SI Physics - Full Discipline Demo

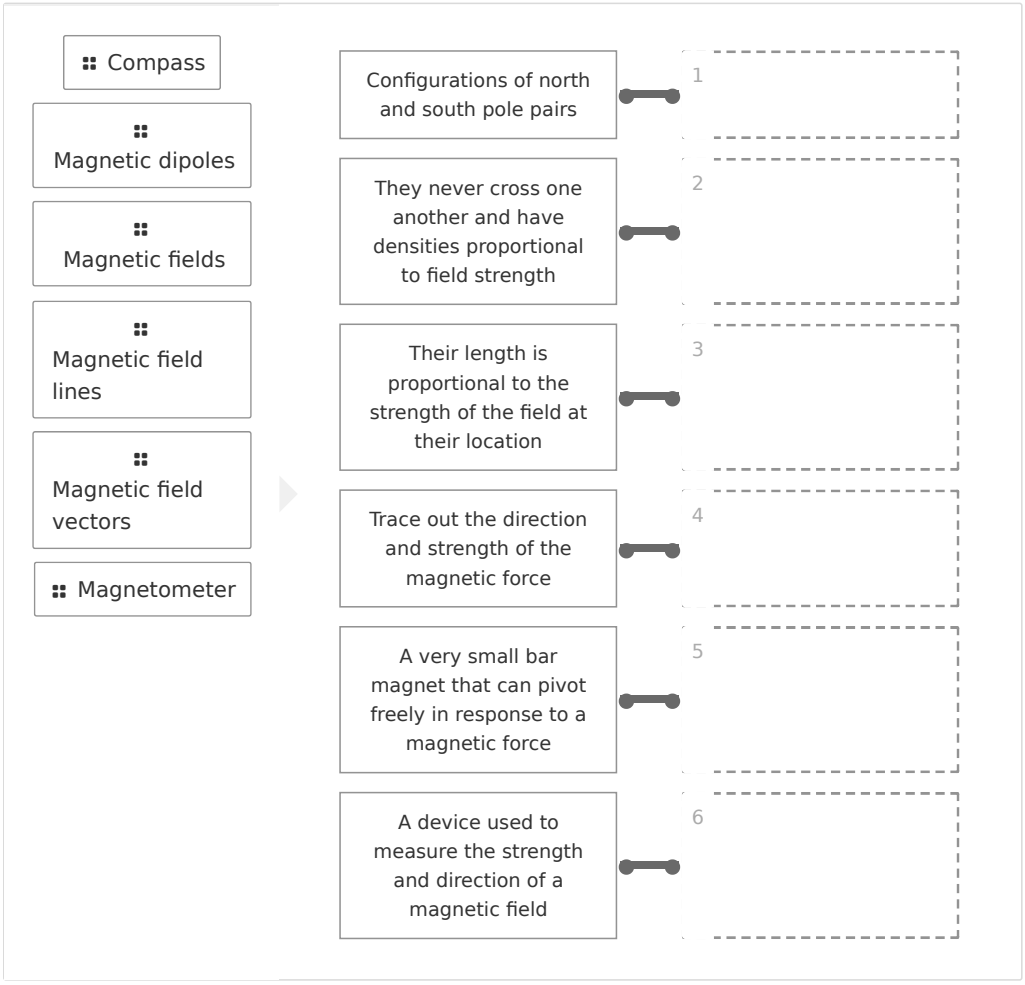
Mapping Magnetic Fields

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Physics - Full Discipline Demo
Course	SI Physics - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

