MAY THE FORCE BE WITH YOU!

Grade Level: Second Grade
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Length of Unit: Five Lessons

I. ABSTRACT

This is an eight class period unit designed to provide the student experience with the concepts concerning magnets and magnetism contained in the Second Grade Core Knowledge Sequence. The unit will also provide a basis for students to conduct inquiry-based investigations. Students will first explore the basic phenomenon of magnetism. They will observe that despite the fact magnetic force is invisible, it acts upon certain objects in a visible way. Students will learn about magnetic poles, magnetic attraction and repulsion, the Earth's magnetic field, and compasses. Students will apply this basic knowledge in conducting investigations into the properties of magnets, magnetic materials, and non-magnetic materials. The assessment will consist of student constructed projects that demonstrate any of the principles they have learned.

II. OVERVIEW

A. Concept Objectives
   1. Students will recognize that there are forces in the world, created by natural phenomenon, that we can't see but have a real effect on objects that we can see.
   2. Students will understand that stability refers to constancy: The ways in which systems do not change, making it possible to predict how these forces operate in the natural world.

B. Content covered from Core Knowledge Sequence
   1. Magnetism demonstrates that there are forces we cannot see that act upon objects
   2. Most magnets contain iron
   3. Lodestones: naturally occurring magnets
   4. Magnetic poles: north-seeking and south-seeking poles
   5. Magnetic field: strongest at the poles
   6. Law of magnetic attraction: unlike poles attract, like poles repel
   7. The earth behaves as if it were a huge magnet: north and south poles
   8. Orienteering use of a magnetized needle in a compass which will always point to the north

C. Skill Objectives (Taken from Colorado Standards)
   1. Hypothesizing
   2. Predicting
   3. Observing
   4. Classifying
   5. Comparing and contrasting
   6. Interpreting data
   7. Drawing conclusions

III. BACKGROUND KNOWLEDGE

A. For the teacher
   1. Hirsch, E.D. Jr. What Your Second Grader Needs to Know
   2. Kent, Amanda and Ward, Alan. Introduction to Physics
   3. Vecchione, Glen. Magnet Science

B. For the student
   1. Ardley, Neil. The Science Book of Magnets
   2. Challand, Helen J. Experiments With Magnets
   3. Fowler, Allan. What Magnets Can Do

IV. RESOURCES

A. Ardley, Neil. The Science Book of Magnets
B. Challand, Helen J. Experiments With Magnets
C. Feigen, Mel. Magnetism and Electricity
D. Fowler, Allan. What Magnets Can Do
E. Hirsch, E. D. Jr. What Your Second Grader Needs to Know
F. Kent, Amanda and Ward, Allan. Introduction to Physics
G. Oxland, Chris. Science Magic with Magnets
H. Schaffer, Frank. Creative Kids Science Project on Magnetism
I. Spero, Daniel J. Permanent Magnets Magnetism and Electromagnets
J. Vecchione, Glen. Magnet Science

V. LESSONS

Lesson One: What Is a Magnet?

A. Daily Objectives
   1. Lesson Content
      a. Magnetism acts upon objects but the force can't be seen
      b. Most magnets contain iron
      c. Lodestone is a naturally occurring magnet
   2. Concept Objectives
      a. Students will recognize that there are forces in the world, created by natural phenomenon, that we can't see but have a real effect on objects that we can see.
   3. Skill Objectives
      a. The students will be able to observe, classify, and interpret data, and show understanding verbally.

B. Materials
   1. Lodestones
   2. Assortment of magnets
   3. String
   4. Variety of iron objects, i.e. nails, needles, nuts, bolts
   5. Variety of non-metal objects, i.e. aluminum, glass, wood, cloth
   6. Chart paper or tablet
   7. Black marker
   8. Transparency of key vocabulary – Appendix A
   9. Student handout of key vocabulary – Appendix B
   10. Overhead projector

C. Key Vocabulary
   1. lodestone – n. a natural magnet
   2. magnet – n. something that attracts
   3. magnetic – adj. having the power to attract

