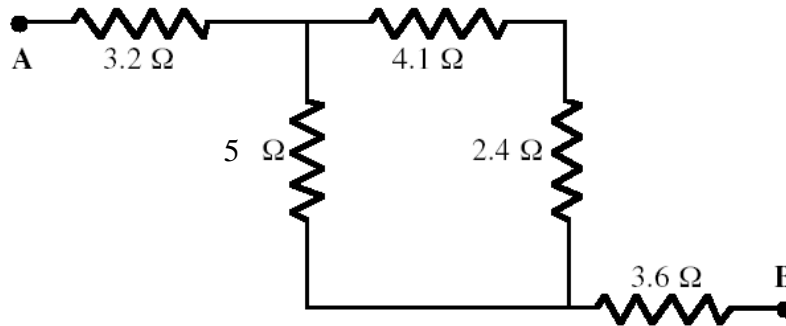
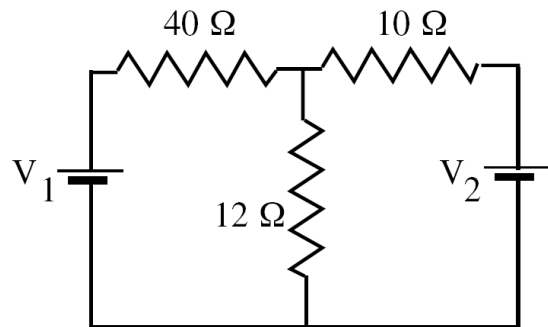


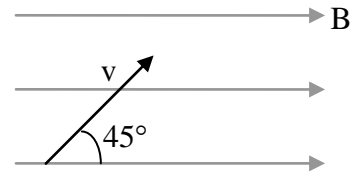
3. Five resistors are connected as shown in the diagram. The potential difference between points **A** and **B** is 15 V. What is the equivalent resistance between the points **A** and **B**?



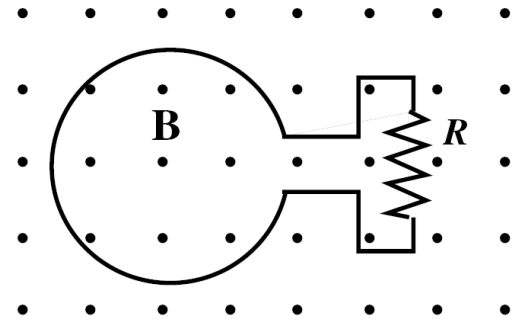
4. Three resistors and two 10.0 V batteries are arranged as shown in the circuit diagram. Determine the current (magnitude and direction) in the 12Ω resistor, given that the magnitude of the current through the 40Ω resistor is 0.1 A.



5. At one instant, an electron is moving in the xy plane. The electron's velocity is $v = 5 \times 10^5$ m/s at an angle of 45° above the x axis, as shown in the figure. A magnetic field of 0.80 T is in the positive x direction. At that instant, what is the magnitude and direction of the magnetic force on the electron?



6. The figure shows a uniform, 3.0 T magnetic field that is normal to the plane of a conducting, circular loop with a resistance of 1.5Ω and a radius of 0.024 m. The magnetic field is directed out of the paper as shown. (Note: The area of the non-circular portion of the wire is considered negligible compared to that of the circular loop.)

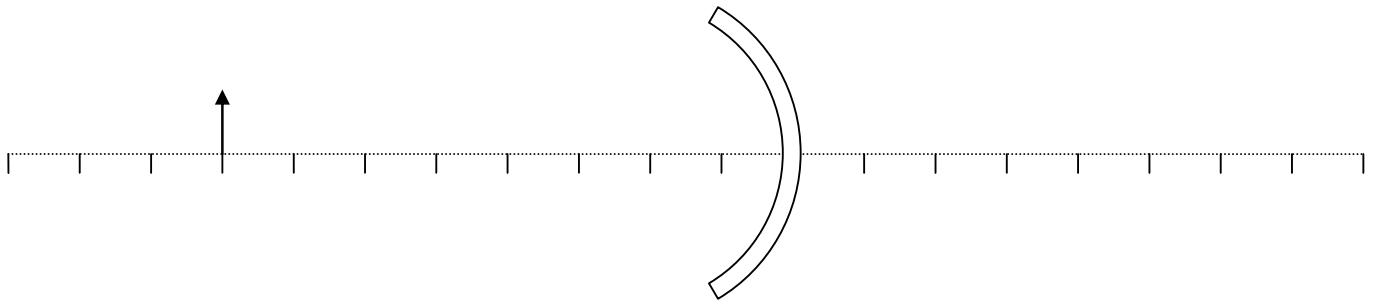


What is the magnitude of the average induced emf in the loop if the magnitude of the magnetic field is doubled in 0.4 s?

