Homework-9

Chapter 22

50. ***REASONING*** When the current through an inductor changes, the induced emf ξ is given by Equation 22.9 as

$$\xi = -L\frac{\Delta I}{\Delta t}$$

where L is the inductance, ΔI is the change in the current, and Δt is the time interval during which the current changes. For each interval, we can determine ΔI and Δt from the graph.

SOLUTION

a. $$\xi = -L\frac{\Delta I}{\Delta t} = -\left(3.2\times10^{-3}\ \text{H}\right)\left(\frac{4.0\ \text{A} - 0\ \text{A}}{2.0\times10^{-3}\ \text{s} - 0\ \text{s}}\right) = \boxed{-6.4\ \text{V}}$$

b. $$\xi = -L\frac{\Delta I}{\Delta t} = -\left(3.2\times10^{-3}\ \text{H}\right)\left(\frac{4.0\ \text{A} - 4.0\ \text{A}}{5.0\times10^{-3}\ \text{s} - 2.0\times10^{-3}\ \text{s}}\right) = \boxed{0\ \text{V}}$$

c. $$\xi = -L\frac{\Delta I}{\Delta t} = -\left(3.2\times10^{-3}\ \text{H}\right)\left(\frac{0\ \text{A} - 4.0\ \text{A}}{9.0\times10^{-3}\ \text{s} - 5.0\times10^{-3}\ \text{s}}\right) = \boxed{+3.2\ \text{V}}$$

---

51. ***REASONING*** We will designate the coil containing the current as the primary coil, and the other as the secondary coil. The emf ξ_s induced in the secondary coil due to the changing current in the primary coil is given by $\xi_s = -M\left(\Delta I_p / \Delta t\right)$ (Equation 22.7), where M is the mutual inductance of the two coils, ΔI_p is the change in the current in the primary coil, and Δt is the change in time. This equation can be used to find the mutual inductance.

SOLUTION Solving Equation 22.7 for the mutual inductance gives

$$M = -\frac{\xi_s \Delta t}{\Delta I_p} = -\frac{(1.7\text{ V})(3.7\times10^{-2}\text{ s})}{(0\text{ A} - 2.5\text{ A})} = \boxed{2.5\times10^{-2}\text{ H}}$$

---

60. ***REASONING AND SOLUTION*** According to the transformer equation (Equation 22.12), we have

$$N_s = \left(\frac{V_s}{V_p}\right)N_p = \left(\frac{4320\text{ V}}{120.0\text{ V}}\right)(21) = \boxed{756}$$

---

64. ***REASONING*** The generator drives a fluctuating current in the primary coil, and the changing magnetic flux that results from this current induces a fluctuating voltage in the secondary coil, attached to the resistor. The peak emf of the generator is equal to the peak voltage V_p of the primary coil. Given a peak voltage in the secondary coil of V_s = 67 V, the peak voltage V_p can be found from

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} \qquad (22.12)$$

In Equation 22.12, N_p and N_s are, respectively, the number of turns in the primary coil and the number of turns in the secondary coil.

SOLUTION Solving Equation 22.12 for V_p, we obtain

$$V_p = V_s\left(\frac{N_p}{N_s}\right) \qquad (1)$$

Since there are N_p = 11 turns in the primary coil and N_s = 18 turns in the secondary coil, Equation (1) gives

$$V_p = (67\text{ V})\left(\frac{11}{18}\right) = \boxed{41\text{ V}}$$

Chapter 24

---

1. ***REASONING*** The distance traveled by the X-rays is equal to their speed multiplied by the elapsed time. Therefore, the elapsed time is equal to the distance divided by the speed. The distance is known. Since X-rays are electromagnetic waves, and all electromagnetic waves move through a vacuum at the speed of light *c*, the speed is known.

SOLUTION The time it takes for the X-rays to travel from the sun to the earth is

$$t = \frac{\text{Distance}}{\text{Speed}} = \frac{d}{c} = \frac{1.50\times10^{11}\ \text{m}}{3.00\times10^{8}\ \text{m/s}} = 5.00\times10^{2}\ \text{s}$$

Since 1 min = 60 s, we have

$$t = \left(5.00\times10^{2}\ \cancel{\text{s}}\right)\left(\frac{1\ \text{min}}{60\ \cancel{\text{s}}}\right) = \boxed{8.33\ \text{min}}$$

---

7. ***REASONING*** The wavelength λ of a wave is related to its speed *v* and frequency *f* by $\lambda = v/f$ (Equation 16.1). Since blue light and orange light are electromagnetic waves, they travel through a vacuum at the speed of light *c*; thus, *v* = *c*.

SOLUTION

a. The wavelength of the blue light is

$$\lambda = \frac{c}{f} = \frac{3.00\times10^{8}\ \text{m/s}}{6.34\times10^{14}\ \text{Hz}} = 4.73\times10^{-7}\ \text{m}$$

Since 1 nm = 10^{-9} m,

$$\lambda = \left(4.73\times10^{-7}\ \cancel{\text{m}}\right)\left(\frac{1\ \text{nm}}{10^{-9}\ \cancel{\text{m}}}\right) = \boxed{473\ \text{nm}}$$

b. In a similar manner, we find that the wavelength of the orange light is

$$\lambda = \frac{c}{f} = \frac{3.00\times10^{8}\ \text{m/s}}{4.95\times10^{14}\ \text{Hz}} = 6.06\times10^{-7}\ \text{m} = \boxed{606\ \text{nm}}$$

---

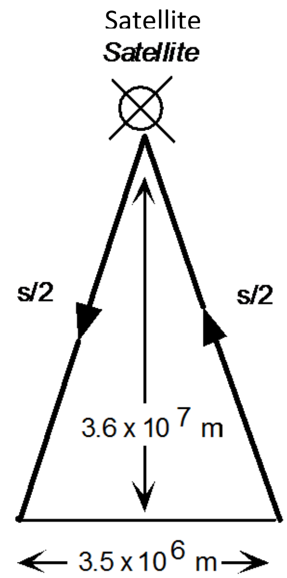
13. ***REASONING*** To determine the difference in frequencies, we will calculate each frequency and subtract one from the other. Each frequency f is related to the wavelength λ and the speed of light c according to $f = c/\lambda$ (Equation 16.1).

SOLUTION Using Equation 16.1 to calculate each frequency, we find that

$$f_2 - f_1 = \frac{c}{\lambda_2} - \frac{c}{\lambda_1} = \left(2.9979\times10^{8}\ \text{m/s}\right)\left(\frac{1}{0.34339\ \text{m}} - \frac{1}{0.36205\ \text{m}}\right) = \boxed{4.500\times10^{7}\ \text{Hz}}$$

---

21. ***REASONING AND SOLUTION*** The time t that it takes for the telephone call to go from one city to the other is equal to the distance s traveled by the electromagnetic wave divided by the speed of light, $t = s/c$. The distance $s/2$ from one city to the satellite is given by the Pythagorean theorem as (see the drawing)



$$\frac{s}{2} = \sqrt{(3.6 \times 10^7 \text{ m})^2 + \left(\frac{3.5}{2} \times 10^6 \text{ m}\right)^2} = 3.6 \times 10^7 \text{ m}$$

The time for the wave to travel from one city up to the satellite and back to the other is

$$t = \frac{s}{c} = \frac{2(3.6 \times 10^7 \text{ m})}{3.0 \times 10^8 \text{ m/s}} = \boxed{0.24 \text{ s}}$$

____