B9 · Magnets and magnetic fields

Student notes - follow the slides, fill the blanks, work the questions

Describe poles, magnetic materials, the field around a magnet, the Earth as a magnet, and domains.

Name: _____ Date: _____

Slide 1 of 5 · Poles and magnetic materials

Every magnet has two poles: _____ and _____. Opposite poles _____. Like poles _____.

Cut a magnet in half: each half still has _____. A single pole, a _____, has never been found.

An iron nail is magnetic, but it is not a magnet. It has _____. It is attracted to _____ end of a magnet and is never repelled.

Strongly magnetic: _____, _____ and _____. Steel is mostly iron, so it is _____ too.

On the diploma: _____ proves a magnet. _____ does not.

Example. Bars X and Y are each brought close to both ends of a bar magnet, using the same end of each bar at both ends of the magnet. X is attracted to the north end and also attracted to the south end. Y is attracted to the north end and repelled by the south end. Which bar is a magnet, which is only magnetic, and which pole of Y is near the south end of the bar magnet?

Work:

Answer: _____

Try it. A bar magnet is cut in half. (a) Describe the poles of each half. (b) An iron nail is attracted to the north end of a bar magnet. Is it attracted, repelled or not affected at the south end, and why?

Work:

Answer: _____

Slide 2 of 5 · Magnetic fields and the test compass

Every field needs a test object. Magnetism uses a small _____, a tiny magnet on a pivot.

The magnetic field is a _____: it has a size and a direction. Its symbol is _____. Its unit is the _____.

Direction: the way the _____ pole of a compass points there. The field points the way the force acts on a north pole.

Outside a magnet, lines leave _____ and enter _____. Lines are closest near the poles, where the field is _____.

At any point the field touches the line (it is _____) and follows the _____.

Between two close opposite poles the lines are straight and parallel. The field is _____: the same size and direction everywhere.

Example. A bar magnet has its north pole on the right and its south pole on the left. Compasses A and B are above and below the middle of the magnet, C is just past the north end and D is just past the south end, both on the line through the magnet. For each of A, B, C and D, give the direction its north pole points: left, right, up or down.

Work:

Answer: _____

Try it. Two bar magnets face each other with a small gap. The right end of the left magnet is a north pole and the left end of the right magnet is a south pole. In the gap, which way does the field point, what kind of field is it, and which way does a compass's north pole point?

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 3 of 5 · Method: how to draw the field lines of a bar magnet

Step 1: mark the _____. Label the north end and the south end.

Step 2: draw the lines out of _____ and into _____. Lines never _____.

Step 3: space the lines by _____. Crowd them near the poles. Parallel, evenly spaced lines mean a _____ field.

Step 4: add an _____ to every line, from N to S outside the magnet. A compass's north pole lines up that way.

Check: no line crosses another or starts in empty space.

Example. A bar magnet has its north pole on the right and its south pole on the left. Compasses A and B are above and below the middle of the magnet, C is just past the north end and D is just past the south end, both on the line through the magnet. Use the four steps to draw the field lines and say which way the north pole of each compass points.

Work:

Answer: _____

Try it. NEW, for teacher review. A bar magnet has its north pole on the left and its south pole on the right. Use the four steps to draw four field lines with arrows. Which way does the north pole of a compass point (a) just above the middle of the magnet and (b) just past the north end, on the line through the magnet?

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 4 of 5 · The Earth is a magnet

A north pole is attracted only to a _____ pole. An iron nail is attracted to _____ pole.

A compass needle’s north end points _____, toward the top of a map. So the pole it is attracted to is up there, and it is a magnetic _____ pole.

The Earth acts like a huge bar magnet. Its south pole is near geographic _____. Its north pole is near geographic _____.

A compass points along the _____, and its north end points to a _____ pole. It follows the _____ of the magnet inside, not the labels on a model. On the diploma, the Earth’s “north” magnetic pole is really a _____ pole.

Example. A globe with a bar magnet inside stands for the Earth, with geographic north at the top. A compass C at the equator points toward the top of the page. Is the end of the Earth’s magnet inside the top of the globe a north pole or a south pole, and in which direction does the Earth’s magnetic field point at C?

