



# Magnetism

## 1 How far does magnetic force reach?

Table 1: Magnetic forces between two magnets

	North-South	South-South	North-North
Distance 1 (mm)			
Distance 2 (mm)			
Distance 3 (mm)			
Average distance (mm)			

## 2 Thinking about what you observed

- a. When referring to many measurements of the same quantity, *precision* describes how close the measurements are to each other. Estimate the precision (in millimeters).

- b. Look at your results and compare the average distances for the three combinations of poles. Are the attract and repel distances *significantly* different? In science, “significantly” means the differences are large compared to the precision of your measurement.

## 3 Using a compass to detect magnetic forces

There are no questions to answer in part 3.

Name: \_\_\_\_\_

Date: \_\_\_\_\_



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#### **4 Thinking about what you observed**

- a. At a distance of 10 cm, which is stronger: the magnetic force from Earth or the magnetic force from the small magnet? How is your answer supported by your observations?

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- b. Is the end of the compass needle a magnetic north or a magnetic south pole? How is your answer supported by your observations?

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- c. Is the geographic north pole of the planet Earth a magnetic north or a magnetic south pole? How is your answer supported by your observations?

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#### **5 Magnetic materials**

**Table 2: Testing materials for magnetic effects**

Material	20 degree deflection distance with air in between	20 degree deflection distance with material in between	Difference in distance	Percent difference

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Date: \_\_\_\_\_



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**6 Thinking about what you observed**

- a. Which materials made almost no change in the magnetic force? Can you list any common characteristics of these materials?

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- b. Which materials made a significant change in the magnetic force? Can you list any common characteristics of these materials?

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# ***Electromagnets***

## **1 Making an electromagnet**

There are no questions to answer in part 1.

## **2 Thinking about what you observed**

- a. Does the compass needle move? What does this tell you about the force created by the electromagnet?

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- b. What happens when the current in the coil is reversed? Use your observations to support your answer.

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- c. Try wrapping 30 more turns on the coil. Does the magnetic force get stronger, weaker, or stay about the same? How do your observations support your answer?

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## **3 Comparing the electromagnet to a permanent magnet**

There are no questions to answer in part 3.

## **4 Magnetic properties of materials**

There are no questions to answer in part 4.

## **5 Thinking about what you observed**

- a. Based on your observations, propose a relationship between the current in the coil and the magnetic force produced. You may use the meter to measure the current to verify your hypothesis.

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- b. Which materials made almost no change in the magnetic force from the electromagnet? Can you list any common characteristics of these materials?

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Name: \_\_\_\_\_

Date: \_\_\_\_\_



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- c. Which materials made a significant change in the magnetic force? Can you list any common characteristics of these materials?

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## 6 Iron and electromagnets

**Table 1: Electromagnet current with and without the steel pin**

Current with bare coil	Current with steel pin	Difference in current	Percent difference

## 7 Thinking about what you observed

- a. How did the steel pin affect the magnetic force created by the coil? Was the magnetic force reduced, increased, or did it stay about the same? Use your observations to support your answer.

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- b. *Class discussion question*

The force produced by an electromagnet *could* be a different kind of force than that produced by a permanent magnet. For example wind and springs make forces that are different than magnetism.

How does this experiment *support* the conclusion that the force from the electromagnet and permanent magnet are actually the same kind force?

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Name: \_\_\_\_\_

Date: \_\_\_\_\_



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# ***Electromagnetic Forces***

## **1 Make the base**

There are no questions to answer in part 1.

## **2 Make the coil**

There are no questions to answer in part 2.

## **3 Making the motor work**

There are no questions to answer in part 3.

## **4 Thinking about what you observed**

- a. Explain the force acting on the coil when there is current flowing. What creates the force?

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- b. Why was it important to sand only one side of the wire on one end of the coil.

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- c. See if you can hold a photogate so the spinning coil breaks the light beam. Perform an experiment to measure the speed of your motor.

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- d. Try adding a second magnet. Does this make the motor go faster, slower, or about the same? What observations did you make that support your answer?

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Name: \_\_\_\_\_

Date: \_\_\_\_\_



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# ***Electromagnetic Induction***

## **1 Making a generator**

There are no questions to answer in part 1.

## **2 Thinking about what you observed**

**a.** Explain the difference between AC and DC electricity.

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**b.** Is electricity produced by the magnets at rest or only by motion of the magnets?

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**c.** Does the generator make AC or DC electricity? Support your answer with your observations.

