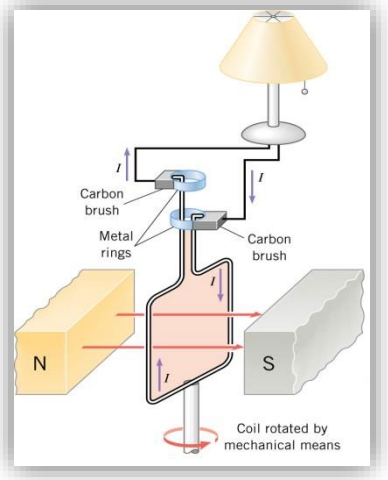
Physics 10-07 Electric Generators and Back Emf

Name: _____

Electric Generators



- A _____ of wire is _____ in a _____ field.
- Since the _____ between the loop and the *B*-field is _____, the _____ is changing.
- Since the magnetic _____ is changing an *emf* is _____.
- *emf* produced in _____ _____ coil

$$emf = NBA\omega \sin \omega t$$

- Where *N* = number of loops, *B* = magnetic field, *A* = area of each loop, ω = angular velocity = $2\pi f$, *t* = time in seconds
- According to _____ Law, the current will flow the one direction when the angle is _____ and it will flow the _____ direction when the angle is _____.
- These generators often called _____ current _____.

You have made a simple generator to power a TV. The armature is attached the rear axle of a stationary bike. For every time you peddle, the rear axel turns 10 times. Your TV needs a V_{rms} of 110V to operate. If the *B*-field is 0.2 T, each loop is a circle with *r* = 3 cm, and you can comfortably peddle 3 times a second; how many loops must you have in your generator so that you can watch TV while you exercise?

Back emf

- When a coil is _____ in a *B*-field an *emf* is _____
- If an electric motor is _____, its coil is _____ in a *B*-field
- By _____ Law, this *emf* will _____ the *emf* used to _____ the motor (called back *emf*)
- It will _____ the _____ across the motor and cause it to draw _____ current ($V = IR$)
- The back *emf* is _____ to the _____, so when motor starts it draws _____ *I*, but as it speeds up the *I* _____

Homework

1. Suppose you find that the belt drive connecting a powerful motor to an air conditioning unit is broken and the motor is running freely. Should you be worried that the motor is consuming a great deal of energy for no useful purpose? Explain why or why not.
2. Calculate the peak voltage of a generator that rotates its 200-turn, 0.100 m diameter coil at 3600 rpm in a 0.800 T field. (OpenStax 23.28) **474 V**
3. At what angular velocity in rpm will the peak voltage of a generator be 480 V, if its 500-turn, 8.00 cm diameter coil rotates in a 0.250 T field? (OpenStax 23.29) $\mathbf{7.30 \times 10^3}$ **rpm**
4. (a) A bicycle generator rotates at 1875 rad/s, producing an 18.0 V peak *emf*. It has a 1.00 by 3.00 cm rectangular coil in a 0.640 T field. How many turns are in the coil? (b) Is this number of turns of wire practical for a 1.00 by 3.00 cm coil? (OpenStax 23.32) **50.0, Yes**
5. This problem refers to the bicycle generator considered in the previous problem. It is driven by a 1.60 cm diameter wheel that rolls on the outside rim of the bicycle tire. (a) What is the velocity of the bicycle if the generator's angular velocity is 1875 rad/s? (b) What is the maximum *emf* of the generator when the bicycle moves at 10.0 m/s, noting that it was 18.0 V under the original conditions? (c) If the sophisticated generator can vary its own magnetic field, what field strength will it need at 5.00 m/s to produce a 9.00 V maximum emf? (OpenStax 23.33) **15m/s, 12.0 V, 0.960 T**
6. (a) A car generator turns at 400 rpm when the engine is idling. Its 300-turn, 5.00 by 8.00 cm rectangular coil rotates in an adjustable magnetic field so that it can produce sufficient voltage even at low rpms. What is the field strength needed to produce a 24.0 V peak *emf*? (b) Discuss how this required field strength compares to those available in permanent and electromagnets. (OpenStax 23.34) **0.477 T, can use normal magnet**
7. Suppose a motor connected to a 120 V source draws 10.0 A when it first starts. (a) What is its resistance? (b) What current does it draw at its normal operating speed when it develops a 100 V back *emf*? (OpenStax 23.39) **12.0 Ω, 1.67 A**
8. A motor operating on 240 V electricity has a 180 V back *emf* at operating speed and draws a 12.0 A current. (a) What is its resistance? (b) What current does it draw when it is first started? (OpenStax 23.40) **5.00 Ω, 48.0 A**
9. What is the back *emf* of a 120 V motor that draws 8.00 A at its normal speed and 20.0 A when first starting? (OpenStax 23.41) **72.0 V**
10. The motor in a toy car operates on 6.00 V, developing a 4.50 V back *emf* at normal speed. If it draws 3.00 A at normal speed, what current does it draw when starting? (OpenStax 23.42) **12.0 A**