

MiniLab: Investigating Electrical and Magnetic Fields

Purpose: To investigate electrical, magnetic and gravitational fields.

Background Information:

ELECTRIC FIELDS are part of our everyday life. Lightning is due to the electrical discharge of a charge built up in the clouds. Static electricity is due to electrical fields. Plastic (including a balloon) becomes negatively charged when rubbed with wool. Glass becomes positively charged when rubbed with silk or polyester. An instrument called a Van de Graaff generator can create large static charges. Charged objects are the source of electrical fields. The direction of the electric field is towards the negative charge or away from the positive charge. The strength of an electrical charges decreases with distance, and can be measured by the formula $E = kq/r^2$. ($k=9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$). **Conductors** allow charges to move, while **insulators** do not let charges move easily.

MAGNETIC FIELDS are lines of force that flow from the North Pole of a magnet towards the South Pole of the same or another magnet. The source of magnetic fields is certain metals (iron, nickel, cobalt and neodymium) which have electrons which all spin in the same direction creating an overall magnetic force. Groups of atoms in a magnet are called domains, which line up causing a magnet to have a north and South Pole. The use of magnets is evident in a lot of technology we use. Motors, generators, telephones, speakers and tape recorders all use magnets.

GRAVITATION FIELDS are lines of force that flow towards the centre of a mass. Rockets and satellites have to overcome these gravitation fields.

In this investigation, the interactions between electrical charges, magnetic poles and gravitational masses will be investigated.

Materials:

- * Plastic (acetate) strip or rod
- * piece of wool
- * 2 stands with ring clamps
- * 3 balloons
- * Salt & pepper in a petri dish
- * glass rods
- * piece of silk
- * 2 pith balls on 40 cm strings
- * Van de Graaff Generator/Tesla Coil (optional)
- * Buret with water

Procedure:

STATION 1: Electrical charges .

1. DEMO: Have a student with long fine hair standing on foam (insulator) and place their hands onto a Van de Graaff generator. Turn on the generator for 2 or 3 minutes. Have the student run one hand through their hair. ***Draw the field lines between the strands of hair on the drawing on the next page. Make sure to include the arrows to indicate direction***
2. Blow up both balloons (15 cm) and tie. Rub BOTH balloons on your head. Hold the balloons a few centimeters from your head. Assume that the hair is negative and the balloons are positive. ***Draw the field lines between the strands of hair and the balloon on the drawing on the next page. Make sure to include the arrows to indicate direction***
3. Put some salt and pepper into a Petri dish and cover. Shake the dish to mix the substances. Rub the cover of the dish with the wool cloth. ***Draw the field lines between the salt particles and the Petri dish on the drawing on the next page. Make sure to include the arrows to indicate direction***
4. Turn the tap on so that a narrow stream of water is flowing. Rub a balloon with fur and place the balloon next to the stream of water. ***Draw the field lines between the stream of water and the balloon on the drawing on the next page. Make sure to include the arrows to indicate direction***