D. Procedures/Activities
   1. Using transparency (Appendix A) have students fill in meanings of key vocabulary.

2. Introduce the unit of study. Display chart paper with the heading, "What we think we know about magnets." As students give responses, record them on the chart. Do not correct the students' inaccurate responses. This will be helpful in ascertaining the students' prior knowledge, including accurate assumptions. Display a second chart with the heading, "What I want to learn about magnets." Record students' responses. These charts can be referred to throughout the unit of study as a way for students to reflect upon their learning and to rethink inaccurate ideas.
3. Hang a nail from a string. Demonstrate forces you can see by pushing the nail with your finger. Demonstrate forces you can not see by placing a magnet close to the nail and observing what happens.
4. Put an iron object (nail, needle etc.) on a table or overhead projector. Demonstrate seen force by pushing the object with your finger. Then demonstrate unseen force by pushing and pulling the object with a magnet.
5. Demonstrate push and pull using two magnets. On a table or overhead projector, show how two magnets will attract or repel. After completing activity, ask the question, "Why do you think what happened occurred?"

E. Evaluation/Assessment
1. Teacher will evaluate students' learning through verbal responses during class discussion of lesson.

F. Standardized Test/State Test Connections
1. Standard 1,c Colorado State Science Standards

Lesson Two: Magnetic Poles

A. Daily Objectives
1. Lesson Content
   a. Law of magnetic attraction: unlike poles attract, like poles repel
   b. Magnetic fields are the strongest at the poles
   c. Magnetic poles: north-seeking and south-seeking poles
2. Concept Objectives
   a. Students will recognize that there are forces in the world, created by natural phenomenon, that we can't see but have a real effect on objects that we can see.
   b. Students will understand that stability refers to constancy: the ways in which systems do not change, making it possible to predict how these forces operate in the natural world.
3. Skill Objectives
   a. Students will be able to observe, hypothesize, predict, and show understanding of material presented.

B. Materials
1. Iron filings
2. Wax paper
3. Ironing board
4. Iron
5. Wax paper slide (prepared ahead) 2 per child – Appendix C
6. Variety of magnets
7. Overhead projector
8. Screen
9. Globe
10. Assortment of iron objects
11. Assortment of non-magnetic material
12. Transparency of key vocabulary – Appendix D

13. Student handout of key vocabulary – Appendix E
14. Overhead projector frames
15. 1 inch wooden blocks (6 per child)
16. Newspaper

C. Key Vocabulary
1. molecule – n. smallest part of something
2. magnetic field – n. space around a magnet
3. poles – n. ends of a magnet
4. concentrate – v. to draw toward the center

D. Procedures/Activities
1. For today's lesson it would be helpful to have two parent volunteers.
2. Using transparency (Appendix D) have students fill in meanings of key vocabulary words on student handout (Appendix E)
3. Review pushing and pulling activity from ending of Lesson One, procedure # 5. Ask the question, "Why do you think the movement occurred?"
4. Set up overhead using wax paper slide (Appendix C). Place magnets under wax paper slide, opposite poles facing each other, and place iron filings on top of wax paper slide. Observe what occurs to the iron filings. Repeat the procedure with like poles facing each other. Ask the question, "Why do you think what happened occurred?"
5. Divide the class into groups of two. Pass out wax paper slides (Appendix C). Guide the students through the experiment done in procedure 3.
6. Have parent volunteers carefully remove results of experiment to the ironing board. Have them place another sheet of wax paper over the slide. Iron over the wax paper with a slightly warm iron, causing the two pieces of paper to melt together. This makes a picture of the design the iron filings made.

E. Evaluation/Assessment
1. Students will be evaluated by sharing their completed slides and verbally explaining why they achieved the results they did.

F. Standardized Test/State Test Connections
1. Standard 1, a Colorado State Science Standards

Lesson 3: Earth as a Magnet

A. Daily Objectives
1. Lesson Content
   a. Magnetic field (strongest at the poles)
   b. The earth behaves as if it were a huge magnet: north and south magnetic poles (near; but not the same as geographic North Pole and South Pole)
2. Concept Objectives
   a. Students will recognize that there are forces in the world, created by natural phenomenon, that we can't see but have a real effect on objects that we can see.
   b. Students will understand that stability refers to constancy: The ways in which systems do not change, making it possible to predict how these forces operate in the natural world.
3. Skill Objectives
   a. Students will be able to observe, predict, draw conclusions, and show understanding verbally.