7. A concave mirror in an amusement park has a radius of curvature of 4.0 m. A child stands in front of the mirror so that she appears 2.5 times taller than her actual height. If the image is upright, how far is she standing from the mirror?

8. The figure is a scaled diagram of an object and a mirror. The object is placed 8 units from a concave spherical mirror with a radius of curvature of 4 units.

- (a) Draw an accurate ray diagram, including all three Principal Rays. Indicate the image location by an appropriately sized and oriented arrow. Use solid lines with arrows to indicate the actual path of the light, and dotted lines to indicate the apparent path of the light.

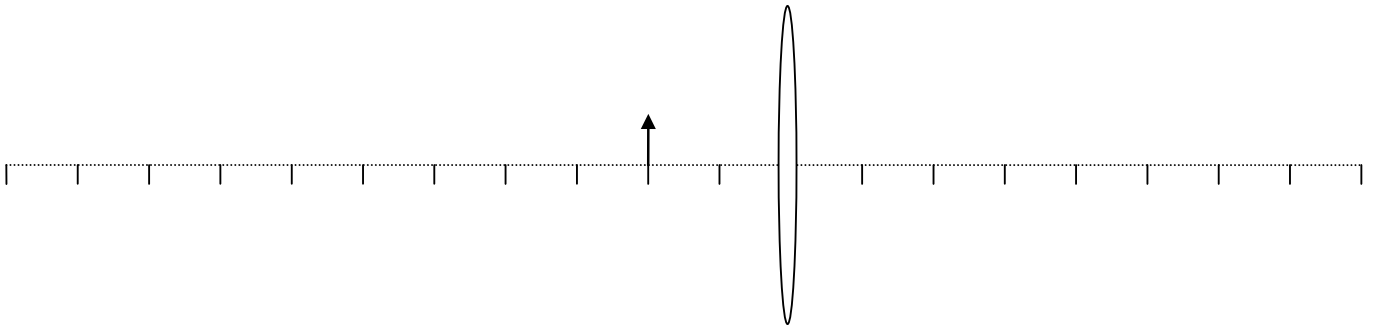


- (b) Is the image real or virtual?

9. A 3-cm object is placed 25 cm from a lens. The virtual image appears at a distance of 7 cm from the lens. What is the focal length of this lens, and is it a converging or diverging lens?

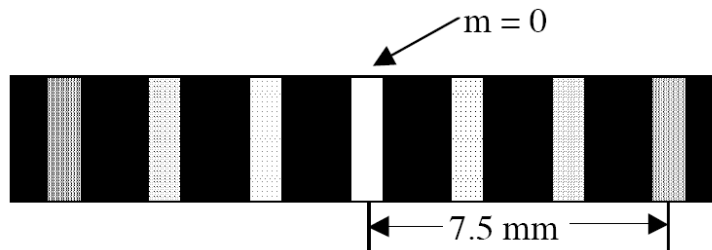
10. The figure is a scaled diagram of an object and a converging lens. The focal length of the lens is 3 units. An object is placed 2 units from the lens as shown.

- (a) Draw an accurate ray diagram, including all three Principal Rays. Indicate the image location by an appropriately sized and oriented arrow. Use solid lines with arrows to indicate the actual path of the light, and dotted lines to indicate the apparent path of the light.



- (b) Is the image real or virtual? Upright or inverted? Enlarged or reduced?

11. Light is incident on two slits that are separated by 0.2 mm. The figure shows the resulting interference pattern observed on a screen 1.0 m from the slits. Determine the wavelength of light used in this experiment.



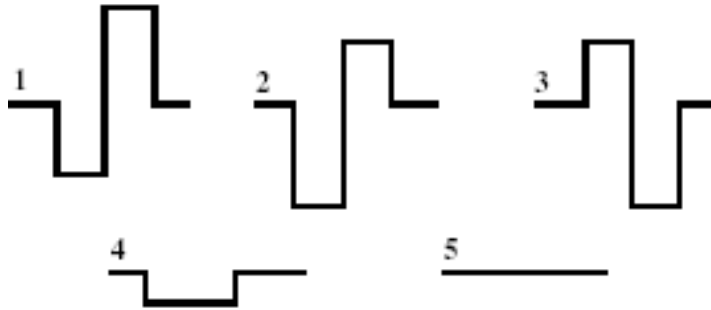
12. Photons of what minimum frequency are required to remove electrons from gold?
(The work function for gold is 4.8 eV.)
13. Determine the energy of an incident photon required to cause an electron transition from the $n = 6$ to the $n = 8$ level in a hydrogen atom.
14. A neutral atom of Radium (${}^{226}_{88}\text{Ra}$) has a mass of 226.025402 u. What is the binding energy of this isotope of Radium?

