CH. 18 ELECTROMAGNETISM
7th Physical Science

WORD BANK (CH. 18 PUZZLE)

- domain
- electric motor
- electromagnet
- Faraday
- ferromagnet
- galvanometer
- generator
- induction
- maglev
- magnet
- magnetic field
- magnetic force
- Oersted
- poles
- solenoid
- transformer
ON THE BACK OF YOUR PACKET...

- Ch. 18 Principles
  - Ampere’s Law: Current \( \rightarrow \) Magnetic Field
    - Cause of magnetism: electron currents, domains

  - Lorentz Force: Moving charge in magnetic field feels a force
    - \( qvxB = F_b \)
    - Galvanometers

  - Faraday’s Law: Changing Magnetic Field \( \rightarrow \) Electric Field
    - Power generators
    - Light!!

TOPICS OF THE DAY...

- What are the magnetic poles?
- What’s a magnetic force?
- Are there monopoles?

- What’s a magnetic field?

- How is Earth like a big magnet?
- What’s a compass?

- Where does magnetism come from? Ampere’s Law
- Why are some materials magnetic? Domains
18.1 Magnet Properties

a) What attracts? \( \sqrt{\text{or} \ x} \)

- foil
- plastic
- coin
- glass
- paper clips
- wood
- metal pen

Magnet = anything that attracts _____
(steel too)

18.1 MAGNETS

- Magnetic Poles?
18.1 MAGNETS

○ What’s a compass?

○ Magnetic force?
18.1 MAGNETS

- Are there magnetic monopoles?

b) Magnetic forces. Draw the force vectors.

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N  S
S  N
N  S
S  N
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c) If you cut a magnet in half, is there still a North and South? ___
18.1 MAGNETS

- Magnetic Field

3. Use a compass to draw the magnetic field lines.

a) 

N S W S

b) Try to see the field lines using iron filings.

c) Draw the Earth's field lines in #2c)
18.1 MAGNETS

○ Earth’s Magnetic Field

**Figure 9** Earth’s Geographic and Magnetic Poles

Earth’s magnetic poles are the points on Earth’s surface where its magnetic forces are the strongest.

The magnetic field lines around Earth are similar to the magnetic field lines around a bar magnet.

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18.1 MAGNETS

○ Earth’s Magnetic Field

(a) Compass
   a) Where is the north pole?

   By bring a magnet near

   N

   S
18.1 MAGNETS

- Earth’s Magnetic Field

18.1 MAGNETS – HOW?

- Magnets?
- Nonmagnets?
- Temporary magnets?
- Electromagnets?
18.1 MAGNETS – HOW?

a) Why do magnets happen?

R: Cause of magnetic field:

b) Atoms have some current: _________

so atoms have _________

II. WHAT MAKES A MAGNET?

- Atom - There are currents: Electron orbit & spin.
18.1 MAGNETS – HOW?

- nonmagnetic material examples:

- magnetic material examples:
  Picture of nonaligned domains
  Picture of paper clip magnet

II. WHAT MAKES A MAGNET?

- Wood: Electrons spin in pairs and cancel.
- Magnetic Domains: Atoms’ B align in clusters
- Iron: The clusters “cancel” each other. Point in different directions.
- Magnetite - Volcanoes. Domains are soft from lava, align with Earth’s B and harden into permanent alignment.

- Why are there no magnetic dipoles?
18.1 MAGNETS – HOW?

6) Types of magnets
   - Ferromagnet
     - How is magnetite made? (Created naturally)
   - Electromagnet
     - When...
     - Example:

5) Make a magnet. Take out 5 staples & an iron nail
   - Iron nail
   - Bar magnet
   - Magnet on nail
   - Stroked 50 times
   - Tapped nail

How many staples are picked up?
18.1 MAGNETS

- How do you make a magnet?
- How do you de-magnetize?

TOPICS OF THE DAY...

- What are the magnetic poles?
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- How is Earth like a big magnet?
- What’s a compass?
- Where does magnetism come from? Ampere’s Law
- Why are some materials magnetic? Domains
18.1 Earth’s Magnetic Field

Why does Earth have a magnetic field?

II. What Makes a Magnet?

- What makes Earth like a big magnet?
  iron-rich, liquid outer core → current
18.1 Earth’s Magnetic Field

- Why do auroras happen near the poles?

18.1 What’s a Geomagnetic Storm?

- Caused a 9-hour power outage in Quebec 1989
II. WHAT MAKES A MAGNET?

- Earth as a big magnet:
  - Biological Compass: Bits of magnetite in pigeon brains align with Earth’s B.
  - Pigeons, bees, bacteria, monarch butterflies, sea turtles...humans?

18.2 CURRENT → MAGNETIC FIELD

- demo

- If no electric current exists in the wire, the compass needles point in the same direction.
- Electric current in one direction in the wire causes the compass needles to deflect in a clockwise direction.
- Electric current in the opposite direction makes the compass needles deflect in a counterclockwise direction.
18.2 CURRENT → MAGNETIC FIELD

1. A law of physics is that a current sets up a magnetic field.

Draw the magnetic field that’s set up.

18.2 CURRENT → MAGNETIC FIELD

- Solenoid

Figure 2 The ends of the solenoid are like the poles of a bar magnet.
18.2 Current → Magnetic Field

b) What's a solenoid?

b) Draw a solenoid

c) Solenoid's magnetic field

d) Like bar magnet

III. More on Ampere's Law
18.2 CURRENT ➔ MAGNETIC FIELD

1) How is Earth like a solenoid, bar magnet?

