B9 · Extra practice, worked solutions

Magnets and magnetic fields | Diploma-style set of 8

Easy · B9-X01. Bar P is brought near the north end of a bar magnet and is repelled. What can you conclude about bar P?

A. P is a magnet, and its end near the magnet is a south pole.
B. P is a magnet, and its end near the magnet is a north pole.
C. P is only a magnetic material, such as iron.
D. Nothing can be concluded, because repulsion can also happen with iron.

1. Givens: bar P is repelled by the north end of a bar magnet. Question: what P must be.

2. Only a magnet can be repelled. A magnetic material, such as iron, is only ever attracted.

3. Like poles repel, so the end of P near the magnet is also a north pole.

4. Answer: B. P is a magnet, and its end near the magnet is a north pole.

Easy · B9-X02. A small compass is placed just beside the north pole of a bar magnet. The compass needle is free to turn. Which way does the north end of the needle point?

A. Away from the north pole of the bar magnet
B. Toward the north pole of the bar magnet
C. Toward the south pole of the bar magnet, through the magnet
D. Straight up, out of the page

1. Givens: a compass beside the north pole of a bar magnet. Question: where the needle’s north end points.

2. The field points the way the north end of a test compass points. Field lines leave a north pole.

3. So the needle’s north end points away from the north pole of the bar magnet, along the field line.

4. Answer: A. Away from the north pole of the bar magnet

Medium · B9-X03. Which statement about the Earth as a magnet is correct?

A. A magnetic north pole is near the geographic North Pole.

B. Both magnetic poles are at the equator.

C. The Earth’s field lines leave the south end of the Earth’s magnet.

D. A magnetic south pole is near the geographic North Pole.

1. Givens: the north end of a compass points to geographic north. Question: the correct statement.

2. A north pole is attracted to a south pole. The compass needle’s north end points north, so a magnetic south pole is near geographic north.

3. Outside the Earth, field lines leave the magnetic north pole near geographic south and enter the south pole near geographic north.

4. Answer: D. A magnetic south pole is near the geographic North Pole.

Medium · B9-X04. A strong bar magnet is dropped many times on a hard floor and becomes weaker. What is the best explanation?

A. The impacts remove the north pole.
B. The impacts turn all the domains to point the same way.
C. The impacts knock some domains out of alignment.
D. The impacts change iron into a non-magnetic element.

1. Givens: a magnet weakened by being dropped. Question: the best explanation.

2. A magnet is strong when its domains are lined up. Shocks and heat make the domains move.

3. Some domains are knocked into other directions, so their effects cancel and the magnet is weaker.

4. Answer: C. The impacts knock some domains out of alignment.

Challenging · B9-X05. An unmagnetized iron nail is held near the north pole of a bar magnet. Which description is correct?

A. The nail is repelled, because its end nearest the magnet becomes a north pole.
B. The nail is attracted, because its end nearest the magnet becomes a south pole.
C. The nail is attracted, because it already had a south pole at that end.
D. The nail is not affected, because iron has no domains.

1. Givens: an unmagnetized iron nail near the north pole of a magnet. Question: what happens and why.

2. The domains in the nail turn so their south ends face the north pole of the magnet.

3. The end of the nail nearest the magnet then acts like a south pole, so opposite poles are close and the nail is attracted.

4. Answer: B. The nail is attracted, because its end nearest the magnet becomes a south pole.

Medium · B9-X06. A bar magnet is cut in half. A student expects one half to be a lone north pole and the other half a lone south pole. Say what you would find and explain why.

1. Givens: a bar magnet cut in half. Question: what each half is, and why.

2. Each half is a smaller magnet with its own north pole and south pole.

3. The domains inside are lined up. Cutting the material does not separate the poles, because every small piece still has domains whose north and south ends line up. A single pole, a monopole, has never been found.

Medium · B9-X07. Describe the magnetic field lines between the north pole of one bar magnet and the south pole of a second bar magnet that faces it, close by. Give direction and spacing.

1. Givens: facing opposite poles, close together. Question: the direction and spacing of the field lines between them.

2. Direction: the lines leave the north pole and enter the south pole, so between the two magnets the arrows point from the north pole toward the south pole.

3. Spacing: the lines are straight, parallel and evenly spaced in the gap, so the field there is uniform. Near the poles the lines are closer together, where the field is strongest.

Challenging · B9-X08. A steel bar is not a magnet. Describe how you could turn it into a permanent magnet, and how you could destroy that magnetism later. Use domains in both answers.

1. Givens: a steel bar with random domains. Question: how to magnetize it and how to demagnetize it, using domains.

2. To make a magnet: bring a strong magnet near the bar, or stroke the bar with it in one direction. The domains turn toward the same direction. In steel they stay lined up when the magnet is removed.

3. To destroy the magnetism: heat the bar or hit it hard. The domains get loose and point in many directions, so their effects cancel and the bar loses its magnetism.