B. Materials
1. Globe
2. Map worksheet – Appendix F
3. Overhead transparency of key vocabulary – Appendix G

4. Student handout of key vocabulary – Appendix H
5. Assorted magnets
6. Paper clips (10 – 12 per group)
7. Diagram – Appendix I
8. Crayons or colored pencils
9. Map worksheet – Appendix J
10. Overhead projector
11. Iron filings
12. Overhead slide from Lesson 2

C. Key Vocabulary
1. core – n. the center
2. electromagnet – n. magnet formed by an electric current
3. electricity – n. source of power

D. Procedures/Activities
1. Using transparency (Appendix G) have students fill in meaning of key vocabulary on student handout (Appendix H).
2. Using a globe, the diagram (Appendix I), and the map worksheet (Appendix J), discuss the Earth's construction including its inner core, geographic north and south poles, and magnetic north and south poles. Have students identify these four locations using the above appendices.
3. Review procedure 3 from Lesson 2 with the iron filings. Use only one magnet this time and lead the discussion toward examining the lines of force, insuring the students see that the greatest amount of iron filings are around the poles.
4. Divide the class into groups of two. Distribute magnets and paper clips. Have the students investigate and predict which parts of the magnet will hold the most paper clips.
5. Have each team develop a conclusion as to why the magnet held the most objects.

E. Evaluation/ Assessment
1. Each team will make a verbal presentation of their conclusions.

F. Standardized Test/State Test Connections
1. Standard 1, a, b, c, d, Colorado State Science Standards

Lesson 4: What Are Compasses and How Do they Work

A. Daily Objectives
1. Lesson Content
   a. Orienteering use of a magnetized needle in a compass, which will always point to the north
2. Concept Objectives
   a. Students will recognize that there are forces in the world, created by natural phenomenon, that we can't see but have a real effect on objects that we can see.
   b. Students will understand that stability refers to constancy: the ways in which systems do not change, making it possible to predict how these forces operate in the natural world.
3. Skill Objectives
   a. Students will be able to observe, interpret data, draw conclusions, and show understanding of principles learned in Lessons 1 – 3.

B. Materials
1. Overhead transparency of key vocabulary – Appendix K
2. Student handout of key vocabulary – Appendix L
3. Map worksheet – Appendix F
4. Assorted magnets

5. Needles (1 per team)
6. Corks (1 per team)
7. Bowls (1 per team)
8. Water
9. Compass directions – Appendix M
10. 8x11 sheet of paper (1 per team)
11. Crayons or colored pencils
12. Compass reporting chart – Appendix N

C. Key Vocabulary
1. compass – n. a device used to determine direction
2. earth's magnetic poles – n. either of two small places close to the north and south poles
3. orienteering – v. using a compass to get from one place to another

D. Procedures/Activities
1. Using transparency of key vocabulary (Appendix K) have the students fill in the meaning of words on student handout (Appendix L).
2. Hang a bar magnet from the ceiling.
3. Start the lesson by reviewing procedure 3 of Lesson 3. Review class conclusion regarding strongest magnetic pull on the magnet. Distribute map worksheet (Appendix F) and discuss.
4. Discuss briefly the history of compasses. Teacher directs attention to the suspended bar magnet. Teacher gently taps magnet and class watches it come back to its beginning position.
5. Distribute materials for making compasses. Teacher will walk through this procedure with the students step by step. (See Appendix M for directions).

E. Evaluation/Assessment
1. The student will demonstrate understanding of orienteering with compasses by navigating to specific points and recording direction on his/her "compass reporting chart' (Appendix N).

F. Standardized Test/State Test Connections
1. Standard 6, b, c, Colorado State Science Standards

Lesson 5: Magnetic Science Fair Preparation

A. Daily Objectives
1. Lesson Content
   a. All content from previous 4 lessons.
2. Concept Objectives
   a. Students will understand that stability refers to constancy: the ways in which systems do not change, making it possible to predict how these forces operate in the natural world.
3. Skill Objectives
   a. The students will be able to hypothesize, predict, observe, classify, interpret, and draw conclusions by using the scientific method.