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### **3 Voltage and speed.**

**Table 1: Voltage versus speed data**

Frequency from Timer (Hz)	Rotational speed (rev. per sec.)	Voltage produced (V AC)

### **4 Thinking about what you observed**

- a.** Does the voltage produced depend on the speed? Support your answer with your observations.

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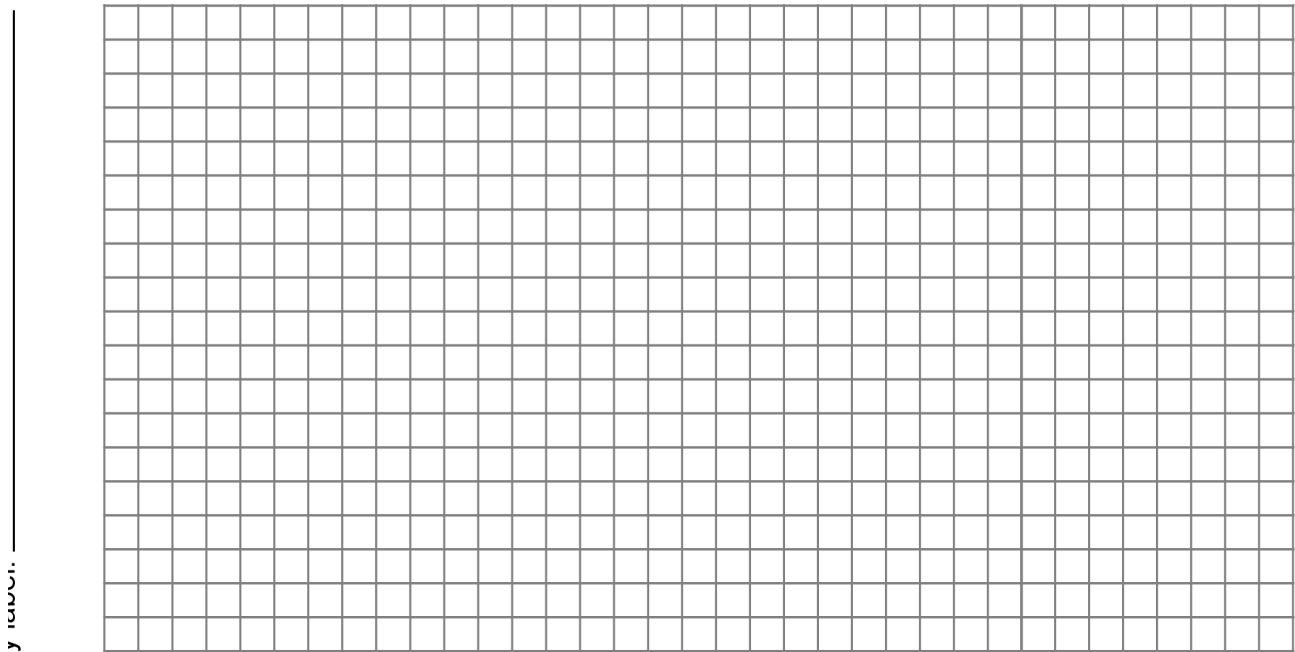
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- b.** Make a graph of voltage versus speed. Is the graph a straight line or a curve?

**Title:** \_\_\_\_\_



x label: \_\_\_\_\_

### **5** Changing the design

There are no questions to answer in part 5.

### **6** Thinking about what you observed

- a.** Which changes you made in part 5 have the largest effect on the voltage produced?

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- b.** Explain why changing one thing made a large difference while changing the other did not. The answer is not obvious so this should be a class discussion question.

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## **7 Building different generators**

**Table 2: Voltage for different magnet configurations**

Magnet configuration (describe)	Rotational frequency (Hz)	Voltage produced (V AC)

## **8 Thinking about what you observed**

- a.** If the number of magnets is increased from 6 to 12, what change do you expect in the voltage? Assume the magnets alternate north-south.

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- b.** Suppose you have 6 magnets (alternate north-south) and double the speed. What change do you expect in the voltage?

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Name: \_\_\_\_\_

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- c. Suppose you change from 6 to 12 magnets and also double the speed. What change do you expect in the voltage?

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- d. Propose a relationship that accounts for the voltage produced at different speeds and magnet configurations. This should be a class discussion question.

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- e. What change in voltage do you expect when changing from 12 magnets with alternating north-south to 12 magnets all facing the same way? Why?

