Lesson 11: Field Lines

An electric field is a vector, so we can represent it using vector diagrams.

- The electric field will show up as arrows drawn at various points around charged objects.
- These **electric field lines** (sometimes also called ***lines of force***) are drawn below for two simple examples.

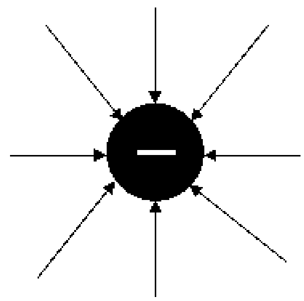

Illustration 1: Field lines around a negative source charge.

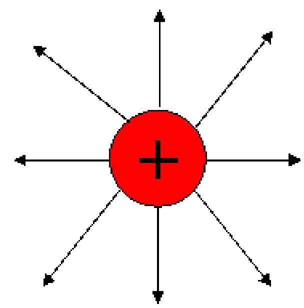

Illustration 2: Field lines around a positive source charge.

Notice that the lines are drawn to show the direction of the force, due to the electric field, as it would act on a **positive** test charge.

- Also, the closer you get to the charge, the closer the lines are to each other. This symbolizes how the electric field gets stronger as you go closer to the source.
- If you pick a spot further out, you'll see that the lines aren't as dense there… so the field is weaker.

If a positive and negative charge are close enough, their field lines can interact.

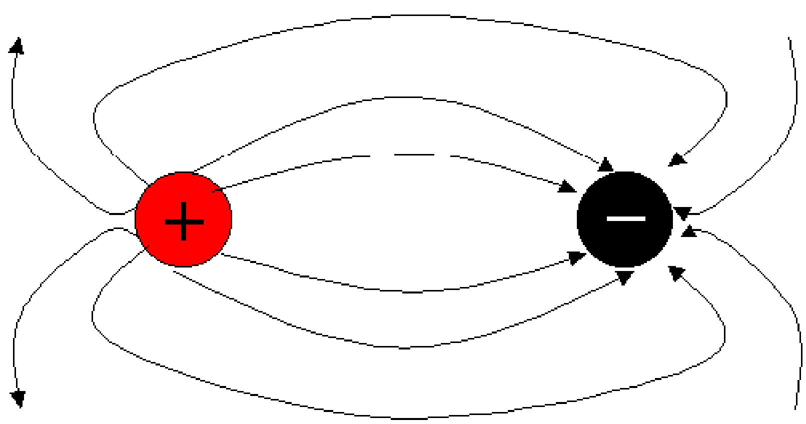

Illustration 3: Two opposite charges showing the interaction of their field lines.

- The arrows go from the positive charge to the negative charge (in exactly the same direction we would expect a positive test charge to move).
- The direction of the field at any point is the tangent drawn to the field line at that point.
- Faraday used this model to explain why these two opposite charges would attract each other.
  - Field lines try to be straight, not curved. If the two charges come closer together, it can be shown mathematically that the field lines overall become straighter on average.

If you have two charges with the same sign, you get a different looking diagram.

- We still follow the rule that the field lines show the direction a positive test charge would move.
- For this example we will assume that we are looking at the field created by two positive source charges near each other.
  - At first, the test charge overwhelmingly just wants to get away from the charge it's closest to.
  - By the time it gets a little distance away, the field of the other object starts to affect it as well, so it begins to curve away from there also.
- Faraday used this to explain why two like charges repel... again, the field lines are trying to straighten out.

Another important example of field lines comes from the need to sometimes have a constant, **uniform** electric field.

- As you can see in the previous examples, the fields have very different field strengths at different points… they're irregular.
  - That’s because they are made up of only two charges, so the field lines wrap around a lot.
- If we could get a whole bunch of charges lined up evenly then we could get a more uniform electric field.
  - It is possible to set this up using two plates that are parallel to each other with opposite charges built up on them, as shown in Illustration 4.
  - This is how physicists set up their lab equipment when a uniform field is needed.
- The field lines are very uniform all the way, except for a slight curvature near the ends.
  - We often ignore this slight curvature, since it is very small as long as the plates have a big surface area and are close together. We just make certain not to do any experiments near the ends.
  - The other thing we must be careful about when using parallel plates is that they can arc. Since we can have quite a bit of charge on these two plates, electrical sparks can jump between them, screwing up any experiment that we might be doing.

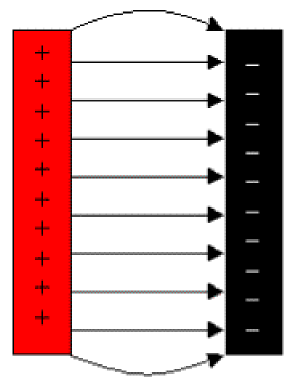

Illustration 4: Parallel Plates with a uniform electric field.

Homework

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