20.1 Induced emf: Faraday's Law and Lenz's Law

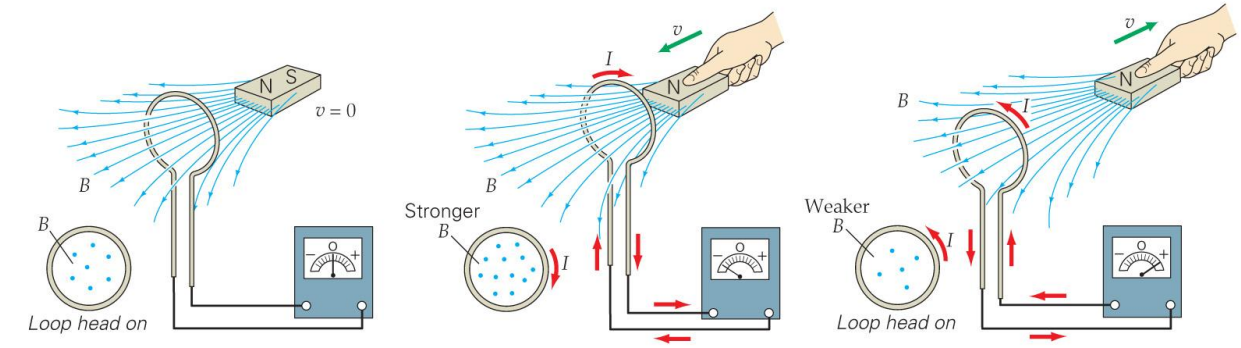
1. **MC** A unit of magnetic flux is (a) Wb, (b) $\mathrm{T\cdot m^2}$, (c) $\mathrm{T\cdot m/A}$, or (d) both a and b. (d)

2. **MC** The magnetic flux through a loop can change due to a change in (a) the area of the coil, (b) the strength of the magnetic field, (c) the orientation of the loop, or (d) all of the preceding. (d)

3. **MC** For a current to be induced in a wire loop, (a) there must be a large magnetic flux through the loop, (b) the loop's plane must be parallel to the magnetic field, (c) the loop's plane must be perpendicular to the magnetic field, or (d) the magnetic flux through the loop must vary with time. (d)

4. **MC** Identical single loops A and B are oriented so they initially have the maximum amount of flux in a magnetic field. Loop A is then quickly rotated so its normal is perpendicular to the magnetic field, and in the same time, B is rotated so its normal makes an angle of only 45° with the field. How do their induced emfs compare? (a) They are the same (b) A's is larger than B's (c) B's is larger than A's or (d) you can't tell the relative emf magnitudes from the data given. (b)

5. **MC** Identical single loops A and B are oriented so they have the maximum amount of flux when placed in a magnetic field. Both loops maintain their orientation relative to the field, but in the same amount of time A is moved to a region of stronger field, while B is moved to a region of weaker field. How do their induced emfs compare? (a) They are the same (b) A's is larger than B's (c) B's is larger than A's or (d) you can't tell the relative emf magnitudes from the data given. (d)

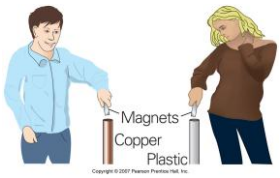


(a) No motion between magnet and loop (b) Magnet is moved toward loop (c) Magnet is moved away from loop

7. **CQ** In Fig. 20.1b, what would be the direction of the induced current in the loop if the south pole of the magnet were approaching instead of the north pole? counterclockwise (in head-on view)

9. **CQ** Does the induced emf in a closed loop depend on the value of the magnetic flux in the loop? Explain. no, it depends on the rate of the flux change with time

10. **CQ** Two identical strong magnets are dropped simultaneously by two students into two vertical tubes of the same dimensions (>Fig. 20.27). One tube is made of copper, and the other is made of plastic. From which tube will the magnet emerge first? Why? from the plastic tube; see Solution