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Date: \_\_\_\_\_



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# ***The Magnetic Field***

## **1 Making a map of a magnetic field**

There are no questions to answer in part 1.

## **2 Thinking about what you observed**

- a. The arrow of the compass shows you the direction of the force felt by the \_\_\_\_\_ pole of another magnet. (Fill in the blank with the word “north” or “south”)
- b. The lines of magnetic field point away from \_\_\_\_\_ and toward \_\_\_\_\_ magnetic poles. (Fill in the blanks with the word “north” or “south”)
- c. Why do all the arrows far from the magnet point in the same direction?

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- d. Research and give a one sentence definition of a “field” as the term is used in physics. This may be a class discussion question.

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- e. Describe two basic kinds of fields and give the difference between them. The magnetic force around a magnet is an example of one and the temperature around a candle flame is an example of the other.

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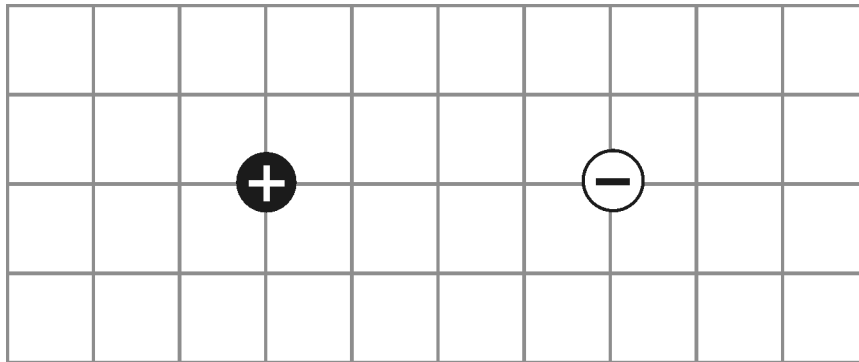
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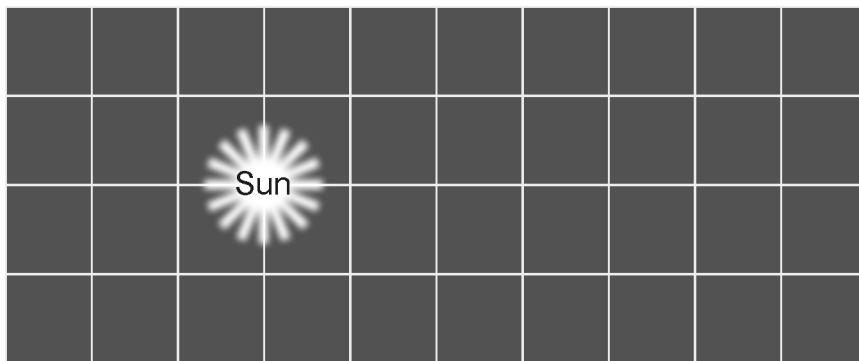
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### 3 The electric field



- a. Draw arrows on each of the grid points in the diagram above to show the force felt by a positive electric charge. This is a diagram of the electric field.

### 4 The gravitational field



- a. Draw arrows on each of the grid points in the diagram above to show the force felt by an asteroid moving near the Sun. This is a diagram of the gravitational field.

