Tangent Galvanometer

PSSC

EM3980-001

Description:

This robust IEC design of TANGENT GALVANOMETER is manufactured from non-magnetic materials. When assembled it permits experiments relating to electric currents in a coil producing magnetic fields. Using the earth's magnetic field as one of the fields, this instrument proves that magnetic fields add as vectors and strength of a field in a coil is proportional to both the current flowing through the coil and the number of turns in the coil. This is often called "Ampere Turns".

Kit Contents:

- 1 pce flat aluminium plate & 2 pcs legs to support the flat plate.
- 4 pcs large aluminium pegs and 1x large strong elastic band.
- 1 roll small insulated wire for winding a coil around the pegs.
- 1 pce magnetic compass.

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Length: 320mm	Width: 420mm	Height: 50mm	Weight: 800g

Assembly Instructions:

1. Unpack components and slip the edges of the large square plate into the slots in the legs and position them to be about half way across the width of the plate.

2. Take the large rubber band and, placing it over the feet of each leg, stretch it tightly around the legs so it is pulling them firmly together. Slide the band upwards until it is directly against the underside of the aluminium plate.

3. Place the assembly on the workbench so that the plate is horizontal. The rubber band pulling the two legs firmly to the edge of the plate should hold the system together firmly.

4. Fully insert the 4x pegs into the 2x holes in the sides of each leg so that they all protrude from the sides of the legs in the same direction.

5. Take the wire and wrap it around the four protruding pegs to form a large coil in the vertical plane completely surrounding the large plate such that the centre of the plate is approximately at the centre of the coil. The wire can be twisted around the pin to stop it from unwinding. Do not cut the wire.

6. Now, either use graph paper or use plain paper and draw 2 main axes at 90^{o}. Take a 30cm long ruler and place it on the aluminium plate with the edge resting against the sides of the two vertical legs on the side that is directly below the coils of wire wound on the pins. Take the paper, slide it under the ruler and align the ruler edge with one of the main axes, then tape the paper to the plate.

7. Place the magnetic compass over the intersection of the 2 axes on the graph paper to be ready to plot the angular deflection of the compass pointer as a DC current is passed through the coil and ALSO as the number of turns in the coil is altered.

Caution:

When controlling the current through the coil, do not overheat the coil. The resistance of the coil is very small, therefore only a very low voltage is required to cause say 1 amp to flow through the coil. Depending to the wire used for the coil, at 1 amp the coil might heat gently and at higher currents it will heat more quickly, Therefore, take care to turn off the current if heating occurs to prevent damage to the coil.

Experiments:

Two experiments can be performed:

1) To prove that magnetic fields add as vectors

2) To prove that field strength varies proportionately as the number of turns in a coil and the current passing through the coil (Ampere Turns).

Equipment Required:

The best power supply for the best results in these experiments is a "Constant Current" power supply (IEC LB2619-001) where the current can be set anywhere between 0 and 2 amps and the setting does not alter when the coil changes its resistance due to warming.

However, if a Constant Current power source is not available, a normal adjustable DC power supply can be used together with a large (perhaps 5 ohm) sliding rheostat in series with a 0-5A DC ammeter to adjust and monitor the current through the coil. It will be necessary to adjust the rheostat as the coil warms to bring the current exactly back to the original value before making any measurements.

If the ASSEMBLY of the galvanometer has been performed, there will be sheet taped to the plate with one main axis parallel to and directly below the coils of wire. The magnetic compass should be positioned at the intersection of the axes.

1) To Prove That Magnetic Fields Add as Vectors:

Place the magnetic compass on the intersection of the axes on the sheet of paper and allow the needle to point N/S with the earth's magnetic field.

Position the Tangent Galvanometer so that the compass needle while pointing North / South is exactly aligned with the axis line that is 90 degrees from the axis line that runs between the vertical legs. This means that the axis through the centre of the coil is now aligned exactly with the line of the earth's magnetic field.

Any magnetic field along this axis of the coil will either add to or subtract from the earth's magnetic field. Use the "right hand rule" to determine which direction the current should flow in the coil to CANCEL the earth's magnetic field. Before doing it, decide which direction North should be and which end of the magnetic needle is North and South. Discuss how to detect if the fields will be adding or subtracting.

Start with 5 turns on the coil and zero amps or volts on the power source. Adjust the voltage and rheostat to increase the current until the compass can no longer find North. At this current your magnetic field from the coil has completely cancelled the earth's magnetic field, therefore it is equal strength. To disturb the compass off the north/south line, use a very weak magnet**. Take note of the number of turns and the exact current used to cancel the earth's magnetic field.**

NOW, turn off the current and rotate the whole instrument around until the axis line directly under the coil turns aligns with the N/S line of the compass. This means that the fields from the earth and the coil will be at 90^o to one another. Now set the coil current to be exactly the same as before so that the 2 fields are exactly the same. **Mark the deflection angle of the compass needle on the sheet.**

NOW reduce the current through the coil to exactly half. **Mark the deflection angle of the compass needle.** Then return the current to the original value.

NOW use double the number of turns and adjust the current to be the same as the original value**. Mark the deflection angle of the compass needle.**

The next step is to discover if the angles you have measured indicate that the addition of magnetic fields add as vectors …. So, draw some vector diagrams:

Draw a rectangle representing value 1 and value 0.5 on adjacent sides. Draw the diagonal and measure the angle from the side representing value 1 (earth's magnetic field).

Repeat drawing rectangles using values 1 and 1, then values 1 and 2. Always measure the angle from the side that represents the earth's magnetic field.

Compare the angles on the vector diagrams with the angles measured in the experiment. Does your result make you decide if the field strengths add together as vectors ?

2) To Prove Magnetic Field Strength is Proportional to Both Current Through a Coil and the Number of Turns of the Coil:

Set up the experiment as above so the earth's magnetic field adds to your coil's field at 90^o. Adjust the currents using a constant number of turns, then adjust the number of turns while using the same current each time. Work out the Ampere Turns each time and note the compass deflection each time.

From your results, decide if the theory is correct.

Why is it called a "Tangent Galvanometer":

1) Because the **Tangent** of the angle deflected by the compass needle away from the N/S line is the ratio between the strengths of the 2 magnetic fields.

2) It is called a **Galvanometer**, because in certain circumstances it can be used to accurately measure currents from known field strengths.

Designed and Manufactured in Australia