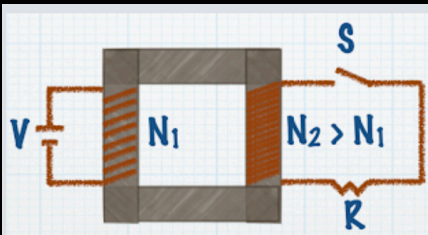


To minimize heat losses for power transported across the country, it is best that current in the wires is...

Low. Heat loss in a wire is due to electrical resistance. The rate of energy dissipation (power) is $P = I^2 R$. If the current is high, the heat loss is huge.



When the switch S is closed, the potential difference across R is:

A. $V_R = V \frac{N_2}{N_1}$

B. $V_R = V \frac{N_1}{N_2}$

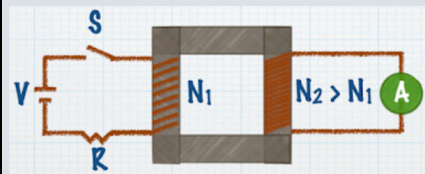
C. $V_R = V$

D. $V_R = 0$

There will be a potential difference across the resistor R as long as there is a potential difference across the coil that the resistor is connected to. That coil (N_2) is coupled with another coil (N_1) in a transformer. The primary coil (N_1) is connected to the DC power supply (V), the secondary coil is not connected to a power supply.

To induce an emf (or potential difference) across the secondary coil (N_2), there needs to be a **changing** magnetic flux in the primary coil (N_1). A DC power supply does not provide the changing emf needed. So no emf is induced in N_2 and therefore, there is no potential difference across the resistor.

The primary coil of a transformer is connected to a battery, a resistor, and a switch. The secondary coil is connected to an ammeter.



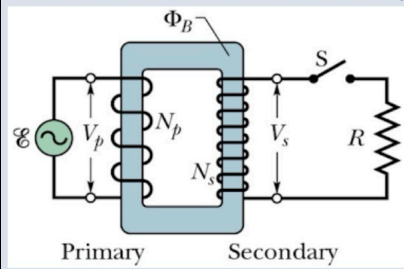
When the switch is thrown closed, the ammeter shows:

Again we have a primary coil connected to a DC power supply but this time there's a switch in the circuit. When the switch is open, the ΔV across the coil is zero and when the switch is closed, the ΔV across N_1 is not zero. So by closing the switch, the ΔV across N_1 is **changing** which will induce a changing magnetic flux that is transferred to the secondary coil (N_2). This changing magnetic flux induces an emf in N_2 which will drive a current through the coil and ammeter.

As long as the ΔV in the primary coil is changing, there will be an induced current in the secondary coil. Since ΔV changes from flipping the switch from open to closed, this change is short lived.

Answer: When the switch is closed, the ammeter shows a non-zero current for a short instant.

An ideal transformer is shown below. The voltage on the primary circuit is 10V. The primary circuit has 4 turns, the secondary circuit has 8 turns.



What is the voltage on the secondary circuit?

This is a step-up transformer. The voltage induced in the secondary coil is higher than the input voltage in the primary coil. We know this is step-up because there are more turns in the secondary coil (N_s) than the primary (N_p).

For transformers:
$$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

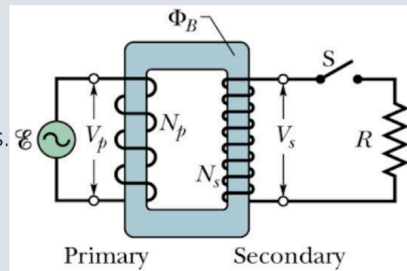
Rearrange this to solve for the secondary voltage:

$$V_2 = \frac{N_2}{N_1} V_1 = \frac{8}{4} (10 \text{ V}) = 20 \text{ V}$$

With a turn ratio of $\frac{8}{4}=2$, the step-up transformer doubles the input voltage.

An ideal transformer is shown below. The current in the primary circuit is 10 mA. The primary

circuit has 4 turns, the secondary circuit has 8 turns.



What is the current in the secondary circuit.

This is the same transformer from the previous example. But now we are considering current in the secondary coil. While a step-up transformer increases the voltage, you can't get something for nothing, so something has to decrease.

The power into the transformer is equal to the power out - this is just energy conservation. And power is current \times voltage:

$$P = I \Delta V$$

constant \uparrow \leftarrow If this increases then this must decrease

For transformers: $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ and $\frac{V_s}{V_p} = \frac{I_p}{I_s}$

$$\text{So } \frac{I_p}{I_s} = \frac{N_s}{N_p} \rightarrow I_s = \frac{N_p}{N_s} I_p = \frac{4}{8} (10 \text{ mA}) = 5 \text{ mA}$$

This step-up transformer doubles the voltage and cuts the current in half.