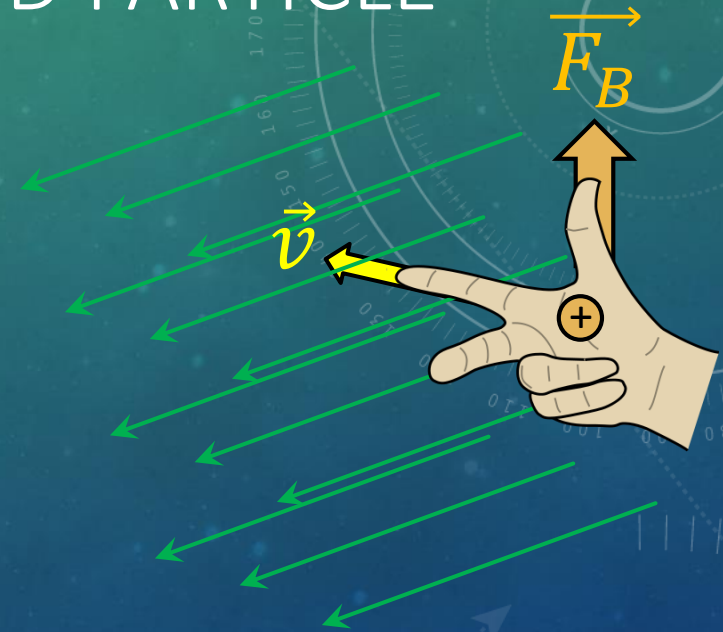
The background features a gradient from light green at the top to dark blue at the bottom. On the left side, there is a large, semi-circular scale with numerical markings from 140 to 260 in increments of 10. Several circular patterns, some solid and some dashed, are scattered across the image, some containing arrows that suggest motion or rotation. The overall aesthetic is technical and scientific.

