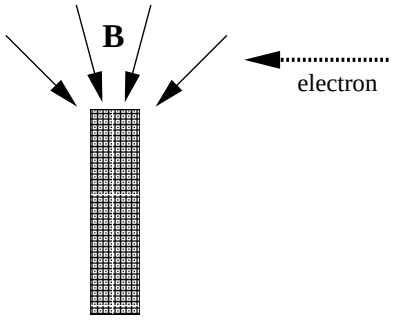
Circle the letter of the single best answer. Each question is worth 1 point

Physical Constants:

proton charge = $e = 1.60 \times 10^{-19}$ C
permittivity of free space = $\epsilon_0 = 8.85 \times 10^{-12}$ F/m
permeability of free space = $\mu_0 = 4\pi \times 10^{-7}$ T·m/A
Coulomb constant = $k_e = 9 \times 10^9$ N · m^2/C^2
speed of light = $c = 3 \times 10^8$ m/s

1. An electron approaches the pole of bar magnet at high speed. The arrows on this diagram show the direction of the magnetic field and the direction of the electron's initial velocity. What type of pole (N or S) is the electron approaching and in which direction will the electron move?

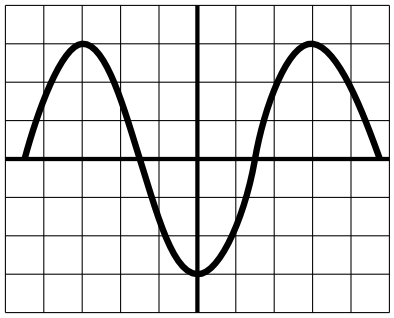


   A. S, into page
   B. S, out of page
   C. N, into page
   D. N, out of page

2. Consider two long straight parallel wires, each carrying a current. The currents are flowing in opposite directions and the current in one wire is twice the current in the other wire.

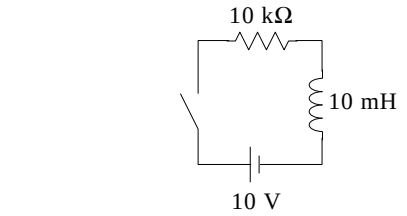
   A. The two wires will attract each other and the large-current wire feels the larger force.
   B. The two wires will repel each other and the large-current wire feels the larger force.
   C. The force on the high-current wire will be in the exact opposite direction as the force on the low-current wire.
   D. None of the above.

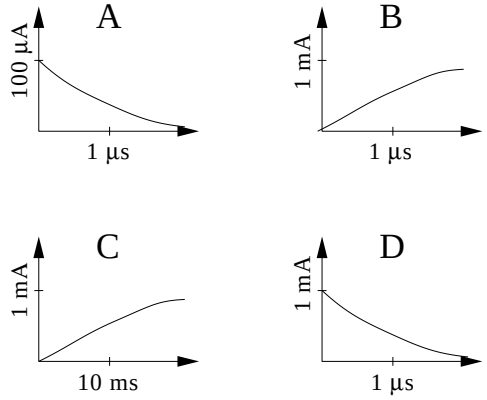
3. The below shows an oscilloscope screen displaying an AC voltage. The oscilloscope is set to 5 Volts/div and 2 μs/div. What are the frequency and rms voltage of this signal?



   A. 30 V, 12 μHz
   B. 15 V, 12 μHz
   C. 10 V, 80 kHz
   D. 3 V, 6 kHz

4. The below circuit shows a series LR circuit. The switch is closed at $t = 0$. Which graph best represents how the current changes in time?

