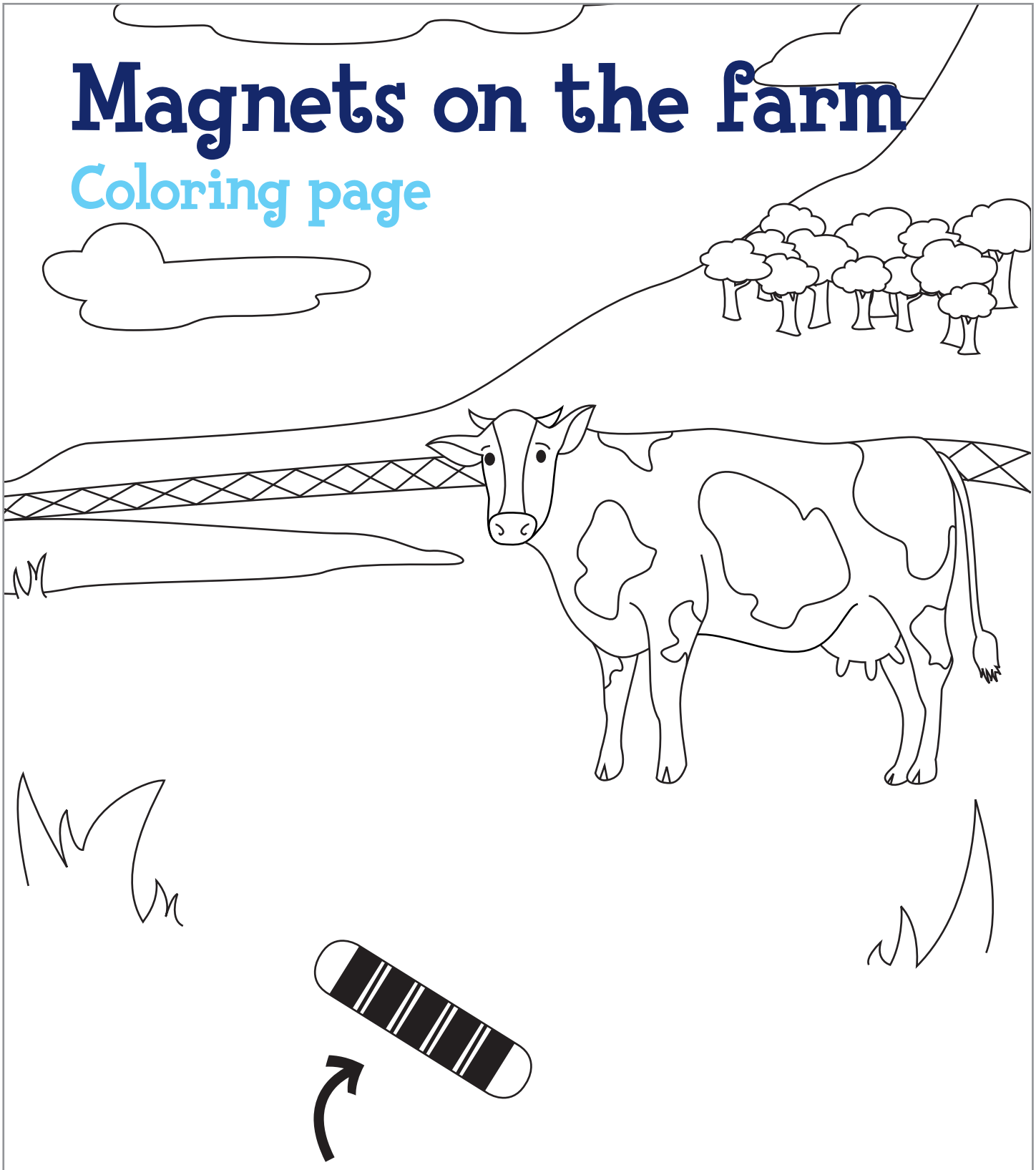
_____

_____

_____

Magnets on the farm

Coloring page



Farmers use cow magnets like this one to help protect cows from loose pieces of metal in a field. The cow eats the magnet and it falls into the cow's stomach. If the cow eats something magnetic, it will attract to the magnet and not hurt the cow's internal organs.

Order the dates

History of Magnetism

Here are some important events in the history of magnetism, but they've gotten out of order. Put them in order by writing the dates on the lines below in order from earliest to latest.

In **1820 AD** Hans Christian Orsted's accidental discovered leads to the first electromagnet and electric motor.

In **1997 AD** the Mag Lab engineers complete a resistive magnet for use on the International Space Station.

In **600 BC** a Greek shepherd named Magnus discovered a lodestone, a naturally occuring magnet.