STATION 2: Magnetic fields around one magnet

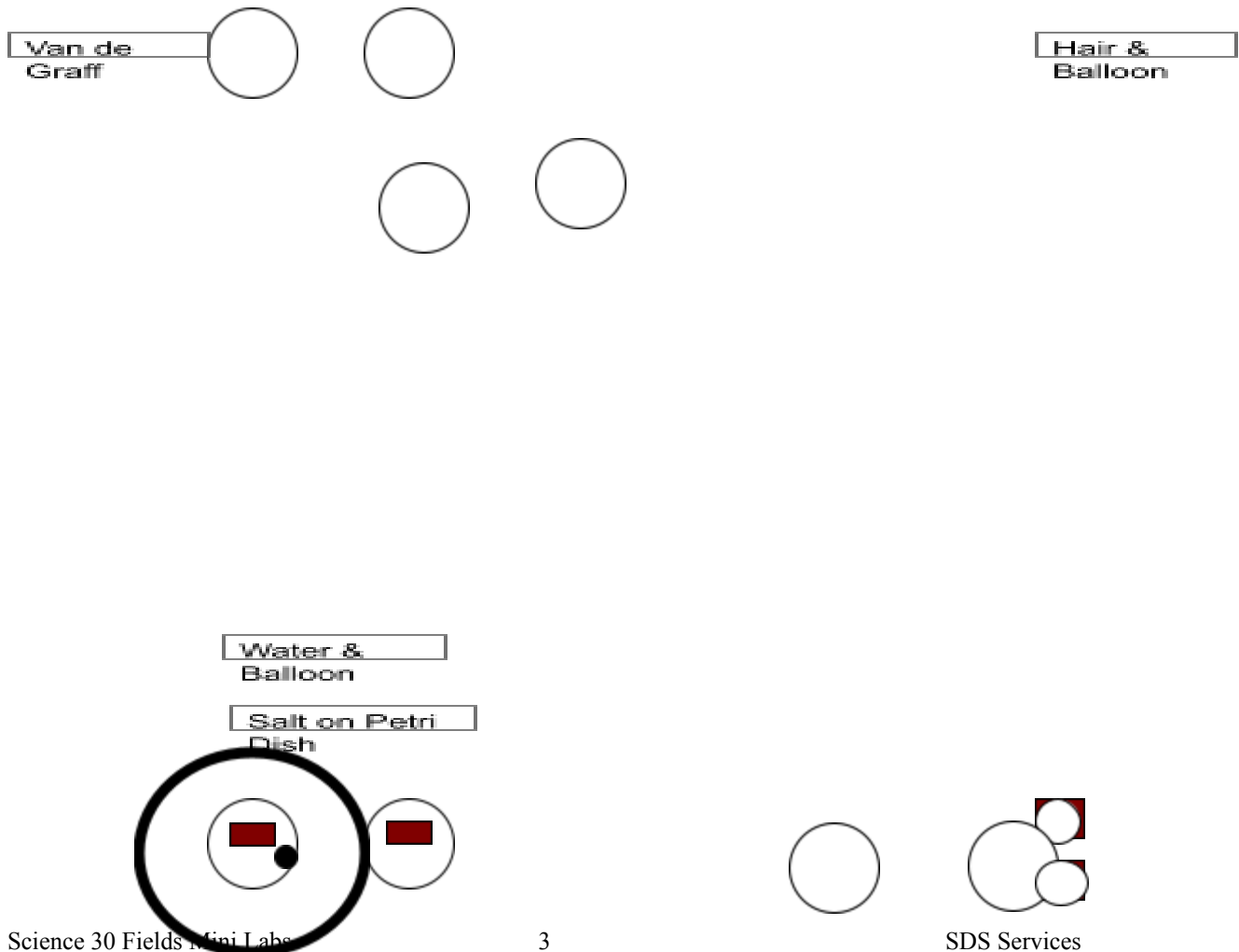
1. Place one of the magnets on the lab bench and cover it with a sheet a paper. Slowly and gently sprinkle iron fillings over the paper until a pattern forms. The pattern represents the magnetic field. ***Draw the pattern observed around the magnet on the next page – make sure to include the arrow heads to indicate direction***
2. Place two magnets on the lab bench so that the two poles repel each other. (A south pole facing a South Pole or a North Pole facing a North Pole). Cover the magnets with a sheet of paper. Slowly and gently sprinkle iron fillings over the paper. ***Draw the pattern observed around the magnet on the next page – make sure to include the arrow heads to indicate direction***
3. Place two magnets on the lab bench so that the two poles attract each other. (A South Pole facing a north pole). Cover the magnets with a sheet of paper. Slowly and gently sprinkle iron fillings over the paper. ***Draw the pattern observed around the magnet on the next page – make sure to include the arrow heads to indicate direction***

STATION 3: Gravitational Fields

1. Weight yourself on the bathroom scale in kilograms (kg). ***Draw the field lines on the picture of Earth on the next page to illustrate the gravitational field of Earth.***

Observations & Data: (8 marks)

STATION 1: Electric Fields



STATION 2: Magnetic Fields

STATION 3: Gravitational Fields (NOT MAGNETIC)



Analysis & Interpretation:

1. Based on your observations, which of the following will attract and which will repel? Fill in the chart below with the appropriate symbols. (4 marks)

- “positive charge and positive charge(+&+)”*
- “positive charge and negative charge(+&-)”*
- “north pole and north pole (N & N)”*
- “north pole and south pole (N & S)”*
- “negative charge and negative charge(-&-)”*
- “negative charge and positive charge(-&+)”*
- “south pole and south pole (S & S)”*
- “south pole and iron fillings (S & I)”*

Attract	
Repel	

2. Fill in the blanks with “attract” or “repel”. (2 marks)
- a. Opposite charges _____ each other, similar charges _____ each other.
 - b. Opposite magnetic poles _____ while similar magnetic poles _____ each other.
3. Calculate the Electrical field strength produced by one negative balloon in STATION 1 if the balloon has a charge of 1.50×10^{-6} C and an object is 2.00 **cm** away. Show your work (2 marks)

4. Calculate the gravitational field strength that you exert on objects 2.00 m away. Show your work (2 marks)

Conclusion: In the table below summarize what you learned about magnetic, electrical and gravitation fields. Include the source, direction and strength formula (except magnetic) as well as whether they are attractive, repulsive or both. HINT: Organize it in a table. (6 marks)

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