MAGNETISM: APPLICATIONS

PES 1000 – PHYSICS IN EVERYDAY LIFE

MAGNETIC FORCE ON A MOVING CHARGED PARTICLE

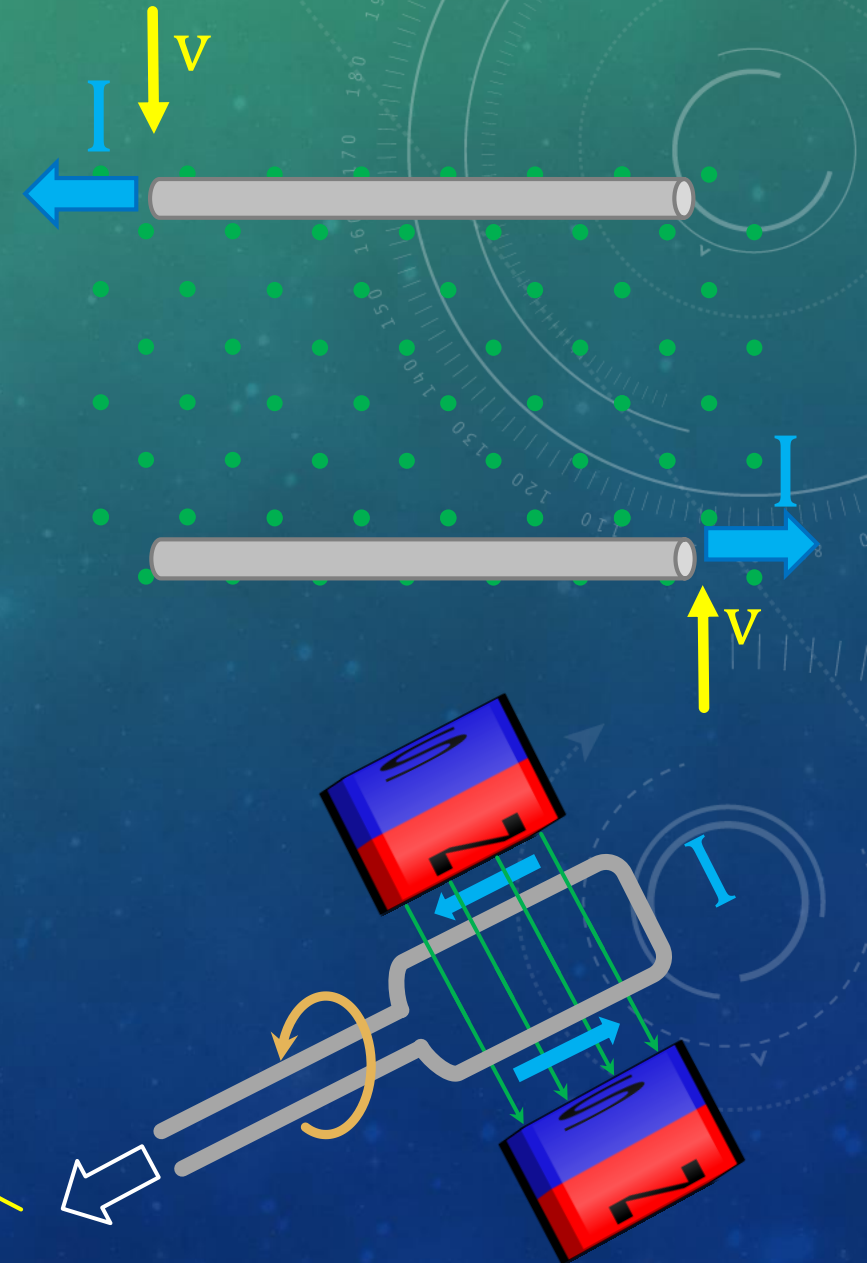
- When a **charge** moves through a uniform magnetic field, it experiences a **force** that is **perpendicular** to the **field** and to its direction of **motion**.
- To make this geometry easier to draw, a notation for a magnetic field directed toward or away from the observer was developed.
 - Field lines **toward the observer** are drawn as **dots** or circled dots.
 - Field lines **away from the observer** are drawn as **X's** or circled X's.
 - To remember which is which, imagine an arrow fired from a bow. The observer would see the **tip of the arrow (dot)** if it was moving toward them, and an **X (the feathers)** if it was moving away.
 - The notation can be used for any vector, including the force and velocity vectors.



ELECTRIC GENERATORS

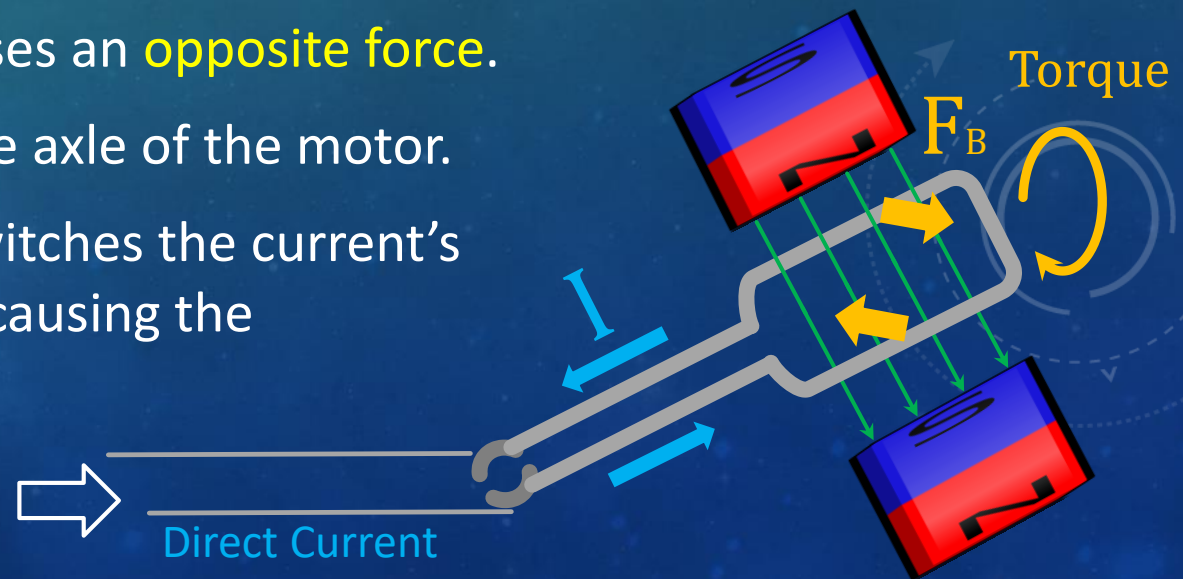
- Picture a **conductor** moving across magnetic field lines:
 - Electrons in the wire are a **moving charge**, so there is a **force** generated on them along the wire, generating a **current**.
- Now imagine you **rotate a wire loop between permanent magnets**:
 - As one **wire crosses magnetic field lines** and **generates a current**, the **other wire is crossing the opposite way**. Together, they push **current around the loop**.
 - Current will rise and fall as each wire passes through the field, slows, reverses, passes through again, slows, ...
 - This naturally generates an **alternating current**.
 - **More loops** generate **more current**.

