Tangent Galvanometer

As you work through the steps in the lab procedure, record your experimental values and the results on this worksheet. Use the exact values you record for your data to make later calculations.

Tangent Galvanometer Lab – Simulation and Tools

Open the Tangent Galvanometer simulation to do this lab. You will need to use the VPL Grapher to complete this lab.

I. Addition of Magnetic Fields at the Center of a Current Loop

2. So how do you find the direction of Earth's field?

   (a) A compass will always point in the direction of Earth's magnetic field.

   - True
   - False

   (b) A compass will always point in the direction of the net magnetic field.

   - True
   - False

4. North is now to the left of your screen. What direction is east on your screen?

9. In what direction, relative to the $\mathbf{B}_{\text{loop}}$ and $\mathbf{B}_{\text{Earth(h)}}$ vectors, does the compass needle point when current is flowing, and why does this make sense for this situation?

11. Record what you've observed in Figure (9a) by drawing a vector diagram. Take a **Screenshot** and upload it as "TG_I_Fig1". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

12. Repeat for Figure (9b). Take a **Screenshot** [icon] and upload it as "TG_I_Fig2". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

13. Which B_net is greater, (9a) or (9b), and why?

16. Record what you've observed in Figure (10a) by creating a labeled vector diagram. Take a **Screenshot** [icon] and upload it as "TG_I_Fig3". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

17. Repeat for Figure (10b). Take a **Screenshot** [icon] and upload it as "TG_I_Fig4". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

18. What's the evidence and how does it prove that $\mathbf{B}_\text{loop}$ is normal to the loop?

19. We now know that $\mathbf{B}_\text{loop}$ is normal to the loop, but that allows for two possible directions. Which one is it? There are several drawings that you've produced that could be used to answer this question. Pick one and explain how it provides the answer.

20. One final question: What about the direction of the current in the loop? With the initial "handle down" setting, is the current flowing into the screen at 180° (the south end) or 0° (the north end)? Explain using the right-hand rule for the field at the center of a current loop.

II. Confirm That the Magnetic Field at the Center of a Circular Loop Is Directly Proportional to the Number of Loops, N, and the Current, I

2. Record your results in Table 1 and calculate $\tan(\theta)$ for each value of θ.

Table 1: θ and $\tan(\theta)$ vs. N (I = 3 A)

Trial	N (turns)	θ (°)	$\tan(\theta)$
1	0	0	0
2	1		
3	2		
4	3		
5	4		
6	5		

3. Test your results by entering your data in Grapher and using it to plot a graph of $\tan(\theta)$ vs. N. Take a **Screenshot** 📷 of your graph and upload it as "TG_tanTheta_N". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

5. Does your graph indicate that $\tan(\theta)$ is directly proportion to N? How? (**Two criteria are required to indicate a direct proportion. See the introductory materials if you need a review.**)

7. Record your results in Table 2 and calculate $\tan(\theta)$ for each value of θ.

Table 2: θ and $\tan(\theta)$ vs. I (N = 5)

Trial	I (A)	θ (°)	$\tan(\theta)$
1	0	0	0
2	0.5		
3	1.0		
4	1.5		
5	2.0		
6	2.5		
7	3.0		
8	3.5		

8. Test your results by plotting a graph of $\tan(\theta)$ vs. I in Grapher. Take a **Screenshot** 📷 of your graph and upload it as "TG_tanTheta_I". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

10. Does your graph indicate that $\tan(\theta)$ is directly proportional to I? How? (**Two criteria are required.**)

III. Experimentally Determine the Horizontal Component of Earth's Magnetic Field at the Location of Your Virtual Apparatus

1. Record I and $\tan(\theta)$ for your chosen point.

$$r = 0.20 \text{ m}$$
$$N = 5$$

Determine the loop's magnetic field, B_{loop}, using equation 1 $\left(B_{\text{loop}} = \dfrac{\mu_0 N I}{2r} \right)$.

Show your calculations.

2. Using equation 3 $\left(\tan(\theta) = \dfrac{B_{\text{loop}}}{B_{\text{Earth(h)}}}\right)$ and the value of $\tan(\theta)$ from your chosen point on your graph, calculate the experimental horizontal component of Earth's magnetic field, $B_{\text{Earth(h)}}$.

Show your calculations.

3. Record the values you find for the latitude and longitude of Hamilton, Bermuda, in either degrees, minutes, and seconds format **or** decimal degrees format in Table 3. (If you enter the degrees, minutes, and seconds format, be sure to enter integers in each answer box. If you enter the decimal degrees format, enter 0 in the minutes and seconds answer boxes. Do not mix the two formats for a given coordinate.)

Table 3

	Degrees (°)	Minutes (′)	Seconds (″)	
Latitude				north (of the equator)
Longitude				west (of Greenwich)

5. Record the "Total Field" B_{Earth}, for Hamilton. Note the nT units. You'll need to convert that to Teslas in standard format scientific notation. ($\#.\#\#\#\# \times 10^{-5}$ T).

6. Record the inclination (dip angle). (If you enter the degrees, minutes, and seconds format, be sure to enter integers in each answer box. If you enter the decimal degrees format, enter 0 in the minutes and seconds answer boxes. Do not mix the two formats.)

Table 4

	Degrees (°)	Minutes (′)	Seconds (″)
Inclination			

Use https://www.fcc.gov/media/radio/dms-decimal.html to convert to decimal degrees. (If you entered decimal degrees above, enter the same number below.)

7. From the current actual total field, B_{Earth} and dip angle, you can determine the current actual value of $B_{\text{Earth(h)}}$. You can figure this one out on your own using Figure 15.

Show your calculations.

8. Calculate and record the percent error between your actual and experimental values for $B_{\text{Earth(h)}}$.