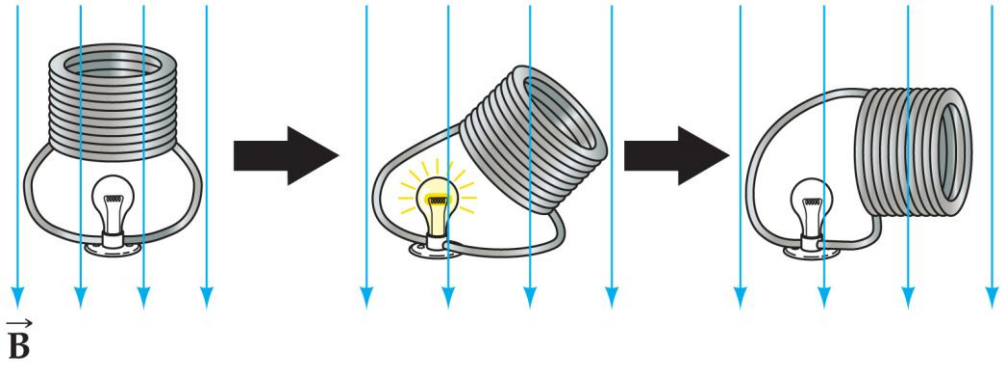
12. ● A circular loop with an area of $0.015\ \mathrm{m^2}$ is in a uniform magnetic field of 0.30 T. What is the flux through the loop's plane if it is (a) parallel to the field, (b) at an angle of 37° to the field, and (c) perpendicular to the field? (a) 0 (b) $2.7\times10^{-3}\ \mathrm{T\cdot m^2}$ (c) $4.5\times10^{-3}\ \mathrm{T\cdot m^2}$

16. ● A square coil of wire with 10 turns is in a magnetic field of 0.25 T. The total flux through the coil is $0.50\ \mathrm{T\cdot m^2}$. Find the area of one turn if the field (a) is perpendicular to the plane of the coil and (b) makes an angle of 60° with the plane of the coil. (a) $0.20\ \mathrm{m^2}$ (b) $0.23\ \mathrm{m^2}$

17. ●● An ideal solenoid with a current of 1.5 A has a radius of 3.0 cm and a turn density of 250 turns/m. What is the magnetic flux (due to its own field) through only one of its loops at its center? $1.3\times10^{-6}\ \mathrm{T\cdot m^2}$

28. ●●● The flux through a loop of wire changes uniformly from +40 Wb to −20 Wb in 1.5 ms. (a) What is the significance of the negative flux? (b) What is the average induced emf in the loop? (c) If you wanted to double the average induced emf by changing only the time, what would the new time interval be? (d) If you wanted to double the average induced emf by changing only the final flux value, what would it be? see ISM

29. ●●● A coil of wire with 10 turns and an area of $0.055\ m^2$ is placed in a magnetic field of 1.8 T and oriented so that the area is perpendicular to the field. The coil is then flipped by 90° in 0.25 s and ends up with the area parallel to the field (▾ Fig. 20.31). What is the magnitude of the average emf induced in the coil? 4.0 V



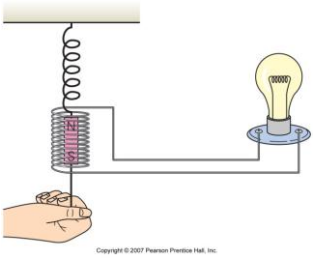
20.2 Electric Generators and Back emf

32. **MC** Doing nothing but increasing the coil area in an ac generator would result in (a) an increase in the frequency of rotation, (b) a decrease in the maximum induced emf, (c) an increase in the maximum induced emf. (c)

33. **MC** The back emf of a motor depends on (a) the input voltage, (b) the input current, (c) the armature's rotational speed, or (d) none of the preceding. (c)

34. **CQ** What is the orientation of the armature loop in a simple ac generator when the value of (a) the emf is a maximum and (b) the magnetic flux is a maximum? Explain why the maximum emf does not occur when the flux is a maximum. see ISM

35. **CQ** A student has a bright idea for a generator: For the arrangement shown in >Fig. 20.33, the magnet is pulled down and released. With a highly elastic spring, the student thinks that there should be a relatively continuous electrical output. What is wrong with this idea? see Solution



38. ● A hospital emergency room ac generator operates at a rotation frequency of 60 Hz. If the output voltage is a maximum (in magnitude) at $t = 0$, when is it next (a) a maximum (in magnitude), (b) zero, and (c) at its initial value? (a) 1/120 s (b) 1/240 s (c) 1/60 s