- Electromagnet - demo
18.2 CURRENT  →  MAGNETIC FIELD

3. What is an electromagnet?

- Connect your electromagnet
  - In series with
  - The ammeter
  - The light bulb

4. Make an electromagnet.
   a) Iron nail
   b) Insulated wire
   c) Tape
   d) Light bulb

1. How many staples are picked up?

5. Draw the magnetic field
   a) Draw a bar magnet representing the nail.

b) List 2 ways to increase the strength of your electromagnet.
   1. ____________
   2. ____________

6. Short out the light bulb. How?

7. How many staples are picked up?

8. What happened to the current? Why?
18.2 Moving Charge in Magnetic Field

- Lorentz Force – write on the last page of packet
  - A moving charge in a magnetic field feels a force

- Moving Charge in Magnetic Field

  - Lorentz Force
    \[ \vec{F}_B = q \vec{v} \times \vec{B} \]

  - Cross-Product
    \[ \vec{a} \times \vec{b} = \vec{c} \]

- Moving charge in magnetic field experience a force
**MOVING CHARGE IN MAGNETIC FIELD**

- An example. Draw how the charge will move.

\[ \vec{F}_B = q \vec{v} \times \vec{B} \]

Charge moves in a circle (Only deflected, no change in speed)

- as centripetal force

- Draw the force vector on the charge
- How will the charge move?
MOVING CHARGE IN MAGNETIC FIELD

- Can you understand these pictures?
- Which way is the current?
- Where is the force arrow?

**Figure 5  Magnetic Force on a Current-Carrying Wire**

- When a current-carrying wire is placed between two poles of a magnet, the wire will jump up.
- Switching the wires at the battery reverses the direction of the current, and the wire is pushed down.

MOVING CHARGE IN MAGNETIC FIELD

- Electric Motor:
  - ___________ energy → ___________ energy
MOVING CHARGE IN MAGNETIC FIELD

- Galvanometer. How does it work?

18.3 ELECTRICITY FROM MAGNETISM

- A cat is an animal. Is an animal a cat?

  Faraday: current \(\Rightarrow\) magnetic field. \[\text{B} \rightarrow \text{B}\]

  True/False: Magnetic field causes a current.

  Correction: \[\text{B} \Rightarrow \text{B}\] causes current.

  This is called \[\text{B} \Rightarrow \text{B}\].
18.3 Electricity from Magnetism

- demo

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**Figure 1** Faraday’s Experiment with Magnets and Induction

One wire was wound around one half of an iron ring.

A second wire was wound around the other half of the iron ring.

A battery supplied an electric current to the wire, making an electromagnet.

A galvanometer measured any current produced in the second wire by the magnetic field.

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1. An electric current is induced when you move a magnet through a coil of wire.
2. A greater electric current is induced if you move the magnet faster through the coil because the magnetic field is changing faster.
3. A greater electric current is induced if you add more loops of wire. This magnet is moving at the same speed as the magnet in 1.
4. The induced electric current reverses direction if the magnet is pulled out rather than pushed in.
18.3 Electricity from Magnetism

a) Is there a current in the wire?
   a) —
       still
   b) —
       moving
   c) —
   d) —
   e) The moment the wire is connected to battery.

II Electric Generators
a) Explain how this works.
   b) What's the difference between a generator and a motor?
18.3 Electricity from Magnetism

Figure 7 How Transformers Change Voltage

The primary coil of a step-up transformer has fewer loops than the secondary coil. So, the voltage of the electric current in the secondary coil is higher than the voltage of the electric current in the primary coil. Therefore, voltage is increased.

The primary coil of a step-down transformer has more loops than the secondary coil. So, the voltage of the electric current in the secondary coil is lower than the voltage of the electric current in the primary coil. Therefore, voltage is decreased.

18.3 Electricity from Magnetism

What's a transformer?
- 
- 
- Only works for ______

Math Practice

What's the voltage in the secondary coil?
18.3 Electricity from Magnetism

**Figure 8** Getting Energy to Your Home

1. The voltage is stepped up thousands of times at the power plant.
2. The voltage is stepped down at a local power distribution center.
3. The voltage is stepped down again at a transformer near your house.

Induction Applications

Applications

d) How does a water boiler work?
**INDUCTION APPLICATIONS**

b) How does an em stove work?

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**CH. 18 ACTIVITY**

1. Electromagnet (P. 8 #8. Add this on the page)
   - Why is the magnet strong if you connect the battery correctly but weak if you connect the battery incorrectly?
   - Test Faraday’s experiment. Describe how and why it works. (P. 8 #6)

2. Demonstrate an electric motor. Describe how it works. (P. 4)
   Demonstrate an electric generator. Describe how it works.
3. Demonstrate the Lorentz Force. Draw a diagram and describe how it works. (P. 8 #5)

4. Finish your own electromagnet. (P. 3)
CH. 18 LAB

- Build your own motor

CH. 19 ELECTRONIC TECHNOLOGY

7th Physical Science
PROJECT
- Pick a topic
- Create a poster explaining how it works
- Present your poster to the class
- Presentation:
  - 2% of your grade

PROJECT TOPICS
1. 1989GeomagneticStorm (Quebec power outage)
2. Biological compass (bacteria, pigeons, ...)
3. Why magnets damage some devices
4. Echolocation: dolphins, bats
5. History of quantum mechanics
6. Semiconductor doping
7. Diode
8. Transistor
9. Integrated circuit and wafers
10. Analog vs. digital signals
11. How a CD player works
12. How a radio works
13. How a bulky TV display works vs. how a plasma display works
14. History of the computer
15. Parts of a computer and what they do
16. How CD-R and CD-RW works
17. Computer networks