

Course and Section _____

Names _____

Date _____

MAGNETISM SIMULATION

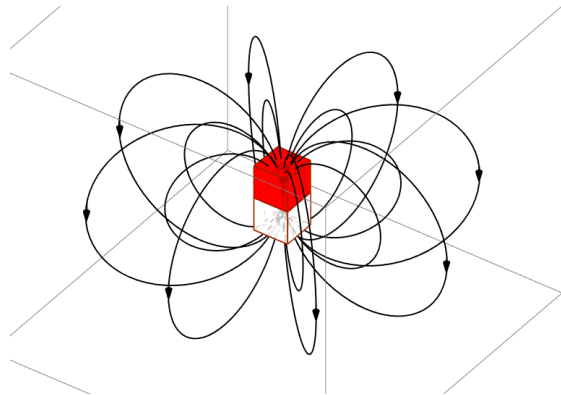
Introduction

In this simulation you explore magnetic fields and their effect, through the Lorentz force law, on charged particles.

Submit your answers using Blackboard.

1 – The Magnet

Open the simulation (<https://www.geogebra.org/m/g9DXB8AD>)



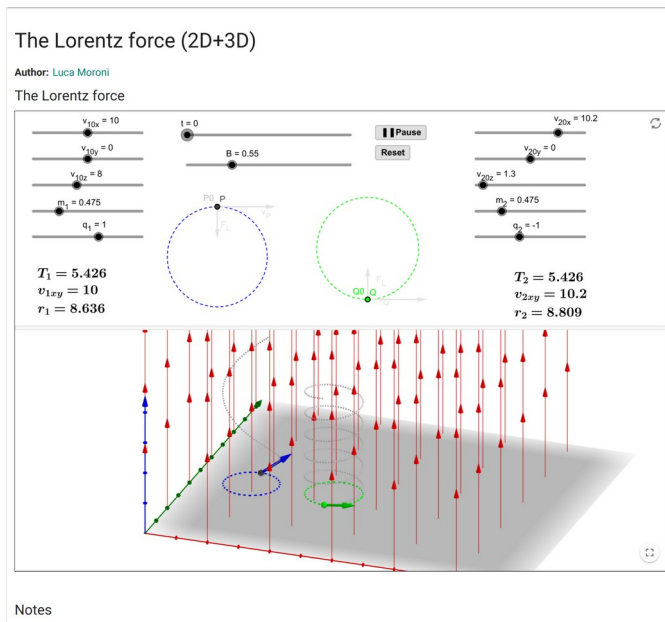
A rectangular magnet is displayed

1. Which pole does the white end of the magnet represent?
2. What do the black lines with an arrow drawn on them represent?
3. Do any of the lines in question 2 leave the magnet and go to infinity?
4. In which location is the magnetic field strongest?

2 – The Lorentz Force in 3D

Open the simulation (<https://www.geogebra.org/m/xpRMzPgc>).

The simulation displays the motion of charged particles in a magnetic field.



The applet displays the motion of both in a magnetic field (red lines). In the upper part of the screen the motion is shown in 2D and in the lower part of the screen the full 3D motion of a charged particle in the magnetic field is shown.

Set the y and the z components the velocity to zero.

5. Which of the two particles is positive?
6. Which of the two particles is negative?

Press play and watch the motion in 2D.

7. What direction does the positive particle rotate?
8. What direction does the negative particle rotate?

Set the z components the velocity to 1m/s

9. What shape do the particles trace out as they move in 3D?

The circles that the particles trace out in the plane have a radius given by

$$r = \frac{mv}{qB}$$

and the period of motion is given by

$$T = 2\pi \frac{m}{qB}$$

If you decrease the mass of the particle,

10. How does the radius of the circle change?
11. How does the period of the motion change?

If you decrease the magnetic field,

12. How does the radius of the circle change?
13. How does the period of the motion change?

If you increase the charge of the particle,

14. How does the radius of the circle change?
15. How does the period of the motion change?

If you decrease the x components of the velocity

16. How does the radius of the circle change?
17. How does the period of the motion change?

3 – Magnitude of the Lorentz Force

The magnitude of the Lorentz force is given as,

$$F = qvB\sin(\theta)$$

Suppose that a physicist sets up a region of uniform magnetic field. A sphere of an unknown charge is going to be shoot into the region perpendicular to the direction of the uniform magnetic field with a velocity of $v = 100$ m/s. The physicist then measures the force on the charged sphere. The following table contains the data of the measurements