39. ● A student makes a simple generator by using a single square loop 10 cm on each side. The loop is then rotated at a frequency of 60 Hz in a magnetic field of 0.015 T. (a) What is the maximum emf output? (b) What would be the maximum emf output if 10 such loops were used instead? (a) 0.057 V (b) 0.57 V

44. ●● The armature of a simple ac generator has 20 circular loops of wire, each with a radius of 10 cm. It is rotated with a frequency of 60 Hz in a uniform magnetic field of 800 mT. What is the maximum emf induced in the loops, and how often is this value attained? 1.9×10^{2} V, every 1/120 s

45. ●● The armature of an ac generator has 100 turns. Each turn is a rectangular loop measuring 8.0 cm by 12 cm. The generator has a sinusoidal voltage output with an amplitude of 24 V. If the magnetic field of the generator is 250 mT, with what frequency does the armature turn? 16 Hz

20.3 Transformers and Power Transmission

50. **MC** A transformer in the electrical energy delivery system just before your house has (a) more windings in the primary coil, (b) more windings in the secondary coil, or (c) the same number of windings in the primary and secondary coils. (a)

51. **MC** The output power delivered by a realistic step-down transformer is (a) greater than the input power, (b) less than the input power, or (c) the same as the input power. (b)

52. **CQ** Explain why electric energy delivery systems operate at such high voltages when such voltages can be dangerous. high voltage and thus low current in order to reduce joule heat

53. **CQ** In your automotive workshop emergency repair, you need a step-down transformer, but have only step-up transformers on the shelves. Can you use a step-up transformer as a step-down one? If so, explain how you would wire it. yes, reverse the primary and secondary coils

58. ● The primary coil of an ideal transformer is connected to a 120-V source and draws 10 A. The secondary coil has 800 turns and a current of 4.0 A. (a) What is the voltage across the secondary coil? (b) How many turns are in the primary coil? (a) 3.0×10^2 V (b) 3.2×10^2 turns

20.4 Electromagnetic Waves

70. **MC** Relative to the blue end of the visible spectrum, the yellow and green regions have (a) higher frequencies, (b) longer wavelengths, (c) shorter wavelengths, or (d) both a and c. (b)

71. **MC** Which of the following electromagnetic waves has the lowest frequency? (a) UV (b) IR (c) X-ray or (d) microwave (d)

72. **MC** Which of the following electromagnetic waves travels fastest in a vacuum? (a) green light (b) infrared light (c) gamma rays (d) radiowaves or (e) they all have the same speed (e)

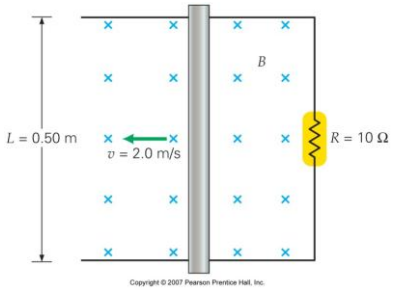
73. **MC** If you doubled the frequency of a blue light source, what kind of light would it then put out? (a) red (b) blue (c) violet or (d) UV (e) X-ray (d)

74. **CQ** An antenna is connected to a car battery. Will the antenna emit electromagnetic radiation? Why or why not? Explain. no, dc current cannot generate a varying magnetic field

79. ● In a small town there are only two AM radio stations, one at 920 kHz and one at 1280 kHz. What are the wavelengths of the radio waves transmitted by each station? 326 m and 234 m

Comprehensive Exercises

85. **IE** In >Fig. 20.35, a metal bar of length L moves in a region of constant magnetic field. That field is directed into the page. (a) The direction of the induced current through the resistor is (1) up, (2) down, (3) there is no current. Why? (b) If the magnitude of the magnetic field is 250 mT, what is the current? (a) (1) up (b) 25 mA



87. A transformer is used by a European traveler while she is visiting the United States. Primarily she uses it to run a 1200-watt hair dryer/blower she brought with her. When plugged in to her hotel room outlet in Los Angeles, she notices it runs *exactly* as it does at home. The input voltage and current are 120 V and 11.0 A, respectively. (a) Is this an ideal transformer? Explain how you came to your conclusion. (b) If it is not an ideal transformer, what is its efficiency? (a) no, input power is greater than output power (b) 90.9%