B. Materials
1. Assorted magnets
2. Assorted magnet items
3. Assorted non-magnetic items
4. Student worksheet – Appendix O
5. Overhead transparency of key vocabulary – Appendix P
6. Student handout of key vocabulary – Appendix Q
7. Data table – Appendix R

C. Key Vocabulary

1. hypothesis – n. an idea based on observed information
2. predict – v. to state beforehand
3. conclude – v. to reach a decision
4. interpret – v. to offer an explanation

D. Procedures/Activities
   1. Using transparency of key vocabulary (Appendix P) have the students fill in the meanings of key vocabulary on student handout (Appendix Q).
   2. The teacher will teach the scientific method through the experiment of identifying which materials are magnetic and which materials are not.
      a. Construct hypothesis # 1 (which will be incorrect) – Metal is magnetic material and can be picked up by a magnet.
      b. Develop an experiment to test this hypothesis.
      c. Construct a revised hypothesis # 2 – Iron is magnetic material and can be picked up by a magnet.
      d. Construct a new experiment to test this new hypothesis
      e. Draw conclusions from experiments.
   3. Conduct a teacher directed discussion to come up with 4 or 5 appropriate experiments that the students would be able to perform.
      a. How to magnetize a magnet or demagnetize a magnet
      b. How will a magnet affect a compass? How can you use a magnet to effect which direction a compass is pointing toward?
      c. How can you make a magnet suspend another magnet in mid-air?
      d. Will different places on a magnet suspend different amounts/different weights of magnetic material? Will different places on a magnet measure difference between poles and center and different stations on a bar magnet?
      e. Try to stop magnetism. Will magnetic force go through every material? Try paper, glass, plastic, different kinds of metal.
   4. Break the class into cooperative groups and have them pick from the suggested experiments for their culminating activity.

E. Evaluation/Assessment
   1. There will be a written assessment of vocabulary words to check for understanding.
   2. The teacher will evaluate the student's learning through presentation of culminating activity.

F. Standardized Test/State Test Connections
   1. Standard 1,a and 6, a Colorado State Science Standards

VI. CULMINATING ACTIVITY

A. The culminating activity of this unit is the student's own creation. They will work in teams of no more than four, to create a "mini magnet science fair" project. (see Resource 8 for further guidelines). They will use one of the experiment suggestions discussed in Lesson 5 for this project. The teams will be set up as cooperative learning groups with each member having one of the following jobs.
   1. Project leader - in charge of reading directions and setting up equipment
   2. Physicist - in charge of carrying out directions
   3. Stenographer - in charge of recording all information
   4. Transcriber - translates notes and communicates findings

B. Each group will present their final project orally and the "science fair rubrics"(Appendix S) will be used by the teacher for final evaluation.

VII. HANDOUTS/WORKSHEETS

Appendix A:
Appendix B:
Appendix C:
Appendix D:
Appendix E:
Appendix F:
Appendix G:
Appendix H:
Appendix I:
Appendix J:
Appendix K:
Appendix L:
Appendix M:
Appendix N:
Appendix O:
Appendix P:
Appendix Q:
Appendix R:
Appendix S:

VIII. BIBLIOGRAPHY

Ardley, Neil. The Science Book of Magnets. Gulliver Books. San Diego, CA: Harcourt Brace and Company, 1991, ISBN 0-15-200581-1

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APPENDIX A

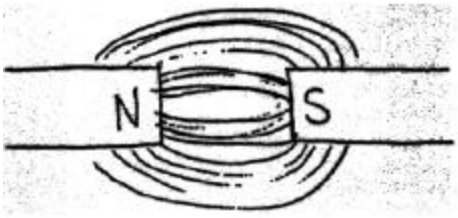
VOCABULARY	MEANING
lodestone	-n. a natural magnet
magnet	-n. something that attracts
magnetic	-adj. having the power to attract