Alternating Current



ELECTRIC MOTORS

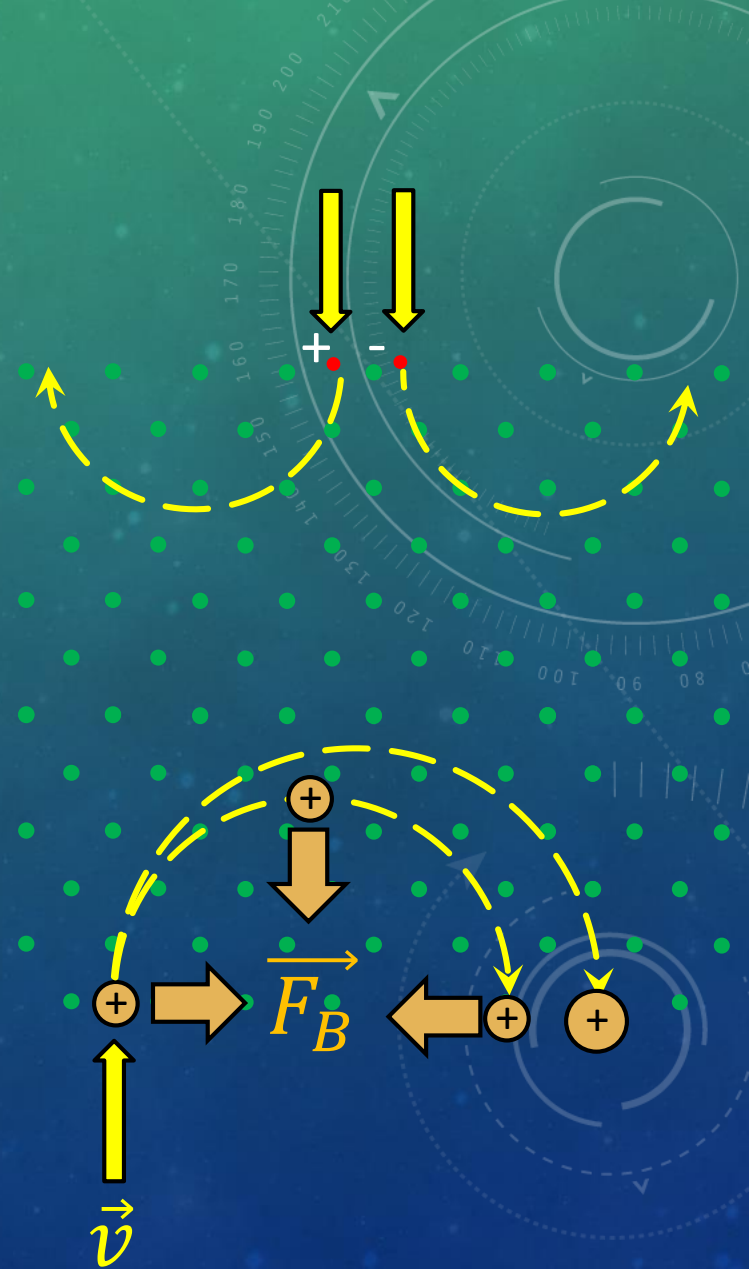
- Electric motors have a similar design to electric generators.
- There is a **loop of wire** within **permanent magnets**.
- In this case, though, a direct **current is run into the loop**.
- The **current** through the bottom wire causes a **sideways force** on the wire.
- The **opposite current** through the top wire causes an **opposite force**.
- These forces generate a **torque**, which turns the axle of the motor.
- A mechanism called a *split-ring commutator* switches the current's direction just as the loop reaches equilibrium, causing the loop to keep spinning.