15. A honeybee (mass = 0.00013 kg) is crawling at a speed of 0.02 m/s. What is the de Broglie wavelength of the bee?

16. *Rn-222* with atomic number 86 decays with a half-life of 3.8235 days by alpha decay to *Po-218*. Write the equation for the nuclear reaction. What are A and Z for the daughter nuclide?

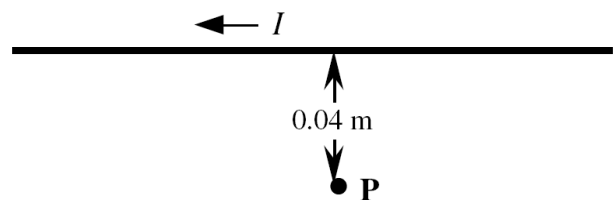
Multiple Choice: Please select the *best* answer for each of the following 8 questions. Circle only one answer for each question. Each problem is worth 4 points for a total of 32 points in this section.

1. Consider the figures below depicting rectangular waves on a string.



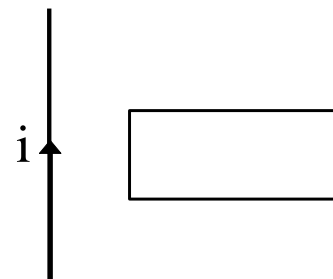
Complete the following statement: If pulse 2 were superimposed on pulse 3,

- (a) the resulting pattern would be represented by 1.
 - (b) the resulting pattern would be represented by 4.
 - (c) the resulting pattern would be represented by 5.
 - (d) the resulting pattern would be different than 1, 4, and 5.
 - (e) constructive interference would occur.
2. A parallel plate capacitor with an air dielectric is attached to a voltage source and charged. The voltage source is removed, and then the plates are separated to double their previous distance. What happens to the potential difference between the plates when they are separated?
- (a) It doubles
 - (b) It quadruples
 - (c) It halves
 - (d) It is diminished by a factor of 4
 - (e) It stays the same
3. A long, straight wire is carrying a current of 5.0 A in the direction shown in the figure. The point P is 0.040 m from the wire. What is the magnitude and direction of the magnetic field at the point P?



- (a) 2.5×10^{-5} T, out of the page
- (b) 2.5×10^{-5} T, into of the page
- (c) 6.8×10^{-6} T, to the right
- (d) 6.8×10^{-6} T, toward the top of the page
- (e) 1.3×10^{-6} T, toward the bottom of the page

4. A long straight wire is in the plane of a rectangular conducting loop. The straight wire initially carries no current. While the current i (in the direction shown) is in the process of being turned on, the current in the rectangle is:



- (a) zero
(b) clockwise
(c) counterclockwise
(d) clockwise in the left side and counterclockwise in the right side
(e) counterclockwise in the left side and clockwise in the right side
5. Complete the following sentence: The various colors of visible light differ in
- (a) frequency only.
(b) wavelength only.
(c) their speeds in a vacuum.
(d) frequency and wavelength.
(e) frequency and their speed in a vacuum.
6. When light goes from a material with a lower index of refraction n_1 into a material with a higher index of refraction n_2 with an angle of incidence of 30.0° , which of the following is true?
- (a) The angle of refraction is more than 30.0°
(b) The angle of refraction is less than 30.0°
(c) Total internal reflection may occur
(d) Both answers a and c are true
(e) Both answers b and c are true
7. Two stars are just barely resolved by a telescope with a lens diameter of 0.500 m. Determine the angular separation of the two stars. Assume incident light of wavelength 500.0 nm.
- (a) 1.22×10^{-6} rad
(b) 5.66×10^{-5} rad
(c) 2.44×10^{-7} rad
(d) 4.88×10^{-5} rad
(e) 1.22×10^{-7} rad

8. Light is usually thought of as wave-like in nature and electrons as particle-like. In which one of the following situations does an *electron* behave as a wave?
- (a) Light of wavelength 300 nm falls on a metal and an electron is ejected.
 - (b) An electron enters a parallel plate capacitor and is deflected downward.
 - (c) An electron, moving at 1,000 m/s is deflected by a magnetic field.
 - (d) A beam of electrons is diffracted as it passes through a narrow slit.
 - (e) Electrons on a conducting sphere spread out evenly across the surface.