Work:

Answer: _____

Try it. A student hides a bar magnet in a plastic ball and uses it as a model Earth. A compass T beside the ball at its equator points up toward the model’s labelled north. The compass stays where it is in the room and only the ball turns. Which pole of the hidden magnet is at the top, and what would T do if the ball were turned upside down?

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 5 of 5 · Domains: why magnets and nails behave this way

A magnetic material has tiny regions called _____. Each is a tiny magnet with a _____ and a _____ end.

Magnet: the domains line up the _____ and stay lined up. Plain iron nail: the domains point in _____ directions and their effects _____.

Bring a south pole near the nail: free domains (they can turn) swing their _____ ends toward it. The near end becomes a _____ pole, so the nail is _____. It is now a _____ magnet, only while a magnet is close. Plastic has _____ a magnet can line up.

Atoms always jiggle a little: _____. When the magnet leaves, jostling turns the domains back to _____ directions. Heat and _____ make the jostling stronger and knock the domains out of line. On the diploma: use the word _____ and link cause and effect with “because”.

Example. A magnet is pulled away from an iron nail that it had attracted. After a short time the nail no longer attracts a paper clip. Use domains to explain why the nail attracted the paper clip while the magnet was close, and why it stopped when the magnet was removed.

Work:

Answer: _____

Try it. A magnet is brought near a plastic comb and near an iron nail. Explain why the nail is attracted but the comb is not, and describe two ways to weaken a permanent magnet.

Work:

Answer: _____

B9 · practice

Magnets and magnetic fields | Questions 1-2 of 8

Constants from the Alberta Physics 30 data sheets: $k = 8.99 \times 10^{9}$ N·m²/C², $e = 1.60 \times 10^{-19}$ C, electron mass $m_e = 9.11 \times 10^{-31}$ kg, proton mass $m_p = 1.67 \times 10^{-27}$ kg, $g = 9.81$ m/s².

Easy · B9-N01. A steel nail is attracted to both ends of a bar magnet. A second object is attracted to one end of the bar magnet and repelled by the other. Which statement is correct?

A. The nail is a magnet.
B. The second object is a magnet.
C. Both objects are magnets.
D. Neither object is a magnet.

Work:

Final answer (with unit and sign): _____

Easy · B9-N02. List the three pure elements that are strongly magnetic. Give one way to destroy a permanent magnet.

Work:

Final answer (with unit and sign): _____

B9 · practice

Magnets and magnetic fields | Questions 3-4 of 8

Easy · B9-N03. A bar magnet has its north pole on the left. A compass is placed above the middle of the magnet. Which way does the compass’s north pole point?

A. Toward the left
B. Straight up
C. Straight down
D. Toward the right

Work:

Final answer (with unit and sign): _____

Medium · B9-N04. In Edmonton, the north pole of a compass points toward the Arctic. What kind of magnetic pole does the Earth have near the Arctic? Explain.

Work:

Final answer (with unit and sign): _____

B9 · practice

Magnets and magnetic fields | Questions 5-6 of 8

Medium · B9-N05. Describe the domains in (a) a bar magnet, (b) an iron nail away from any magnet, and (c) a plastic comb.

Work:

Final answer (with unit and sign): _____

Medium · B9-N06. A nail is stroked many times in one direction with the north pole of a magnet. What happens inside the nail?

A. The domains line up, so the nail becomes a weak magnet.
B. New domains are created in the nail.
C. The nail loses all of its domains.
D. The atoms in the nail change into iron.

Work:

Final answer (with unit and sign): _____

B9 · practice

Magnets and magnetic fields | Questions 7-8 of 8

Challenging · B9-N07. The north pole of a bar magnet is brought near the end of a long iron nail. A second nail hangs from the first nail. What explains this?

A. The first nail becomes charged by the magnet.
B. Gravity pulls the nails together.
C. The second nail has more domains.
D. The first nail’s domains are lined up by the magnet, so it attracts the second nail.

Work:

Final answer (with unit and sign): _____

Challenging · B9-N08. A bar magnet is cut in half. A student says one half is a north pole and the other half is a south pole. Correct the statement using domains.

Work:

Final answer (with unit and sign): _____