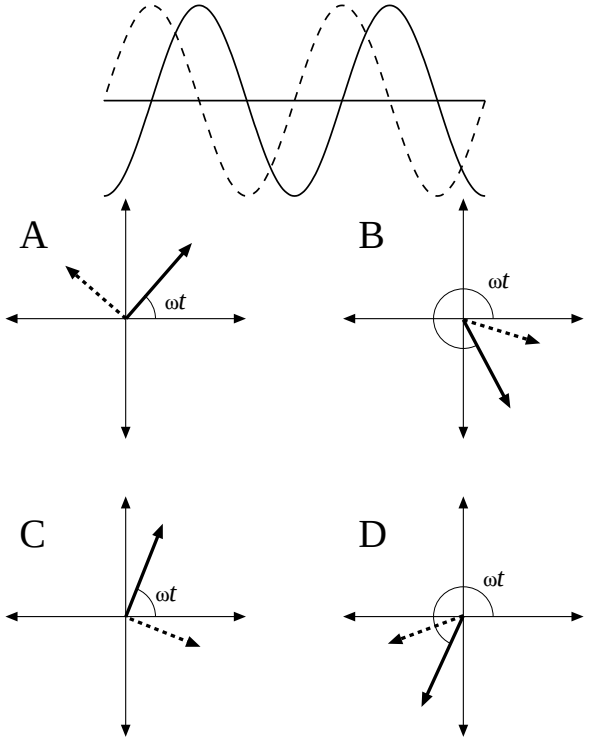




5. The primary winding of a transformer has 200 turns and is connected to a normal U.S. household receptacle. The secondary has 1000 turns. The output (secondary) voltage is most nearly

   A. 600 V
   B. 120 V
   C. 25 V
   D. 5 V

6. Much like an oscilloscope, the below plot displays two voltages (solid and dotted) as functions of time. Which of the below phasor pairs is consistent with this plot?



7. A ray of light moving in vacuum has a wavelength of $\lambda = 0.5\ \mu$m. When it enters water ($n = 1.333$):

   A. its velocity is slowed: c/n
   B. its frequency is slowed: f/n
   C. its wavelength is increased: $\lambda \times n$
   D. more than one of the above

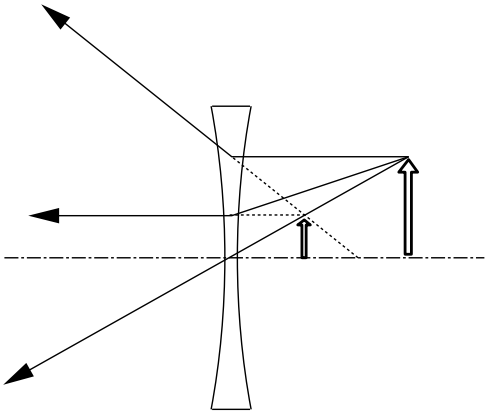
8. Which of the following list of types of light correctly orders the light in terms of increasing wavelength?

   A. X-ray, microwave, visible, radio
   B. visible, infrared, microwave, radio
   C. infrared, visible, ultraviolet, gamma
   D. gamma, ultraviolet, microwave, infrared

9. A single-lens slide projector is to form an image on a screen that is 100 times the size of the slide. The screen is located 5 m from the from the lens. How far should the slide be from the lens?

   A. 50 cm
   B. 5 cm
   C. $3\frac{1}{3}$ cm
   D. Cannot be determined.

10. Consider the below ray diagram for a lens. The *signs* of f, p, q are :



   A. $f < 0$, $p > 0$, $q > 0$
   B. $f > 0$, $p > 0$, $q < 0$
   C. $f < 0$, $p > 0$, $q < 0$
   D. None of the above.

The following questions are worth 10 pts each

Record your steps! (Grade based on method displayed not just numerical result)

To receive full credit your answers should have exactly three significant figures