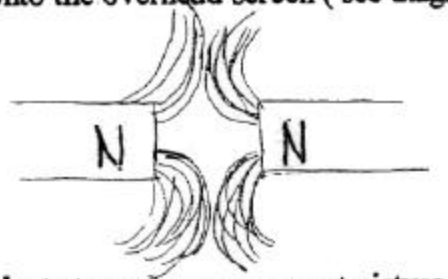
APPENDIX B

VOCABULARY	MEANING
lodestone	
magnet	
magnetic	

APPENDIX C

1. Prepare overhead transparency to demonstrate magnetic lines of force.
   a. Tape standard blank acetate transparency to overhead slide frame.
   b. Tape empty slide frames together in a single stack.
   c. Place stack on overhead projector.
   d. Put magnets on the overhead projector inside the stack.
   e. Place transparency on top of stack above magnets.
   f. Gently tap iron filings onto transparency; they will line up on the magnet lines of force projecting a beautiful picture onto the overhead screen (see diagram)





2. Prepare wax paper slides permitting students to make a permanent picture of magnetic lines of force.
   a. Tape wax paper to overhead transparency slide frame; student will need two of these.
   b. Put six one inch blocks on each child's desk to support slide frames (one for each corner, one about half way down the long edge of each slide) Arrange magnets inside the blocks; place slide frame on top of blocks.
   c. Gently tap iron filings onto waxy side of wax paper; they arrange themselves along the lines of force.
   d. Carefully move each slide to ironing board without disturbing picture.
   e. Place second wax paper frame on top of iron filing picture, waxy side down. Iron with cool iron until wax paper sheets stick together. Remove cooled picture from slide frames. You may have students mount on another sheet of construction paper if you wish.