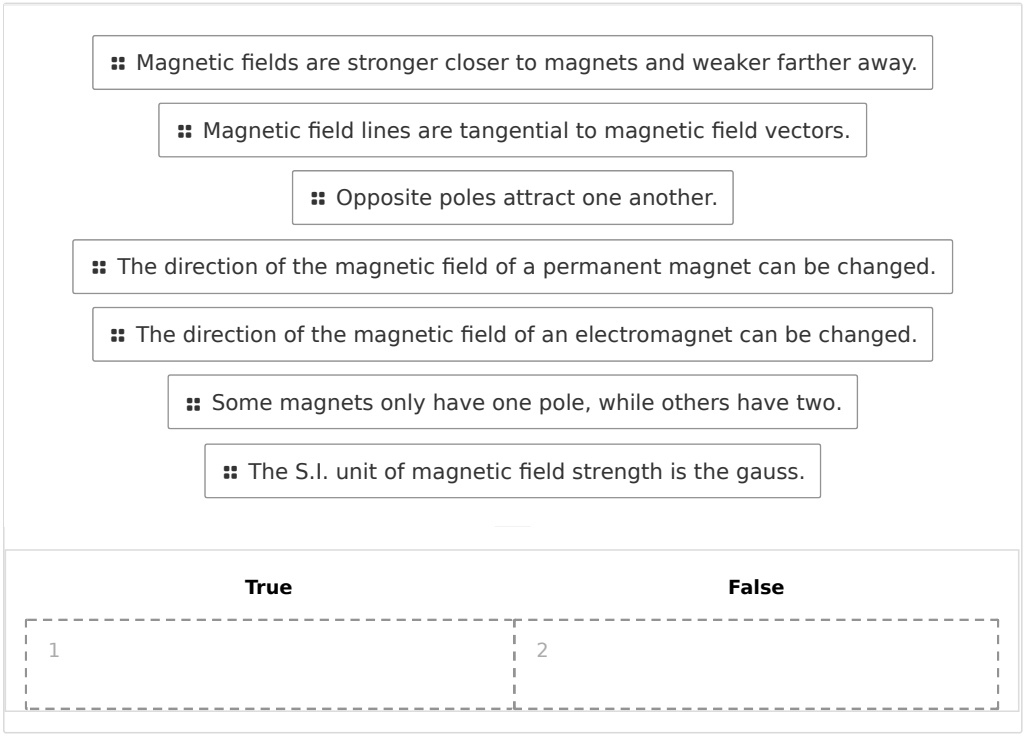


Correct answers:

1 Magnetic dipoles 2 Magnetic field lines 3 Magnetic field vectors

4 Magnetic fields 5 Compass 6 Magnetometer

Categorize each statement as true or false.



Correct answers:

1 Magnetic fields are stronger closer to magnets and weaker farther away.

Magnetic field lines are tangential to magnetic field vectors.

Opposite poles attract one another.

The direction of the magnetic field of an electromagnet can be changed.

2

The direction of the magnetic field of a permanent magnet can be changed.

The S.I. unit of magnetic field strength is the gauss.

Some magnets only have one pole, while others have two.

Exploration

Like magnetic poles, either north and north or south and south, attract one-another.

- True
- False ✔

A paperclip will be attracted to both the north and south poles of a bar magnet because the paperclip becomes _____.

- magnetically charged
- magnetically polarized ✔
- a magnetic dipole
- None of the above

Magnetic field lines point _____ north poles and _____ south poles.

- away from; toward ✔
- toward; away from
- toward; toward
- None of the above

The principle of _____ states that the total field strength and direction at any given point in space is the vector sum of all the individual fields present at that location.

- equalization
- conservation
- superposition ✔
- None of the above

The north pole of a compass needles points toward the _____ of a nearby magnet.

- north pole
- south pole ✔
- middle
- None of the above

Magnetic resonance imaging uses _____ to measure magnetic field strength.

- magnetometers ✔
- gaussmeters
- compasses
- None of the above

_____ is a magnetic material.

- Iron
- Nickle
- Cobalt
- All of the above ✔

Magnets created using electric currents are called _____.

- permanent magnets
- geomagnets
- electromagnets ✔
- All of the above

The Northern and Southern lights are caused by charged particles traveling along Earth's magnetic field lines.

- True ✔
- False

All magnetic fields are continuous, forming closed loops, unlike electric fields.

- [x] True
- [ ] False

Exercise 1

How are the magnetic field lines from Photo 2 and Photo 3 similar and different? Consider the general shape of the magnetic field, the location of the zero field, and the direction of the magnetic field lines.

The field lines from **Photo 1** and **Photo 3** are essentially identical – the field lines take on the same general shape, connecting north and south poles with magnetic field lines, and the location of the zero field is the same. Along the line between the magnets, the field lines split to connect to each magnet. The major difference is the direction of the magnetic field lines; this is because magnetic field lines always point from the north magnetic pole to the south magnetic pole.

How are the magnetic field lines from Photo 1 and Photo 4 similar and different? Consider the general shape of the magnetic field and the direction of the magnetic field lines.

The field lines in **Photo 4** are similar to **Photo 1** because the field lines near each of the magnets match the field lines for a single magnet. Looking at the field lines farthest away from the configuration, we see lines connecting the north pole of one magnet to the south pole of the other. This means that, zoomed out, the field line of the two magnets in **Photo 4** will look just like the field lines of a single magnet. A major difference between the two drawings is the field lines between the magnets in **Photo 4**, though it would be expected that field lines connecting the north and south poles of the two magnets wouldn't be present for a single magnet.

Do the field lines seen in Photos 2-4 align with the principle of superposition? Explain your answer.

