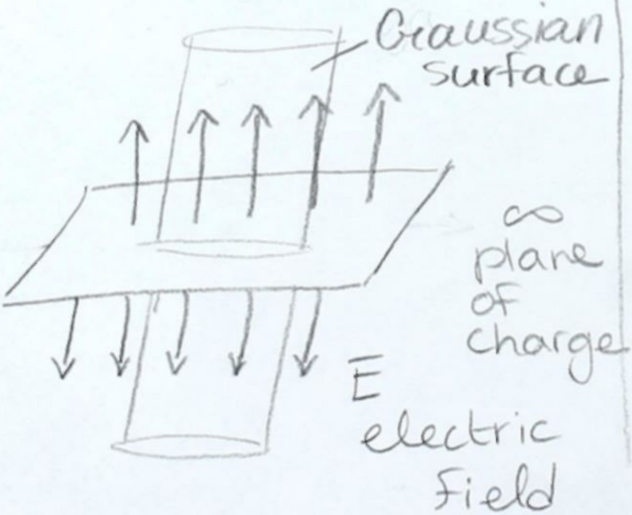
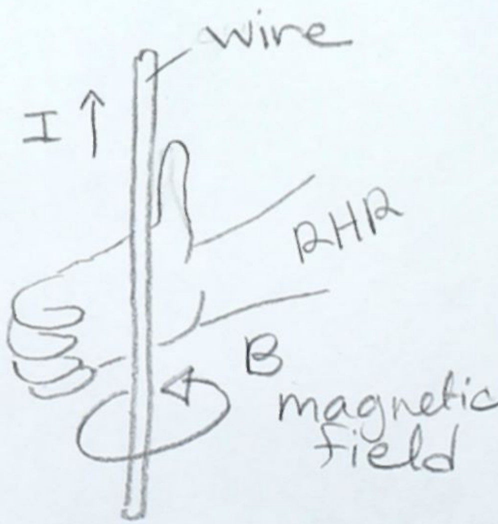
1.) Gausses law states that the net flux of an electric field in a closed surface is directly proportional to the enclosed electric charge.

2.) Relates the net magnetic field along a closed loop to the electric current passing through the loop.

3.) Gausses law. It relates the flux due to electric field to charge.

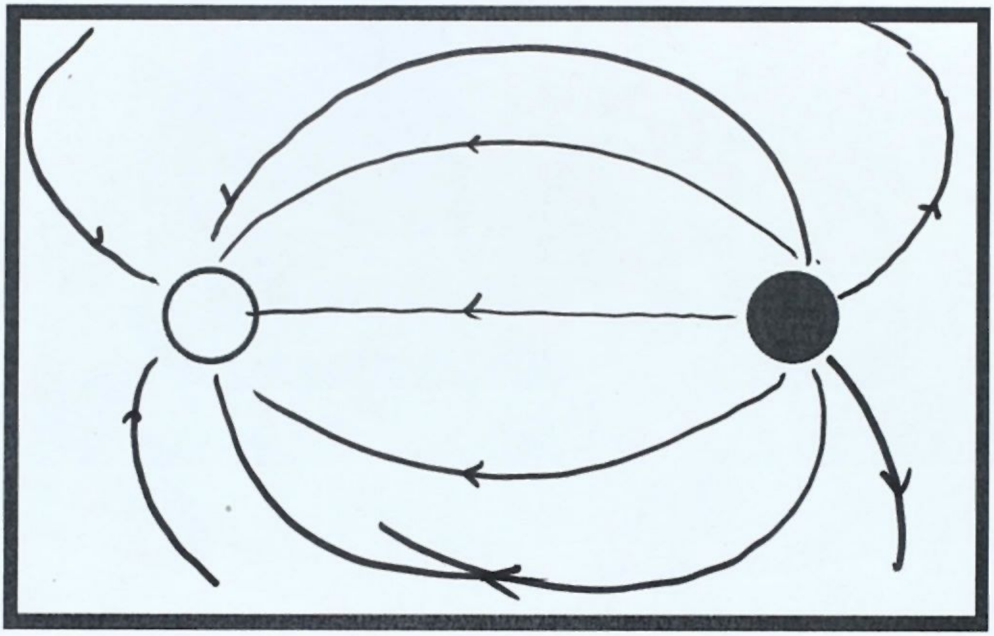
4.) Gausses law | Ampere's law





1. The rectangle below represents a basin, where there is a source of water at the solid circle and a sink (hole) where water can leave at the open circle.