In **2010 AD** the Mag Lab reclaims world record for highest field resistive magnet.

In **1989 AD** the Los Alamos National Laboratory in New Mexico and the University of Florida in Gainesville propose a new national magnet lab be built at Florida State University in Tallahassee, Florida.

In **1600 AD** William Gilbert discovered that the Earth was a magnet.

By **1100 AD** the Ancient Chinese used compasses for entertainment and navigation.

Earliest date

Latest date

Did you know...

The NHMFL currently holds 14 World Records for its work with magnets! Most of the records are shortlived because we keep surpassing them. That's a very good reason why hundreds of researchers a year travel to our unique lab to use these awesome tools.

Answer Key

Page 1

Is it Attractive?

Magnets at Home

	1 F	R	I	D	G	E			
	R						2 M		
3 T	E	L	E	4 V	I	S	I	O	N
	E			A			C		5 D
	Z			C			6 R	A	D	I	O
	E			U			O				O
	R			U			W				R
				M		7 L	A	M	P		B
							V				E
			8 P	H	O	N	E				L
											L

Answer Key

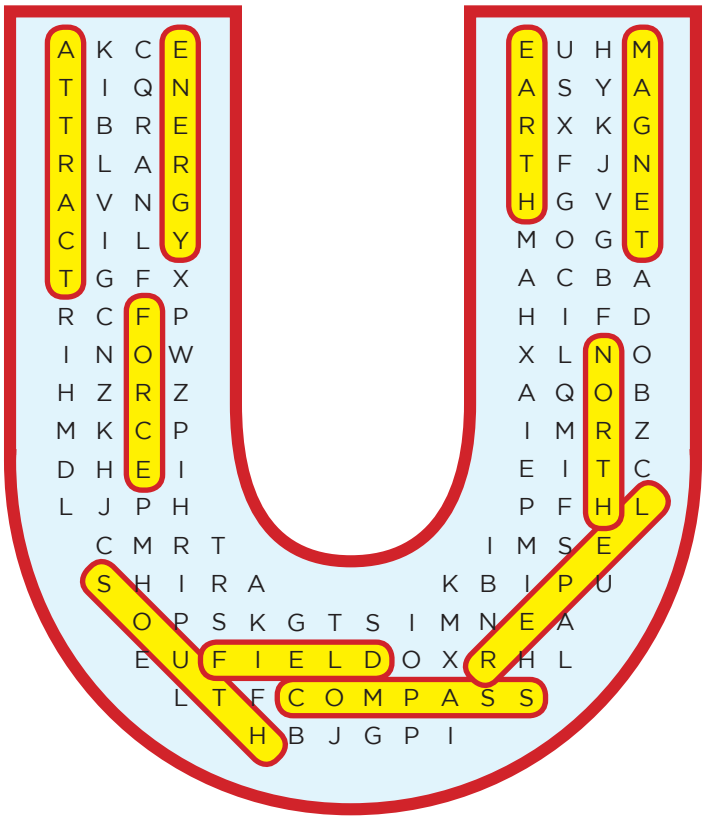
Page 2

Basic & Applied Research

Circle the kind of research used in each of the following scenarios:

1. Building a better microchip. — *BASIC or APPLIED*
2. Studying properties of superconductors. — *BASIC or APPLIED*
3. Mapping the surface of a virus. — *BASIC or APPLIED*
4. Measuring the strength of metal. — *BASIC or APPLIED*
5. Developing a cancer drug. — *BASIC or APPLIED*