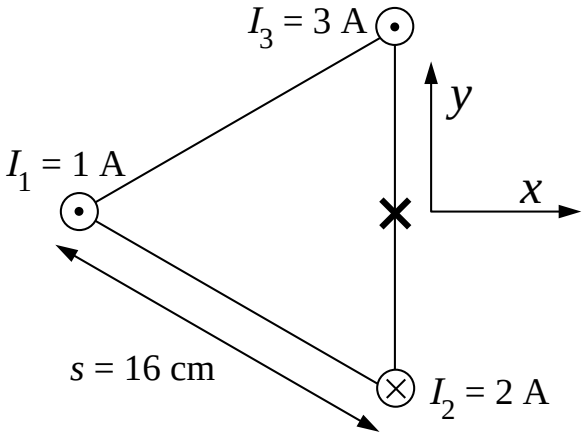
11. As shown below three long wires are arranged in an equilateral triangle with side $s = 16$ cm.. The currents I_1 and I_3 come directly out of this page; I_2 goes into the page. We seek the magnetic field vector at the spot marked X (i.e., the midpoint of the vertical segment).

    A. Directly on the diagram, draw (approximately) and label the magnetic field vector (including direction) at X due to each of the three currents. Label the magnetic field due to I_1: $\mathbf{B}_1$, etc.

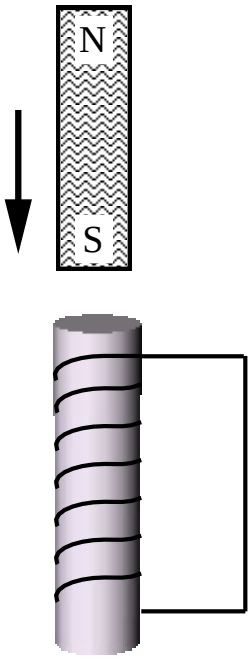
    B. Draw (approximately) the sum of these three magnetic field vectors. Label an angle that describes the direction of this net magnetic field vector.

    C. Calculate the net magnetic field vector at the spot marked X, by finding its x and y components.

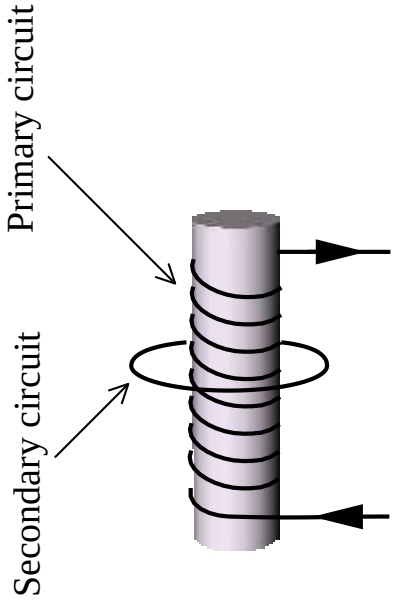
    D. Calculate the numerical value of the angle you labeled in part (B).



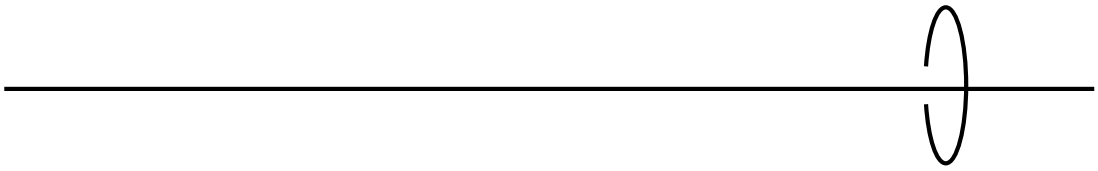
12. The below diagrams show three separate circuits. For each case, add an arrow directly on a wire showing the direction of the induced current in that wire. (Note that the bottom case of the long straight wire has two secondary circuits and hence two separate arrows are required.)

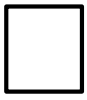


The south pole of a bar magnet is approaching the solenoid



The current shown flowing through the primary circuit is decreasing





A long straight wire and a square loop of wire sit in the plane of this sheet of paper. A circular loop of wire is centered on the long wire, but sits in a plane perpendicular to this sheet of paper. For several minutes there has been no current flowing in any wire. A battery (not shown) is connected and a current starts to flow to the left through the long straight wire.