   a. Please describe the motion of water in all directions as it leaves the source and heads towards the sink using field lines.



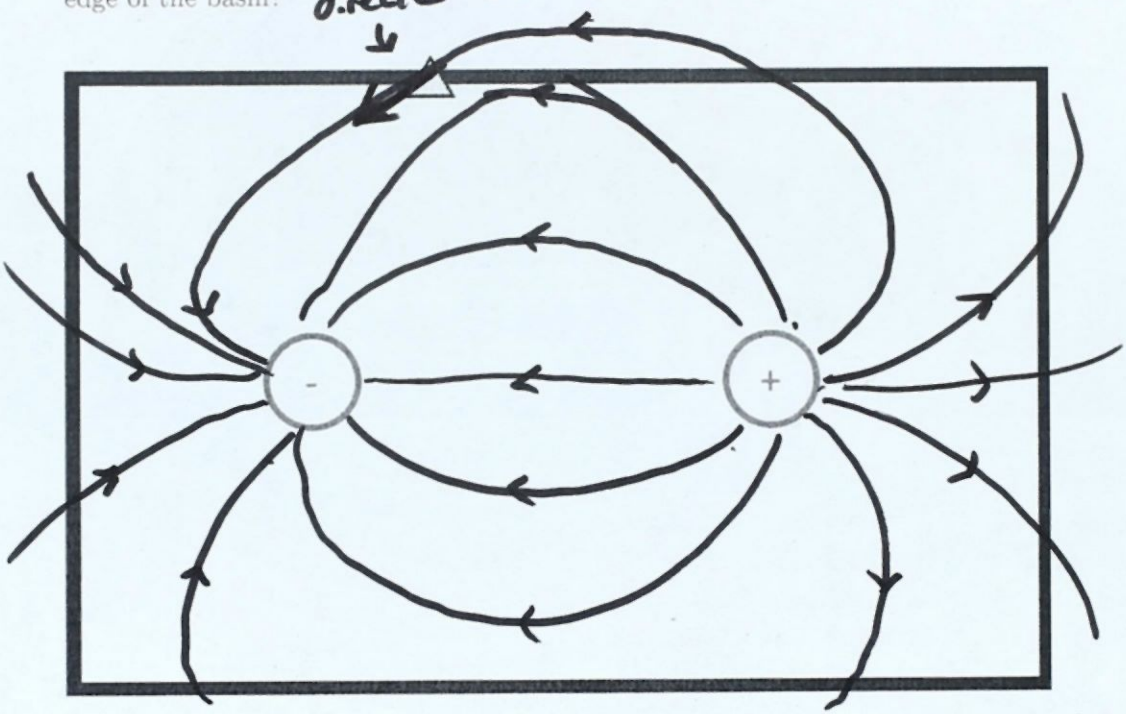
   b. If the sink and the source are equal (in other words, the sink soaks up a drop of water each time a drop leaves the source) then will the basin overflow with water after a long time? Explain yes or no.

The basin will not overflow, because the net increase in water is zero.

2. Next, let's extend the fluid analogy into the realm of Electromagnetism! Imagine now that instead of a sink and a source, we have a positive and a negative charged particle of equal magnitude that are sitting in the basin.

a. Please describe the motion of a test particle by drawing the electric field lines. What is the direction of the electric field at the location of the yellow triangle on the edge of the basin?

directed bottom-left!



b. Since the positive and negative charges are of equal magnitude (in other words, their **net** charge is zero) then what is the electric flux as measured using the basin as a two-dimensional "**Gaussian Surface**"?