CYCLOTRON MOTION

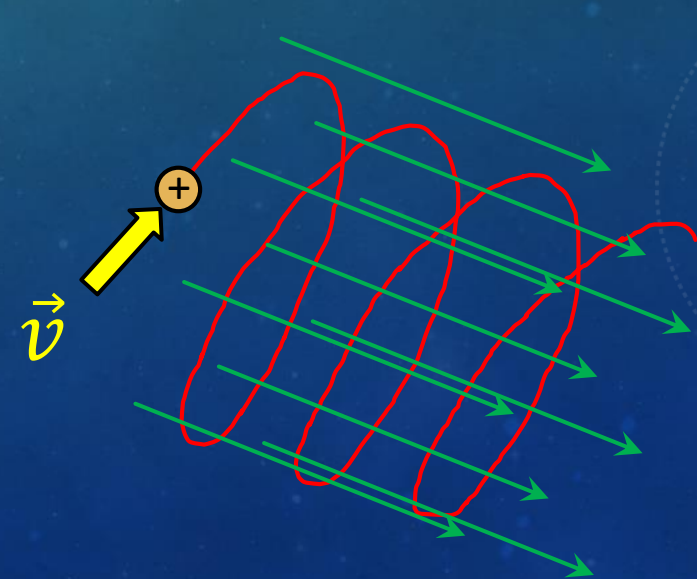
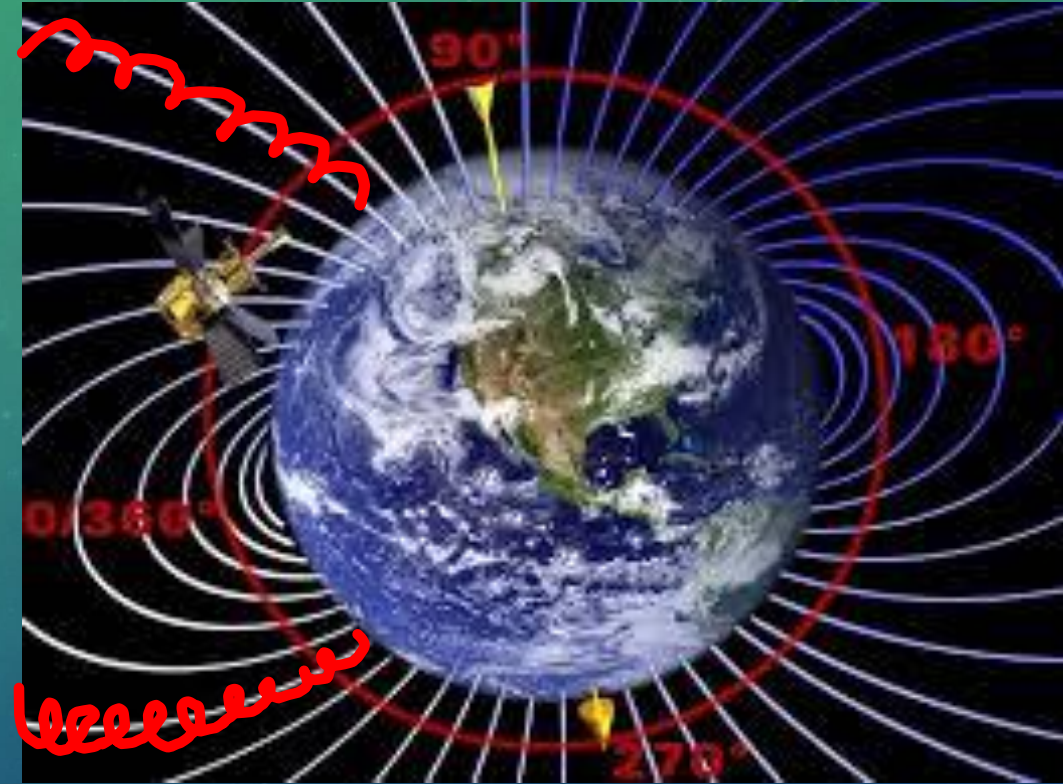
- Imagine a uniform magnetic field directed outward toward the observer.
- Inject a **positively charged molecule** (ion) into the field with a **velocity** perpendicular to the field.
 - The moving charge in the magnetic field experiences a **magnetic force**. The force is **perpendicular to the velocity (and the field)**. This force accelerates the particle, not along its path, but sideways to it.
 - As the particle turns, the force turns with it, causing a circular path. The **magnetic force** causes **centripetal acceleration**.
 - Here is how the circle depends on the parameters of the situation:
- Applications:
 - **Mass spectrometer**: Since the **size of the circle depends on the mass** of the particle, we can determine that mass
 - **Anti-matter detector**: Since the **direction around the circle depends on the sign** of the charge, we can detect the difference between matter and anti-matter