13. Consider the below right LRC circuit, driven by a generator at a frequency of $f = 25$ kHz

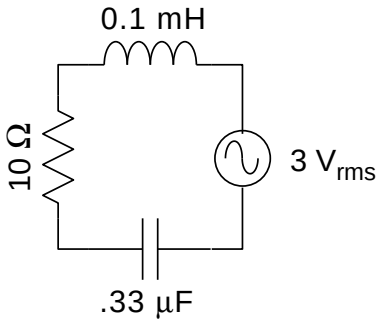
A. What rms current flows through the circuit?

B. What is the rms voltage across the inductor (V_L)? Across the capacitor (V_C)? Across the resistor (V_R)?

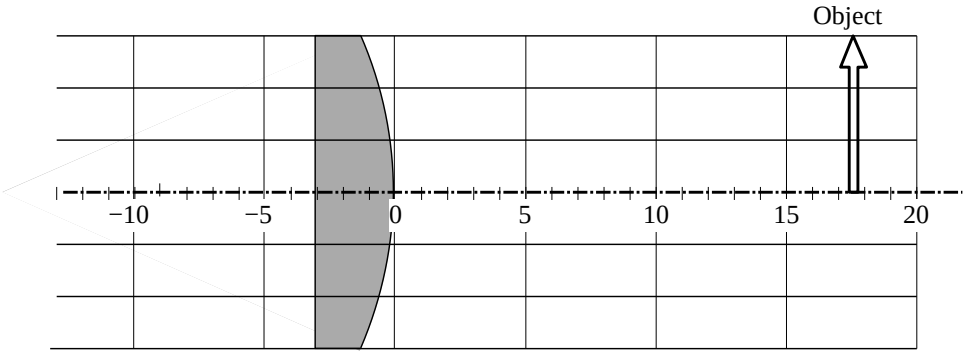
C. Accurately draw a phasor diagram showing/labeling how the voltages: V_L, V_R, V_C add to produce the total voltage of the source.

D. On your phasor diagram label the angle ϕ that is used to find the power factor $\cos\phi$. (No need to calculate this angle, just label it.)

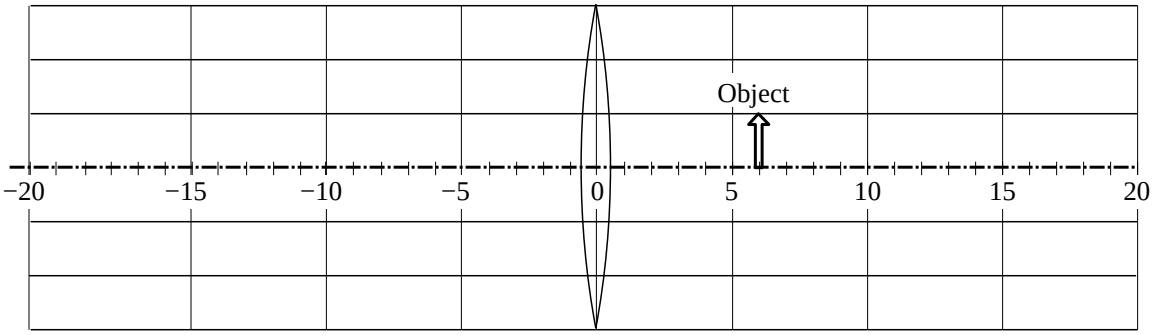
E. Circle one: the total voltage leads the current
the total voltage lags the current



14. Find below two diagrams: a lens & object and a mirror & object. For each situation accurately draw the three principal rays described in our textbook. Follow the book's convention: dotted lines for rays extrapolated by the viewing eye and solid line for the actual rays. Draw an arrow accurately showing the size, location and orientation of the image. Draw an eyeball located/oriented so that it could see the image.



$f = -7$



$f = 4.5$