Yes, they align with the principle of superposition, which states field lines add together. In **Photos 2** and **3**, the central line is the addition of the field lines from each magnet. Superposition is clear at the midpoint between the two magnets, where the field lines point in opposite directions, canceling to produce a field strength of zero. In **Photo 4** the horizontal field lines of the two magnets add together farther away from the magnet and vertical components cancel between the magnets due to their opposing directions, creating a single field line.

How would the magnetic field lines appear for a bar magnet cut at the midpoint, with the two pieces placed end to end with a space in between such that the cut edges are closest to each other? What would the general shape of the field lines look like? What would the field lines look like in between the two pieces?

The field lines would look like what is seen in **Photo 4**. When a magnet is split in half, isolated poles are not created. Instead, two magnets are created, each with north and south magnetic poles.

Do magnetic field lines ever cross? Reference Photos 1-4 in your answer and explain any discrepancies between what you saw and what you'd expect to see.

Magnetic field lines never cross, as the drawings indicate. This is due to the principle of superposition – when two field lines approach each other, they simply add instead of cross. (Student answers may vary based on the accuracy of their drawings.)

Where is the magnetic field of a bar magnet the strongest?
Note: Field line density is indicative of magnetic field strength.

The magnetic field is strongest near the north and south poles of the magnet. This is where the density is the largest on each of the four drawings.

Photo 1: Magnetic Field Lines of a Single Magnet
(SAMPLE ANSWER BELOW)

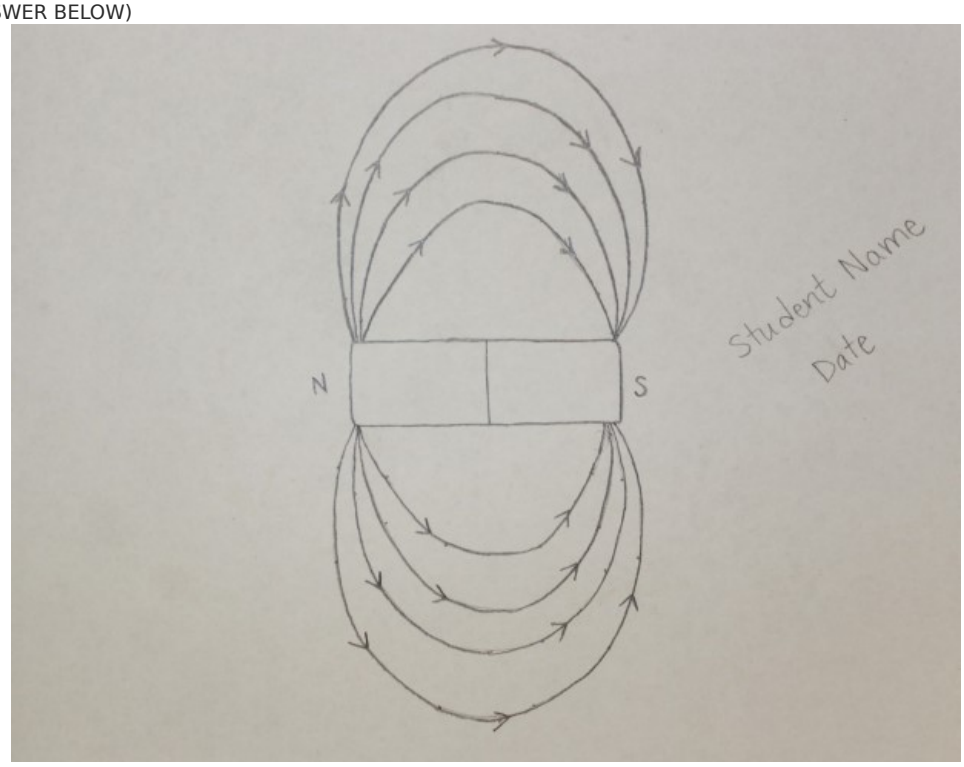


Photo 2: Magnetic Field Lines of Two Magnets: N-N

(SAMPLE ANSWER BELOW)