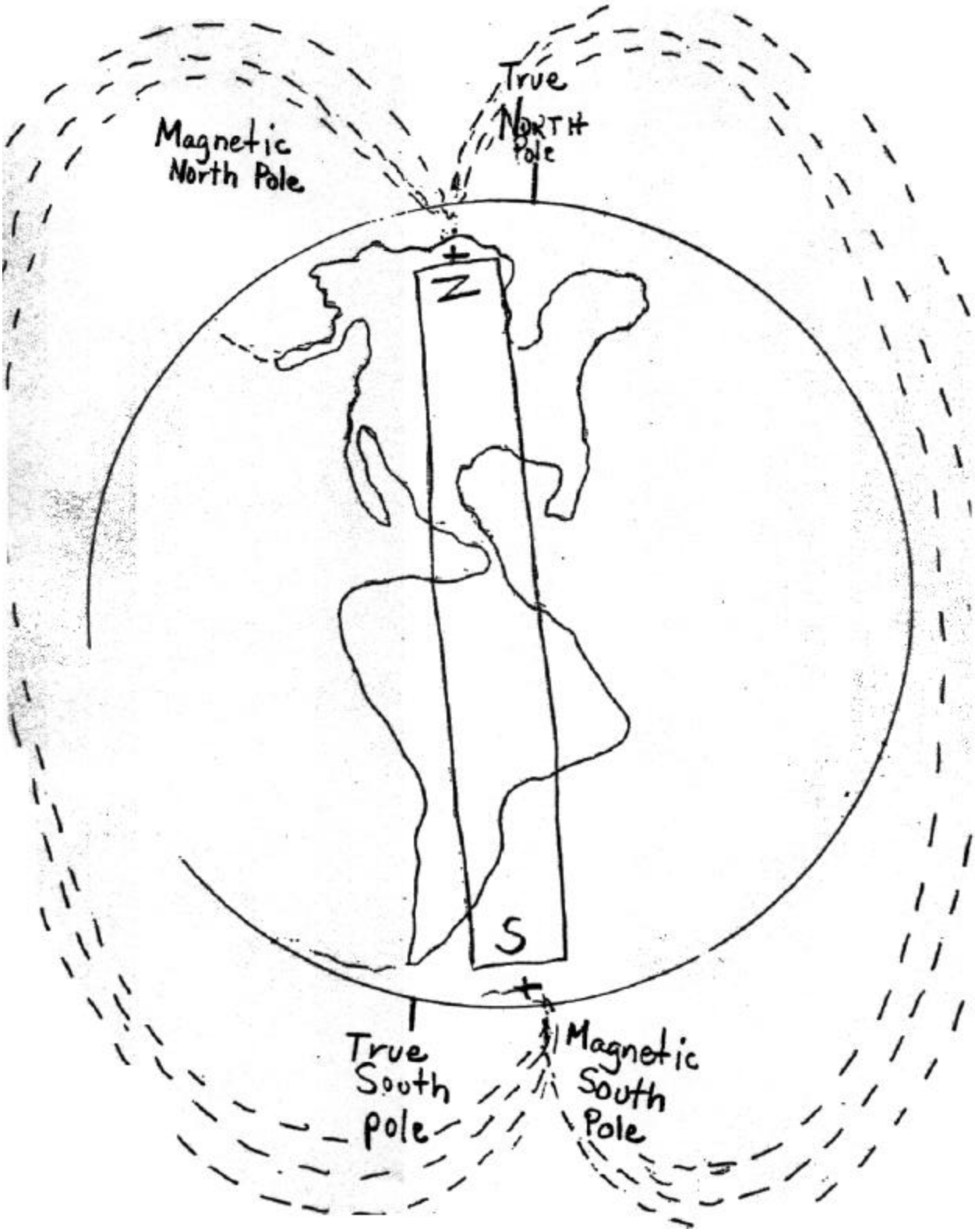
APPENDIX D

VOCABULARY	MEANING
molecule	-n. the smallest part of something
magnetic field	-n. the space around a magnet
poles	-n. the ends of a magnet
concentrate	-v. to draw toward the center