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Date: \_\_\_\_\_



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## ***Using Fields***

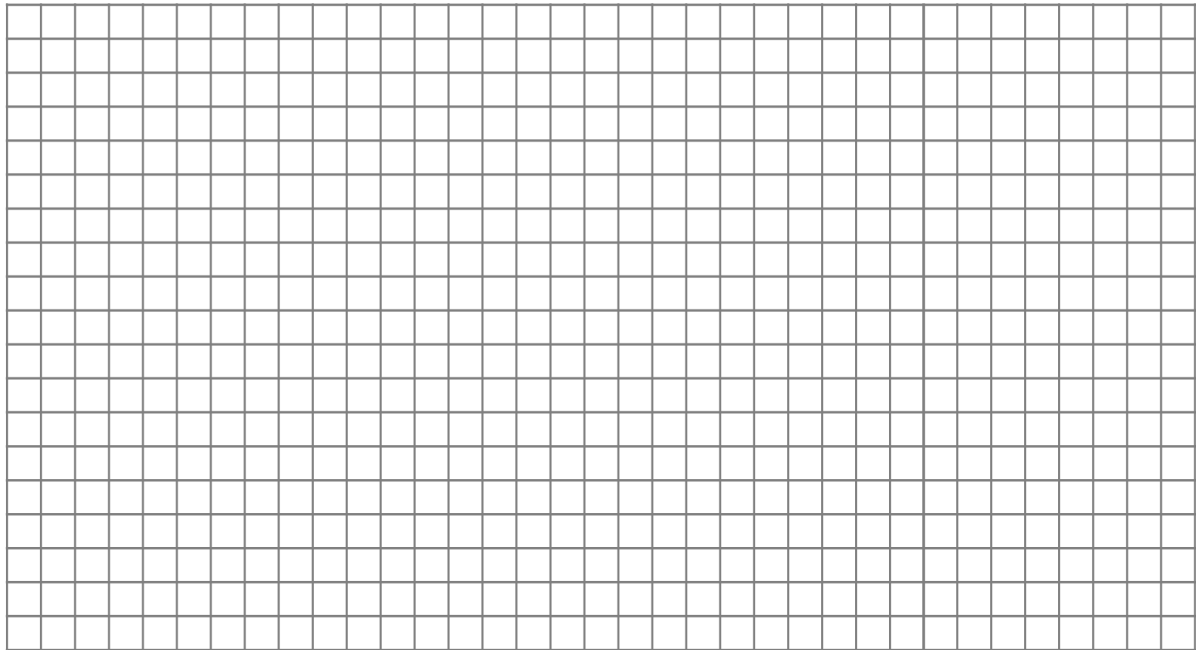
### **1 Making the puzzle**

There are no questions to answer in part 1.

### **2 Thinking about what you are going to do**

There are no questions to answer in part 2.

### **3 Solving the puzzle**



### **4 Thinking about what you observed**

- a. How can you use the map you made to determine the location and orientation of the hidden magnet?

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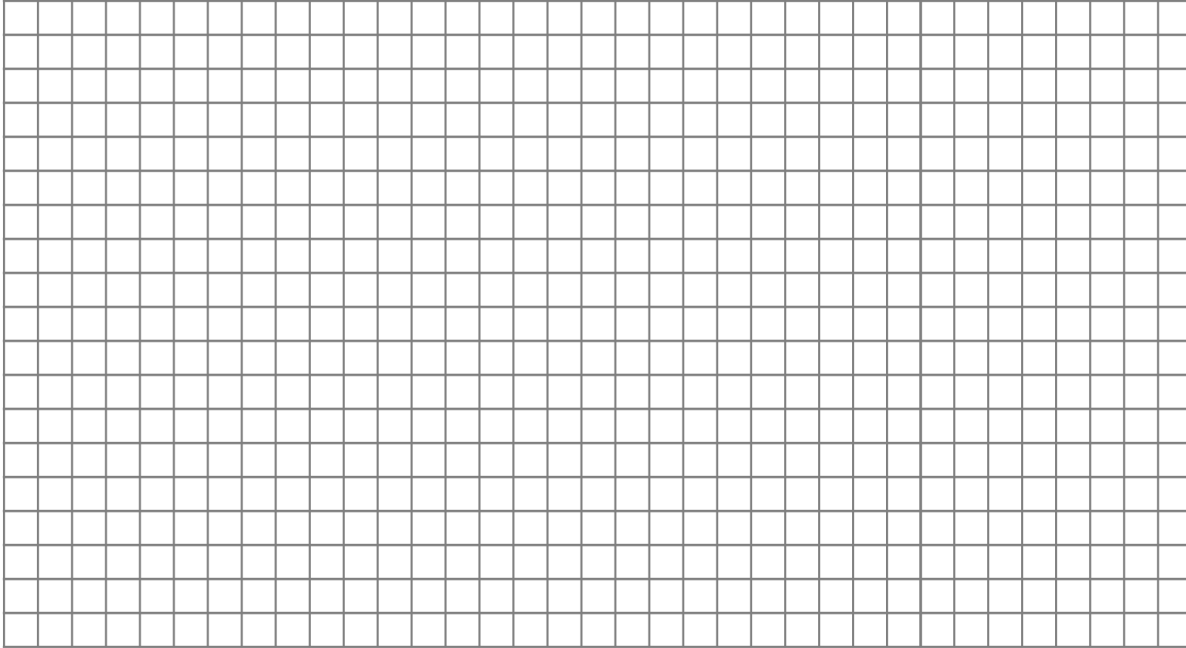
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**b.** Sketch the magnetic axis of the magnet on your map.



**c.** Flip the cardboard grid over and check your results. Did you get the location and orientation correct?

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