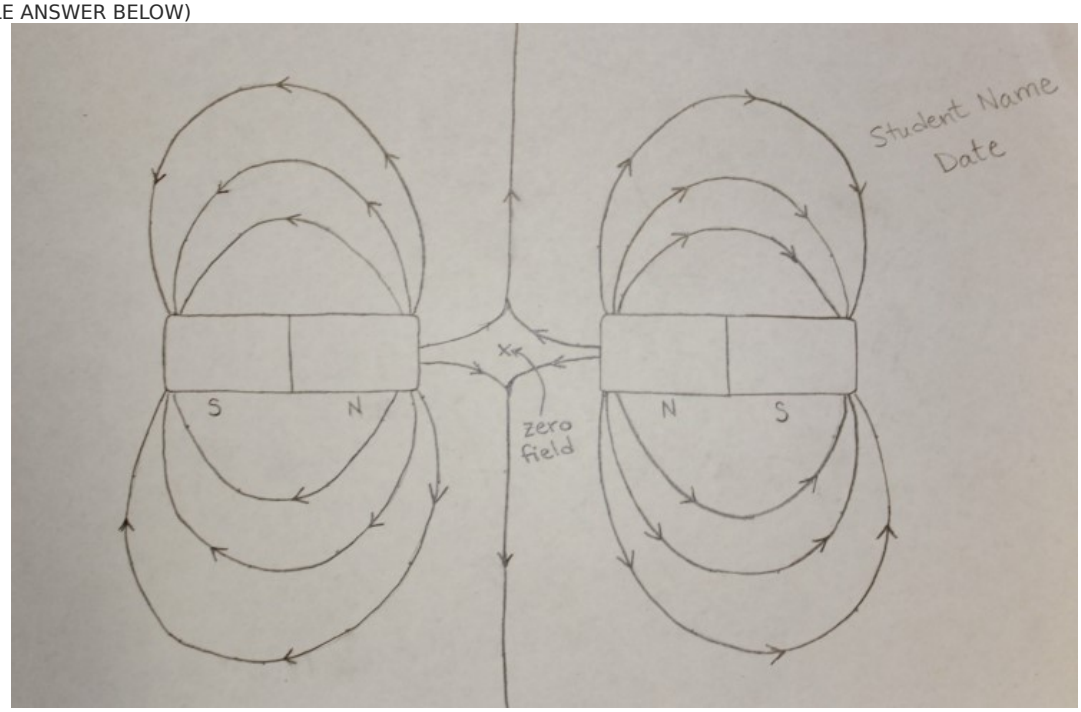


Photo 3: Magnetic Field Lines of Two Magnets: S-S
(SAMPLE ANSWER BELOW)

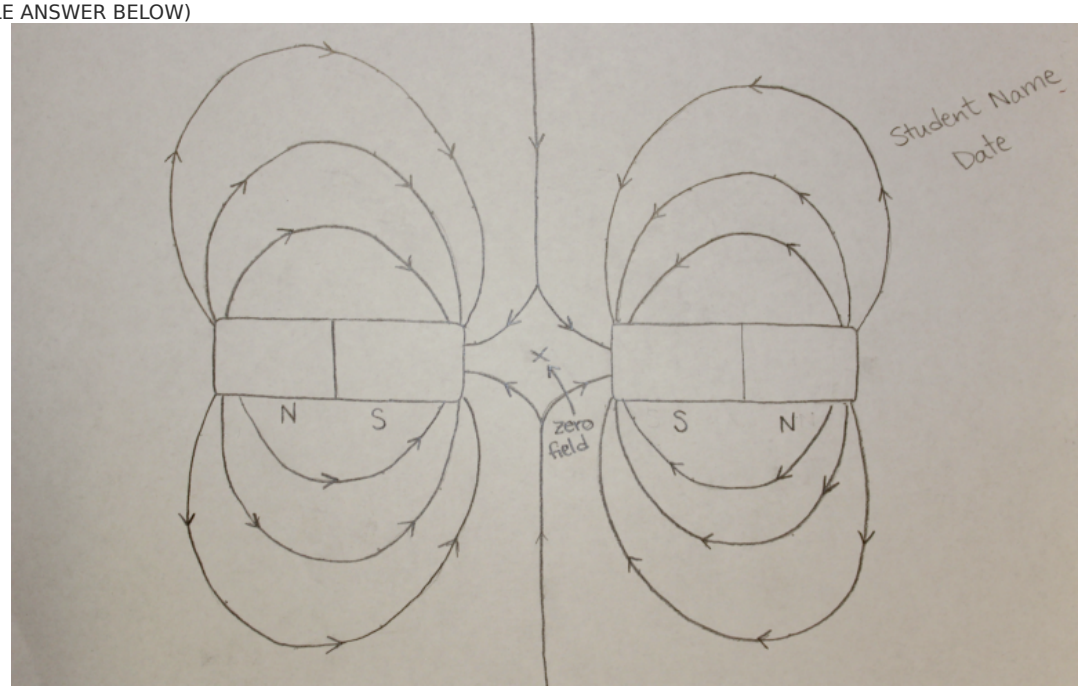
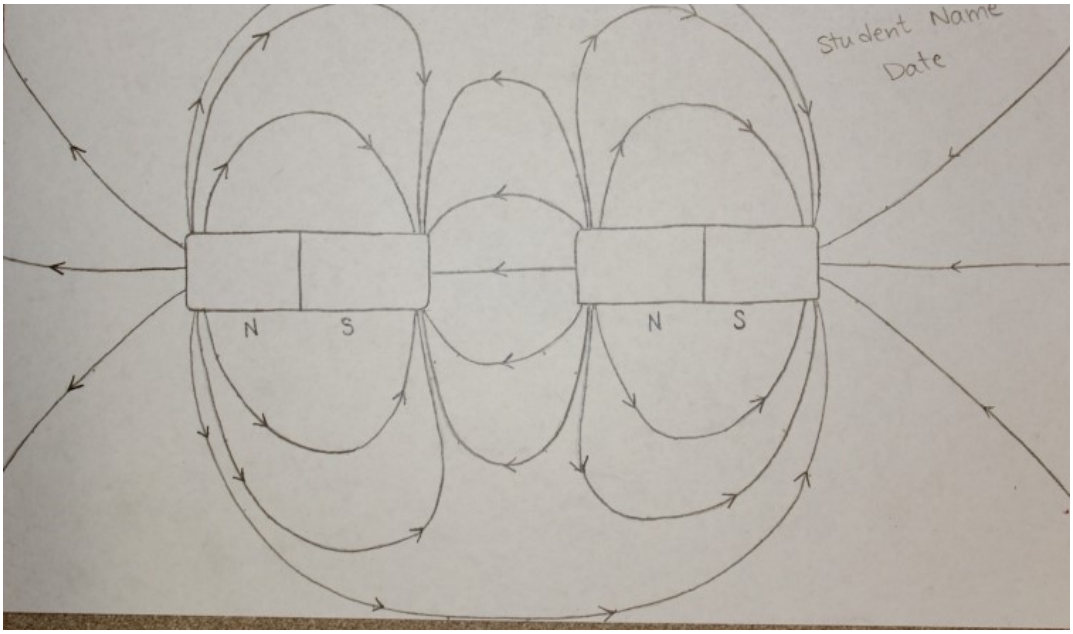