Attractive Word Search



Answer Key

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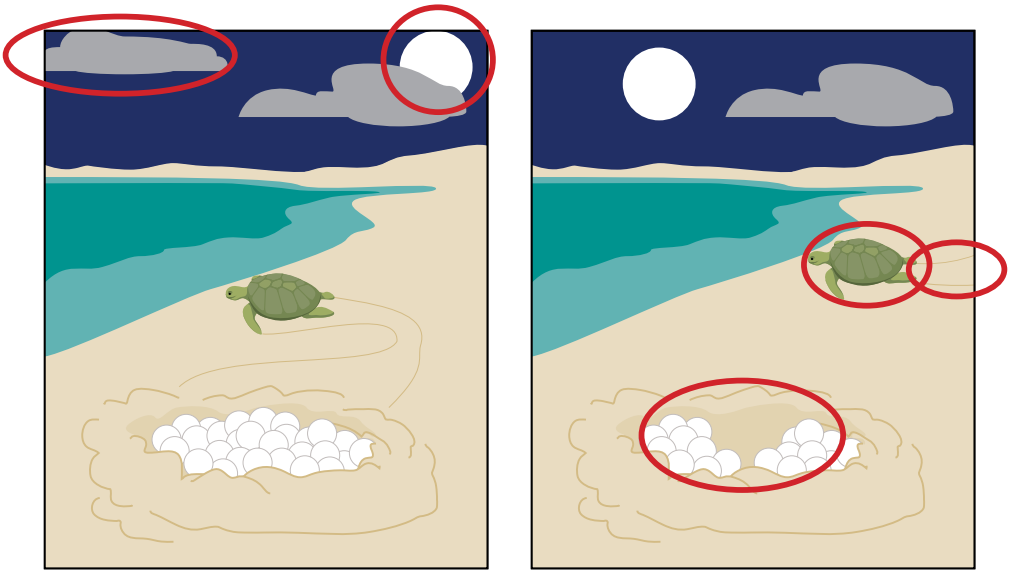
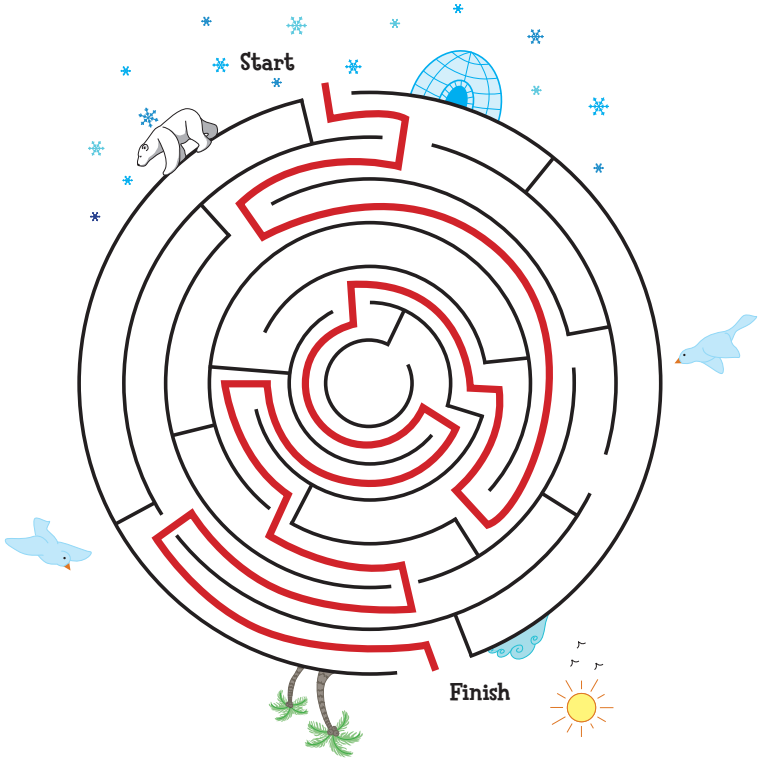
Spot the Differences



Migration Maze



Answer Key

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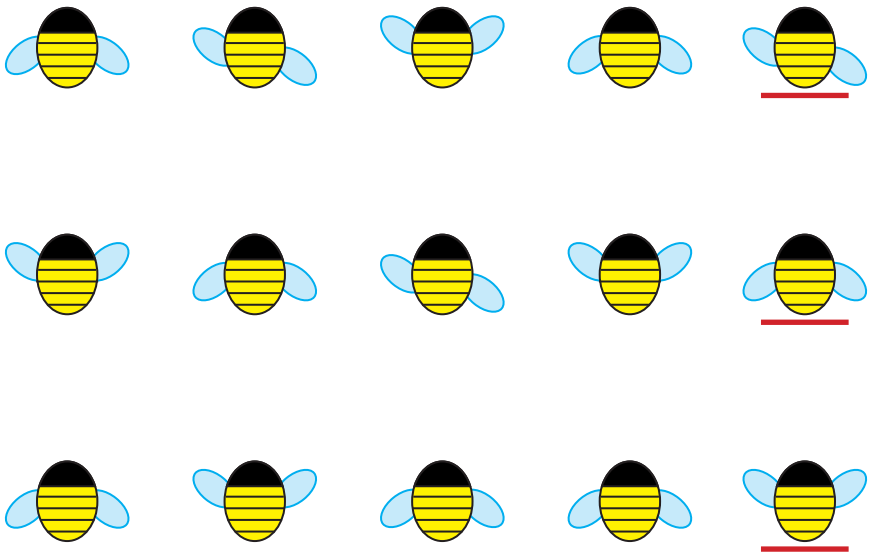
Find the Pattern



Order the Dates

600 BC 1100 AD 1600 AD 1820 AD 1989 AD 1997 AD 2010 AD

Earliest date

Latest date