Motors, KVL, and V_{back}

A motor produces mechanical energy output with electrical energy input.
A generator produces electrical energy output with mechanical energy input.

What happens to a motor when it starts to run? Shouldn't it output electrical energy? Yes, it should

Motor becomes a generator

The reality is that YES, a motor does output electrical energy. Being that is the case, why can we not just use the output of the motor to run it?

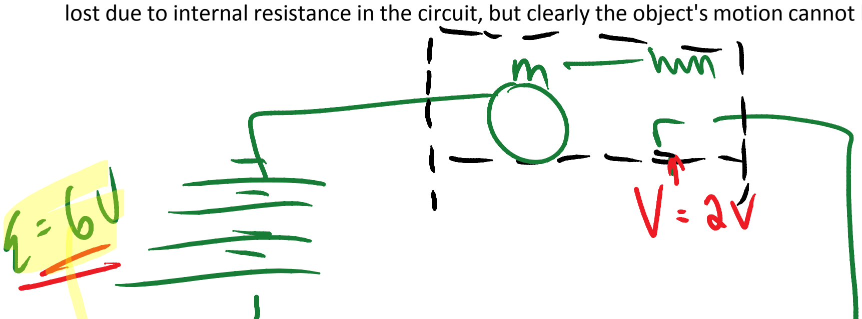
① Law of conservation of energy → Not all output = electric

(1a) You would have no work output

(1b) You would have to operate at zero K

$$\mathcal{E} = -\frac{n\Delta\phi}{\Delta t}$$

The answer (of course) is the Law of Conservation of Energy. If the output of a motor could be used to operate the motor itse lf then a motor would require no input and could operate without an external energy source while still providing a mechanical output. Of course the re would be some energy lost due to internal resistance in the circuit, but clearly the object's motion cannot be its own source.



How many Volts must be accounted for in operation of the motor 4V

$$\mathcal{E}_{Source} = V_{MOTOR} + Ir$$

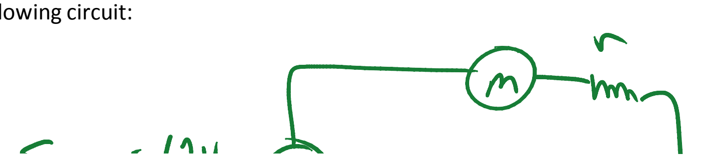
$$\mathcal{E} = V_{back} + Ir$$

$$\mathcal{E}_s = \mathcal{E}_{Back} + Ir$$

Then how does this work? Look at Lenz's Law where

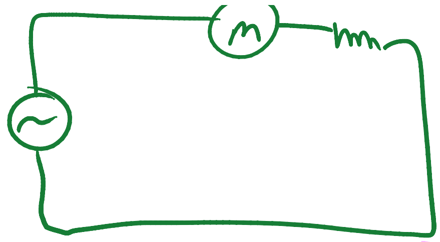
$\mathcal{E} = -\frac{n\,\Delta\Phi}{\Delta t}$ As the motor begins running the rotation rate of the armature increases causing a corresponding decrease in Δt. This means the EMF generated must increase at the same rate as frequency. BUT the negative tells us this induced EMF must oppose the change that created it. MEANING the EMF generated by the rotation will try to drive a current backward through the circuit.

Consider the following circuit:



2 situations

$\mathcal{E}_{source} = 12V$



2 situations

motor in full rotation

motor not moving ← startup, jammed

$\mathcal{E}_s = V_{back} + I r$

$\uparrow I_{min}$

$\mathcal{E}_s = I r$

$\uparrow I_{max}$

$\mathcal{E}_s \leftarrow$ fixed value

$r \leftarrow$ fixed value

I will change

Any motor has two operating states: Running and not running. When not running, Vback = 0 therefore

Ɛ = Ir

Consider a motor whose internal resistance is 10.0 ohms, and operates off 120 V what current will the motor draw at start up?

$\mathcal{E} = I r$

$120 = I(10) \quad I = 12.0A$

Once operating at full speed the current will drop because a back EMF is generated. If our example has operating current of 3.0 A, determine the back EMF.

$\mathcal{E} = V_{back} + I r$

$120 = V_{back} + (3)(10) \quad V_{back} = 90V$

If you place a load on the motor (make do mechanical work) what happens to the frequency? It decreases. The effect is to decrease Vback and increase I.

Do 1 - 5 p.260

Review ← Ch 5

$\boxed{\alpha \quad \beta \quad \gamma \quad \text{Radiation}}$

Natural transmutations

balanced Nuclear reactions

${}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{87}_{38}Sr + {}^{141}_{54}Xe + 3{}^{1}_{0}n$