$$r = \frac{m \cdot v}{q \cdot B}$$

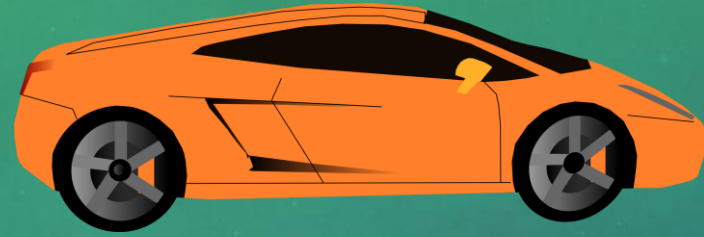


AURORAS

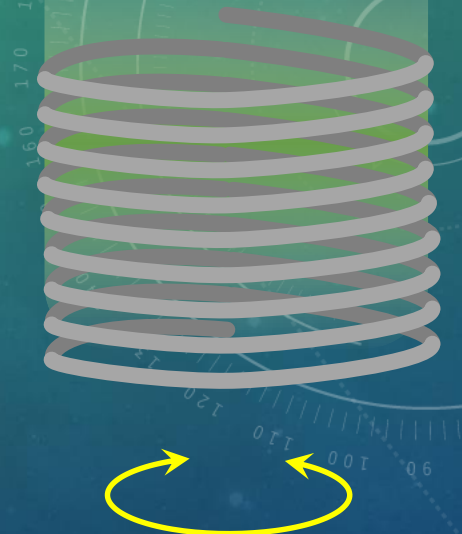
- The Earth has natural magnetic field.
- **Charged particles** from the Sun encounter **Earth's magnetic field**.
- They will experience **cyclotron motion about the field lines**, and the circle will drift along the field lines, forming a spiral.
- The charged particles then **hit atmospheric particles**, causing them to **emit light**.
- This is how the **auroras** are generated.



