Magnetism: What is in a Nail?

# **Introduction**

# **Purpose**

#  To investigate what is in a nail and how nails can change by rubbing with a magnet.

**Discussion**

A common misconception is that magnetism is a separation of charge and that magnets “break”. In the previous activities you developed a technique for rubbing a nail with a magnet so that one end pointed north when the nail was placed on a floating coffee cup lid. You also discovered that the floating nail would then behave differently, depending on whether you brought either a second “rubbed” or “unrubbed” nail nearby. These observations suggest that something happens to the nail when it is rubbed.

**Materials** Cut Nails Bar Magnet or Cow Magnet

**Procedures**

1. INDIVIDUALLY answer the following questions before proceeding to work with others.

1. What do you think is different about the nail after it has been rubbed? In other words, what does the process of “rubbing” with a magnet do to the nail?

 How did you decide? (*Give evidence from your earlier activity observations*)

 Are there any preconceptions in our thinking as we address this problem?

2. Below are two drawings of the nail, representing its state before and after rubbing with a magnet. Sketch what you think might be different about the nail in these two conditions:

Before Rubbing

After Rubbing

B. Now discuss your thinking and drawings with other students. Record ideas and sketches that differ from your own. Each student should also discuss the evidence that he or she used as a basis to construct a model.

Before Rubbing

After Rubbing

Before Rubbing

After Rubbing

What Does Breaking a Nail Do?

**Discussion**:

You will make predictions based on your previously developed model of magnetism and test those predictions by doing an experiment. You will then be in a position to decide whether your model is valuable to keep as it is, or if you will need to modify or change your model.

# **Materials**: Cut Nails Cutting Tool Bar Magnet or Cow Magnet

#  Pie Tin Plastic Lid Iron Wire

 Wire Cutters Masking Tape Small Piece of Styrofoam

**Procedures**:

1. Unrub your cut nails before beginning this activity.

2. You already know that when a “point-North” nail is floated in the water, the pointed end will point towards geographic north. **Predict** what would happen if you cut or break the Cut Nail into two pieces. What would happen to each piece, if it was then floated by itself? Would it have a preferred orientation? If so, how would it orient itself? Use your previous model to predict. Then, copy the drawing below and complete it for your lab report.

Head Piece

Point Piece

#  How did you decide your prediction?

3. **Predict** what would happen if you separately floated each half of the original “point-north” nail. Suppose you take another “point-North” nail and bring its North-pointing end near each end of the floating nail-halves. (*These ends are labeled as Head, a, b, and Point in the sketch below*). A “point-North” nail is shown being brought near the Head end of the Head piece nail. **Predict** what would happen to each end. Would it be attracted, repelled, or show no effect? Complete the prediction table.

Point

Second point North nail

B

A

Head

|  |  |
| --- | --- |
| PREDICTION TABLE | What happens when the North-pointing nail of the 2nd rubbed nail is brought near? |
| Head |  |
| A |  |
| B |  |
| Point |  |

BREAKING THE CUT NAIL:

1. Obtain a Cut Nail and magnetize it by rubbing the Cut Nail so that the pointy end points north, then make sure it's working properly by floating it. **Remove the magnet you used far away from all the nails and pie tin apparatus for the remainder of this activity**.
2. **Test** your predictions from step 2 by floating each half piece of the original “point–north” nail SEPARATELY, and describe how each half piece behaves. Do they have any particular orientation? Complete the drawing below to show your results. Record any observations of the floating pieces in the space provided.

|  |  |
| --- | --- |
| OBSERVATION TABLE | What happens when the point of the North-pointing nail of the 2nd rubbed nail is brought near? |
| Head |  |
| A |  |
| B |  |
| Point |  |

* Sketch what you observed *(label poles and relative strength of the magnetism*)

Point

Second point North nail

Head

B

A

Your observations about breaking the nail in half may have prompted you to change your model of magnetism. Breaking the nail at the midpoint, however, was only done for convenience. You could have broken it anywhere. To see the effects of breaking a magnetized object at some other location, you will use a piece of iron wire.

USING A COAT HANGER:

1. First rub the wire with a magnet, float it, and use a piece of tape to identify the North-pointing end of the wire. The North-pointing end of a magnetized object is also called the north pole of the object, labeled with an **N**. The opposite end is called the south pole of the object, labeled with an **S**.

**N**

**S**

1. **Predict** what would happen if you cut the wire at a point one-third along its length. You would then have two unequal pieces: a shorter 1/3 piece and a longer 2/3 piece. Would they also be two-ended, with N and S poles? Or would one be N and the other piece S? Copy and sketch your prediction based on the drawing below (*label poles and relative strength*).
2. **Test** your predictions. Use the wire cutters to cut the wire as indicated in step 6. Use a second piece of tape to label the end of the shorter piece that was closest to the longer piece. Then float each piece and use your “North-point” nail to test whether each piece is two-ended, and if so, which end is which. Sketch your observations based on the drawing below, labeling the wire with the results as before.
3. If you like, you may cut the piece of wire again and test it. However, be careful to label which end of each piece was closest to the original taped end.
4. Carefully review all of your predictions and observations for this lab. **Draw** your best current model of the composition of an unrubbed nail and a rubbed nail.

Before Rubbing

After Rubbing

* If you changed your model from before you began this activity, explain why you made the changes. What makes your model better now?

Summary

A2. Below are two drawings of the nail, representing its state before and after rubbing with a magnet. Sketch what you think might be different about the nail in these two conditions:



B. Now discuss your thinking and drawings with other students. Record ideas and sketches that differ from your own. Each student should also discuss the evidence that he or she used as a basis to construct a model.

Prior Knowledge:



Before Rubbing

After Rubbing

-electrons spin randomly from 3d sublevel orbitals -electrons align the same directions

-each iron atom has its own magnetic field -electrons rotate in the same plane

This is NOT a magnetic observation, but conjecture based on electron orbital spin (modern atomic theory).

What Does Breaking a Nail Do?

**Procedures**:

BREAKING THE CUT NAIL:

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2. **Test** your predictions from step 2 by floating each half piece of the original “point–north” nail SEPARATELY, and describe how each half piece behaves. Do they have any particular orientation? Complete the drawing below to show your results. Record any observations of the floating pieces in the space provided.

***The pointed end points “NORTH” meaning it must be the “SOUTH” pole (opposite poles attract). Therefore, the “HEAD” end must be the “NORTH” pole.***

|  |  |
| --- | --- |
| OBSERVATION TABLE | What happens when the point [**S**] of the North-pointing nail of the 2nd rubbed nail is brought near? |
| Head [N] | Attract |
| A [S] | Repel |
| B [N] | Attract |
| Point [s] | Repel |

* Sketch what you observed *(label poles and relative strength of the magnetism*)

A

Head

**N**

**S**

Point

B

**S**

**N**

Second point North nail

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N

S

S

N

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2. Carefully review all of your predictions and observations for this lab. **Draw** your best current model of the composition of an unrubbed nail and a rubbed nail.
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MAGNETISM

Non-magnetized metal

Domains are randomly aligned.

S

N

N

S

Domains become aligned in the same direction.



Breaking a magnetized object creates magnets in each of the broken pieces.