Conceptual Questions

23.1 Induced Emf and Magnetic Flux

1.

How do the multiple-loop coils and iron ring in the version of Faraday's apparatus shown in Figure 23.3 enhance the observation of induced emf?

2.

When a magnet is thrust into a coil as in Figure 23.4(a), what is the direction of the force exerted by the coil on the magnet? Draw a diagram showing the direction of the current induced in the coil and the magnetic field it produces, to justify your response. How does the magnitude of the force depend on the resistance of the galvanometer?

3.

Explain how magnetic flux can be zero when the magnetic field is not zero.

4.

Is an emf induced in the coil in Figure 23.51 when it is stretched? If so, state why and give the direction of the induced current.

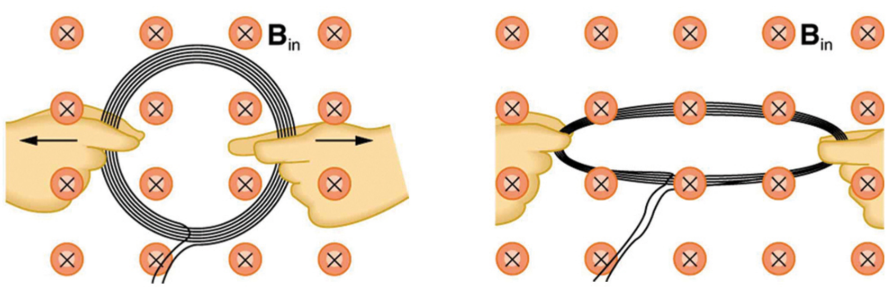

Figure 23.51 A circular coil of wire is stretched in a magnetic field.

23.2 Faraday's Law of Induction: Lenz's Law

5.

A person who works with large magnets sometimes places her head inside a strong field. She reports feeling dizzy as she quickly turns her head. How might this be associated with induction?

6.

A particle accelerator sends high-velocity charged particles down an evacuated pipe. Explain how a coil of wire wrapped around the pipe could detect the passage of individual particles. Sketch a graph of the voltage output of the coil as a single particle passes through it.

23.3 Motional Emf

7.

Why must part of the circuit be moving relative to other parts, to have usable motional emf? Consider, for example, that the rails in Figure 23.10 are stationary relative to the magnetic field, while the rod moves.

8.

A powerful induction cannon can be made by placing a metal cylinder inside a solenoid coil. The cylinder is forcefully expelled when solenoid current is turned on rapidly. Use Faraday's and Lenz's laws to explain how this works. Why might the cylinder get live/hot when the cannon is fired?

9.

An induction stove heats a pot with a coil carrying an alternating current located beneath the pot (and without a hot surface). Can the stove surface be a conductor? Why won't a coil carrying a direct current work?

10.

Explain how you could thaw out a frozen water pipe by wrapping a coil carrying an alternating current around it. Does it matter whether or not the pipe is a conductor? Explain.

23.4 Eddy Currents and Magnetic Damping

11.

Explain why magnetic damping might not be effective on an object made of several thin conducting layers separated by insulation.

12.

Explain how electromagnetic induction can be used to detect metals? This technique is particularly important in detecting buried landmines for disposal, geophysical prospecting and at airports.

23.5 Electric Generators

13.

Using RHR-1, show that the emfs in the sides of the generator loop in Figure 23.22 are in the same sense and thus add.

14.

The source of a generator's electrical energy output is the work done to turn its coils. How is the work needed to turn the generator related to Lenz's law?

23.6 Back Emf

15.

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.

23.7 Transformers

16.

Explain what causes physical vibrations in transformers at twice the frequency of the AC power involved.

23.8 Electrical Safety: Systems and Devices

17.

Does plastic insulation on live/hot wires prevent shock hazards, thermal hazards, or both?

18.

Why are ordinary circuit breakers and fuses ineffective in preventing shocks?

19.

A GFI may trip just because the live/hot and neutral wires connected to it are significantly different in length. Explain why.

23.9 Inductance

20.

How would you place two identical flat coils in contact so that they had the greatest mutual inductance? The least?

21.

How would you shape a given length of wire to give it the greatest self-inductance? The least?

22.

Verify, as was concluded without proof in Example 23.7, that units of $\mathrm{T \cdot m^2}/A = \Omega \cdot \mathrm{s} = \mathrm{H}$.

23.11 Reactance, Inductive and Capacitive

23.

Presbycusis is a hearing loss due to age that progressively affects higher frequencies. A hearing aid amplifier is designed to amplify all frequencies equally. To adjust its output for presbycusis, would you put a capacitor in series or parallel with the hearing aid's speaker? Explain.

24.

Would you use a large inductance or a large capacitance in series with a system to filter out low frequencies, such as the 100 Hz hum in a sound system? Explain.

25.

High-frequency noise in AC power can damage computers. Does the plug-in unit designed to prevent this damage use a large inductance or a large capacitance (in series with the computer) to filter out such high frequencies? Explain.

26.

Does inductance depend on current, frequency, or both? What about inductive reactance?

27.

Explain why the capacitor in Figure 23.52(a) acts as a low-frequency filter between the two circuits, whereas that in Figure 23.52(b) acts as a high-frequency filter.

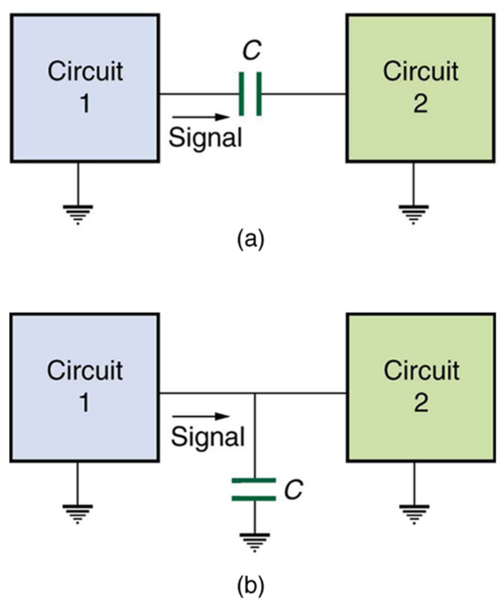

Figure 23.52 Capacitors and inductors. Capacitor with high frequency and low frequency.

28.

If the capacitors in Figure 23.52 are replaced by inductors, which acts as a low-frequency filter and which as a high-frequency filter?

23.12 RLC Series AC Circuits

29.

Does the resonant frequency of an AC circuit depend on the peak voltage of the AC source? Explain why or why not.

30.

Suppose you have a motor with a power factor significantly less than 1. Explain why it would be better to improve the power factor as a method of improving the motor's output, rather than to increase the voltage input.