INDUCTIVE SENSORS



- When the **magnetic properties of an AC circuit change**, there is a **voltage change**.
 - This is how a **traffic light trigger** works. **AC current** flows back and forth through the coil and the **voltage** from coil's self-inductance is monitored.
 - If a piece of **metal enters the alternating magnetic field**, **currents are induced** in it from the detector.
 - These **currents generate their own magnetic field**, influencing the magnetic field of the coil.
 - This results in a **drop in the circuit's voltage**, which then triggers some action.
- This is also how **metal detectors** work. Metal that passes into the field triggers a change in the circuit's voltage.

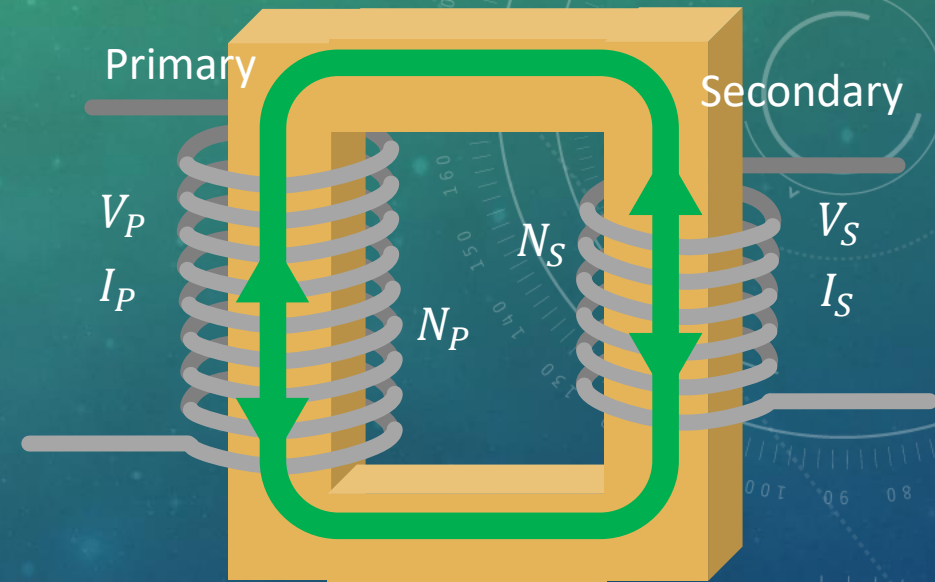


AC Current



TRANSFORMERS

- **Transformers** give us the ability to reduce the cost to transmit power by **lowering the current** with **high-voltage wires**.
 - **Transformers** work by magnetic induction, which requires that the current be constantly changing, as it does in an **AC circuit**.
 - The **primary** side is the **power-supply** side, and the **secondary** side is the **power-consumption** side.
 - There are a **different number of coils** on the primary (N_p) and secondary (N_s) sides. They are wrapped around an **iron core**.
 - The **primary coils** generate an **alternating magnetic field** which the **iron core** magnifies and **directs through the secondary coils**.
 - The alternating **magnetic field induces a current** on the secondary side.
 - The change in current and voltage depend entirely on the **relative number of coils** on the two sides.



$$V_S = \frac{N_S}{N_P} V_P$$

$$I_S = \frac{N_P}{N_S} I_P$$

$$P = I * V$$

CONCLUSION

- Magnetic fields are used in many ways in modern life.
- **Electric generators** transform **mechanical rotation** into **alternating current** by **moving wires** through a permanent magnetic field.
- **Electric motors** transform **electric current** into **mechanical rotation** by running a **current** through wires near a permanent magnetic field.
- **Charged particles** that move through a magnetic field will be forced into **circles about the magnetic field lines**.
 - This can be used to **determine the mass or charge** of particles too tiny to measure otherwise.
 - The **aurora** effect is a result of this phenomenon.
- **Magnetic induction** is the basis of **sensors** like traffic light triggers and metal detectors.
- Magnetism allows **transformers** to **adjust current and voltage** for efficient power transmission.