F (mN)	0.246	0.496	0.745	0.985	1.246	1.484	1.765	2.007	2.215	2.461
B (T)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

Plot F vs B .

18. What is the slope of the line? (Cm/s)
19. What is unknown charge on the sphere? (μC)

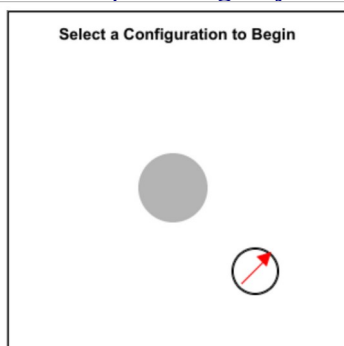
As we saw above when charged particles move through regions of magnetic fields they make circles in the plane.

Consider the charged sphere used by the physicist in the previous problem when $B=0.5\text{T}$ (the velocity is still $v = 100$ m/s), if the mass of the sphere is $m=5 \times 10^{-8}\text{kg}$:

20. What is the radius of the circle traced out by the charged sphere? (m)
21. What is the period of the motion? (s)
22. What is the angular frequency $\omega = 2\pi/T$? (rad/s)

4 – Map the Field Lines

Open the simulation (https://www.compadre.org/Physlets/electromagnetism/ex27_1.cfm)



Underneath the gray circle is a source for a magnetic field. Use the compass to explore the directions of the magnetic field around the object. If you click and hold the simulation will show coordinates in the bottom left of the window.

Select Configuration 1. In which direction is the compass pointing...

23. In the region on the left of the source?
24. In the region beneath the source?
25. In the region on the right of the source?
26. In the region above the source?
27. What is the source of the magnetic field?

Select Configuration 2. In which direction is the compass pointing...

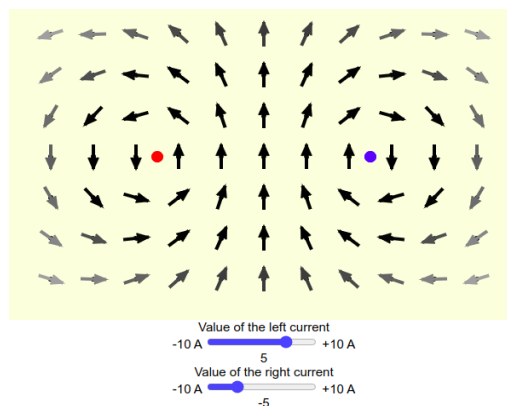
28. In the region beneath the source ($x=0, y=-1$)?
29. In the region to the right of the source ($x=1, y=0$)?
30. In the region to the left of the source ($x=-1, y=0$)?
31. In the region above the source ($x=0, y=1$)?

If you double click on any point the simulation displays the magnetic field lines. Draw as many lines as needed in order to answer the following question.

32. What is the source of the magnetic field?

5 – Two Wire Carrying Currents

Open the simulation (<http://physics.bu.edu/~duffy/HTML5/BField.html>)



You can change the value of the currents using the two bars located at the bottom.

Set the current on the left to -5 A, current on the right to zero

33. In which direction is the current?

Set the current on the left to +5 A, current on the right to zero

34. In which direction is the current?

Set the both current to the same value

35. Is there a point where the magnetic field is zero?

Set the current on the left to -10 A, current on the right to +10 A

36. In which direction is the magnetic field pointing in the center?

Set the current on the left to 10 A, current on the right to -10 A

37. In which direction is the magnetic field pointing in the center?