$\Phi_E = \frac{Q_{enc}}{\varepsilon_0} = \boxed{0}$ ← Since $\Sigma Q = 0$.

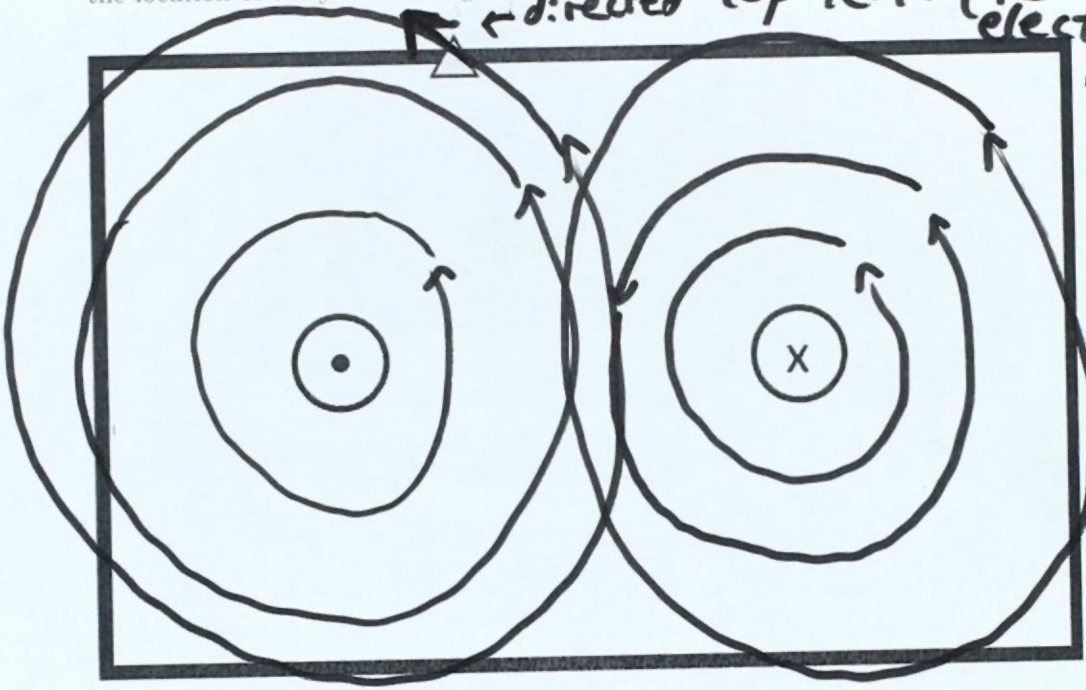
c. Analyze together your results from part (a) and part (b). How can both be true via Gauss's Law?

Because while E is non-zero everywhere on the surface, flux is $\oint \vec{E} \cdot d\vec{A}$, not just E. $Q_{enc} = 0$ tells us flux is zero.

3. How would this problem change if we were to look at two wires carrying current in opposite directions, as shown in the diagram below?

a. Please draw the magnetic field lines. What is the direction of the magnetic field at the location of the yellow triangle on the edge of the basin?

← directed top-left! (90° from the electric field in #2...)



b. Since the out-of-the-page and into-the-page wires carry an equal magnitude current (in other words, their **net** current is zero) then what is the magnetic flux as measured using the basin as an **Amperian Loop**?

Since $I_{enclosed} = 0$, $\Phi_B = 0$.

c. Analyze together your results from part (a) and part (b). How can both be true via Ampere's Law?

While $B \neq 0$ everywhere on the loop, this does not imply that $\oint \vec{B} \cdot d\vec{l} \neq 0$. In fact, from Ampère's Law,

$$\Phi_B = \int \vec{B} \cdot d\vec{l} = \mu_0 \overset{=0}{I_{enc}} = 0.$$