APPENDIX E

VOCABULARY	MEANING
molecule	
magnetic field	
poles	
concentrate	

APPENDIX F


Magnetic
North Pole
True
North
Pole
+
Z
S
+
True
South
Pole
Magnetic
South
Pole

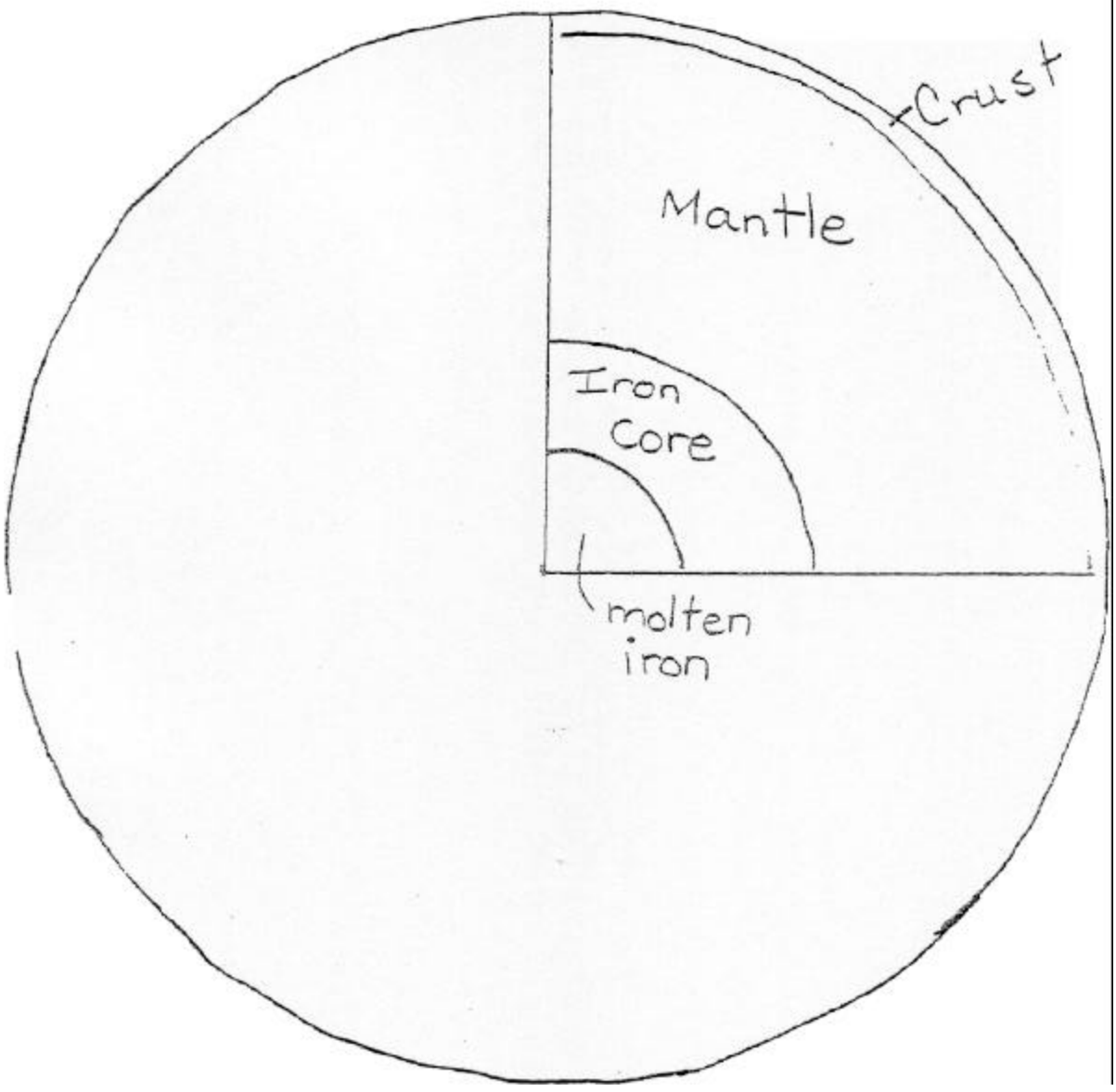
APPENDIX G

VOCABULARY	MEANING
core	-n. the center
electromagnet	-n. a magnet formed by an electric current
electricity	-n. a source of power