Photo 4: Magnetic Field Lines of Two Magnets: N-S
(SAMPLE ANSWER BELOW)



Competency Review

North poles exert a(n)_____ force on south poles.

- repulsive
- neutral
- attractive ✔
- All of the above

A magnetic _____ is the configuration of magnetic poles consisting of a north and south pole.

- dipole ✔
- monopole
- pair
- None of the above

The magnetic field is a visualization of the magnetic _____ between magnetic poles.

- charge
- force ✔
- aura
- None of the above

Magnetic _____ are useful for representing the magnetic field at one particular location.

- fields
- field vectors ✔
- field lines
- All of the above

A compass needle is a small _____ that responds to the magnet force exerted on it by a nearby magnetic field.

- [x] bar magnet
- [ ] electromagnet
- [ ] gaussmeter
- [ ] All of the above

A(n) _____ is made of magnetic materials and has a static magnetic field.

- [ ] electromagnet
- [ ] geomagnet
- [x] permanent magnet
- [ ] All of the above

The direction of the magnetic field of an electromagnet can be changed by changing the direction of the electric current.

- [x] True
- [ ] False

Two bar magnets aligned south pole to south pole will attract one another if not affixed in place.

- [ ] True
- [x] False

By marking the tip and tail locations of a compass in the presence of a magnetic field, the magnetic _____ are traced out.

- [x] field lines
- [ ] field vectors
- [ ] flux
- [ ] All of the above

Magnetic field lines directly between two north poles curve away from the two poles.

- [x] True ✔
- [ ] False

Due to the principle of superposition, the magnetic field centered between two south poles is _____.

- [ ] the strongest
- [ ] variable
- [x] zero ✔
- [ ] None of the above

The magnetic field is _____ closer to a magnet as compared to farther away.

- [x] stronger ✔
- [ ] weaker
- [ ] unchanged
- [ ] None of the above

Extension Questions

The south pole of a bar magnet is brought near the center of a second bar magnet. Will the force between the two magnets be attractive, repulsive, or zero? Explain your answer. (SAMPLE ANSWER BELOW)

The force will be attractive between the south pole of the moving bar magnet and the north pole of the stationary bar magnet, and repulsive between the two south poles, so that the stationary magnet will experience a torque and will rotate so that its north pole aligns with the south pole of the moving magnet.