**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, \( \omega = \) 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 to the rear axle of a stationary bike. For every time you peddle, the rear axle turns 10 times. Your TV needs a \( V_{\text{rms}} \) of 110V to operate. If the B-field is 0.2 T, each loop is a circle with \( r = 3 \text{ cm} \), 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?

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**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) **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) **15 m/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 \Omega, 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 \Omega, 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**