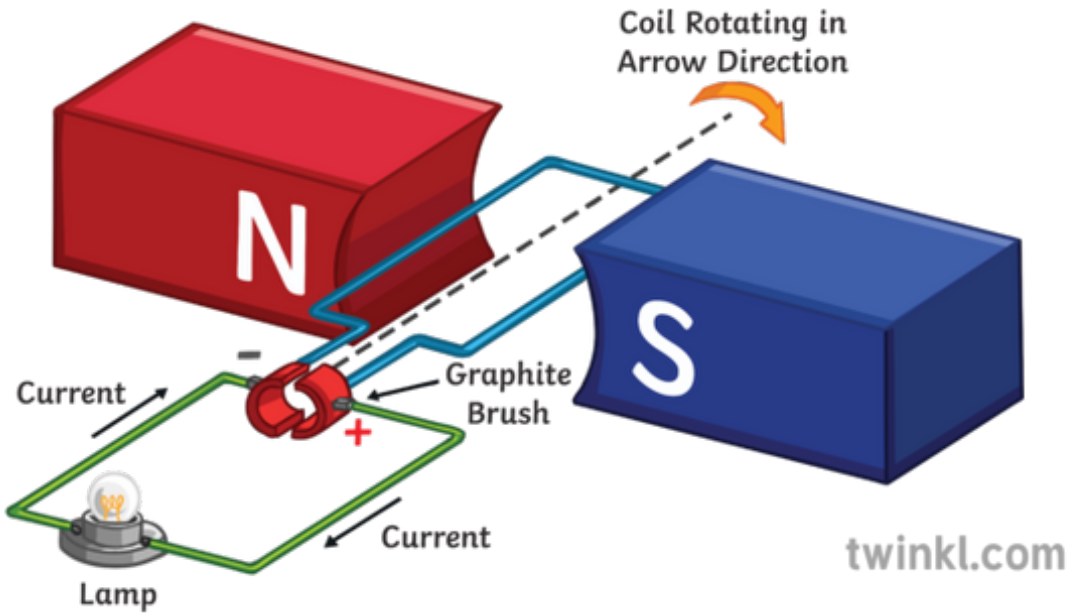
Induced EMF

Open this Desmos graph: https://www.desmos.com/calculator/iahpkurkzy

In this graph, treat the x-axis at time. This simulates the rotation of a dynamo/generator at a constant angular frequency, denoted here as w. The red graph shows the magnetic flux through the loop, and the green graph shows the EMF generated.



Change the magnetic field strength. How does this affect the two graphs? Why? We know that the magnetic flux is defined loosely as the "amount" of magnetic field going through an enclosed area. If we change the magnetic field strength, this changes the flux going through the loop. The points where the flux is zero are when the loop is perpendicular to the magnetic field, where no magnetic field component goes through the loop. When we change the magnetic field strength, this fact doesn't change, so the zeros stay zeros. Only the amplitude changes.

Change the area of the loop. How does this affect the graphs? Why? The same reason as why changing the magnetic field strength changes the graphs. If we increase the area of the loop, there's a greater magnetic flux through it.

Change the number of loops in the coil. How does this affect the graphs? Why does it only affect the EMF generated? The flux through the area is the same — there's still the same amount of magnetic field going through the same area. However, changing the loops increases the magnetic flux *linkage*, and the EMF generated is the rate of change of the magnetic flux linkage. We can think about like this: consider the EMF induced in one loop. Now add another loop to it — this has its own enclosed area and its own induced EMF. If we keep adding more loops, we eventually get a coil of loops with the number of loops directly proportional to the total induced EMF.

Change the angular frequency of the rotation. Why does this only affect the EMF generated again? Well, changing the parameters surrounding the rotation of the coil doesn't affect the area of the loop, nor does it affect the magnetic field strength. Hence, the magnetic flux stays the same. However, the induced EMF is the rate of change of the magnetic flux (linkage) over time — if the coil is rotated faster, the rate of change increases, so the induced EMF also increases.

Look at the functions. Does this support what you observed? (Keep in mind that in this case, x represents the time, so it should be t.)