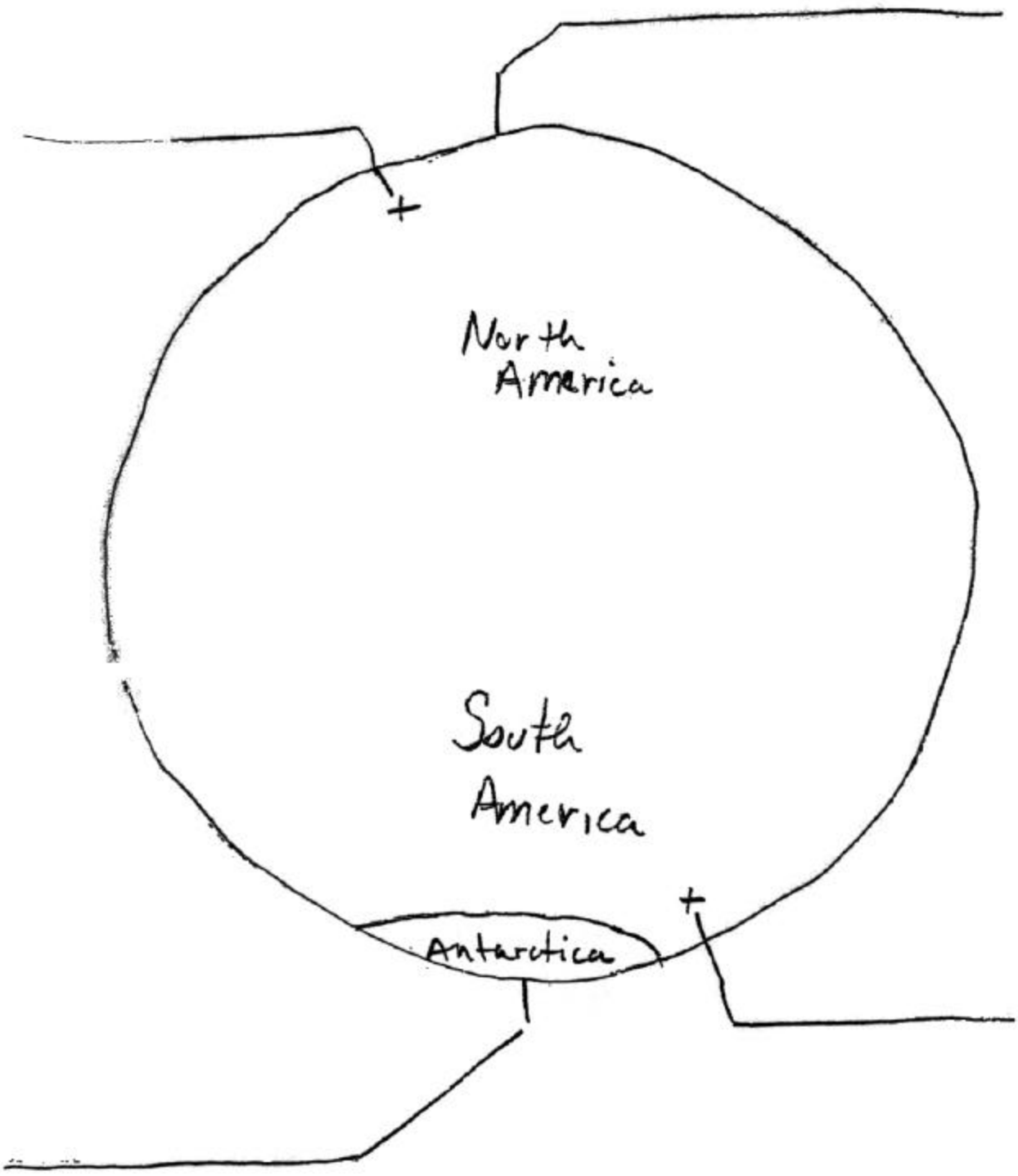
APPENDIX H

VOCABULARY	MEANING
core	
electromagnet	
electricity	

APPENDIX I



APPENDIX J



APPENDIX K

VOCABULARY	MEANING
	-n. a device used to determine direction
earth's magnetic poles	-n. either of two small places close to the north or south poles
	-v. using a compass to get from one place to another

APPENDIX M

MAKING A COMPASS

1. Materials required:
   a. small bowl (plastic or paper is best)
   b. small flat circular piece of cork
   c. unmagnetized needle
   d. magnet
   e. pitcher of water (enough to fill each bowl with about 1 inch of water)
   f. piece of white construction paper
2. Divide the students into working groups (at least 2 no more than 4)
3. Have each group magnetize their needle by rubbing it several times, in the same direction, with the magnet. Test needle by making sure it can attract a small magnetic object such as a tack or paper clip.
4. Fill each bowl with about one inch of water and place bowl in center of white construction paper.
5. Place piece of cork in the bowl.
6. Put the needle on the piece of cork.
7. Have each group observe how the needle aligns itself in the bowl of water (it should wind up pointing north)
8. Have students construct a compass rose on the white paper. Start by labeling the direction that the needle is pointing as north, then add south, east and west.

APPENDIX N

COMPASS REPORTING CHART

LOCATION	DIRECTION

APPENDIX O

STUDENT WORKSHEET

Type of Object	Attracted to Magnet	Not Attracted to Magnet

APPENDIX P

VOCABULARY	MEANING
hypothesis	-n. an idea based on observed information
predict	-v. to state beforehand
conclude	-v. to reach a decision
interpret	-v. to offer an explanation

APPENDIX Q

VOCABULARY	MEANING
hypothesis	
predict	
conclude	
interpret	

APPENDIX R

DATA WORKSHEET

Type of Object	Attracted to Magnet	Not Attracted to Magnet

APPENDIX S

SCIENCE FAIR RUBRIC

GROUP NAME_____

PROJECT TITLE_____

Project Write-Up					
Title is appropriate	5	4	3	2	1
Purpose asks a clear and complete question	5	4	3	2	1
Hypothesis is written in complete sentence	5	4	3	2	1
Hypothesis answers question asked in purpose	5	4	3	2	1
List of materials is provided	5	4	3	2	1
Procedure tells how investigation was done	5	4	3	2	1
Data tables are used and labeled	5	4	3	2	1
Conclusions summarize experiment findings	5	4	3	2	1
Conclusion goes with data and results	5	4	3	2	1
Correct use of spelling and grammar	5	4	3	2	1
Display					
Display is visually attractive	5	4	3	2	1
Display is organized	5	4	3	2	1
Display is self explanatory	5	4	3	2	1
Display contains all required sections (title, purpose, hypothesis, materials, procedure, data, results, conclusion)	5	4	3	2	1
Science Log					
Data sheet is complete	5	4	3	2	1
Interview With Student					
Student is confident about work completed	5	4	3	2	1
Student demonstrates knowledge of project	5	4	3	2	1
Student is able to answer questions accurately	5	4	3	2	1
Student is able to express some things learned	5	4	3	2	1
Student is enthusiastic about project	5	4	3	2	1

Total Score:_____**/100**