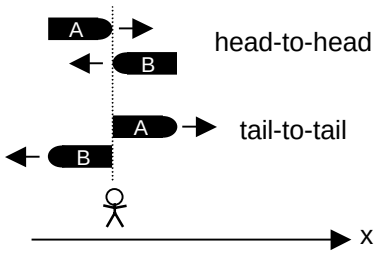
Physics 133 Sample Final

Problem 1. An observer sees Rocket A moving in the +x direction and Rocket B moving along –x, each with speed s = 0.850 c. The rest lengths of the rockets are both L_o = 200 m. The rockets pass each other, meaning they go from being head-to-head to tail-to-tail.



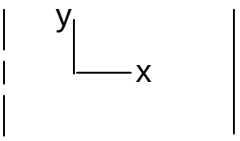
(a) How long does it take them to pass as seen by the observer?

(b) How long does it take them to pass as seen by Rocket A?

(c) What is the velocity of Rocket B as seen by Rocket A?

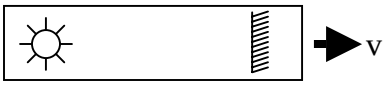
[As usual, there are several ways to solve this, some of which involve answering these questions in a different order. Just make sure the questions get answered. The order is not important.]

Problem 2. A beam of 5.0 eV electrons passes through a double-slit apparatus and forms a pattern on a screen 20 cm away. Starting from the center, the distance to the first location on the screen where the probability of finding the electrons is zero is 2.0 mm. What is the slit separation? What should the slit width be to eliminate the m=10 interference maximum? What should the slit width be if 5.0 eV neutrons are used instead?



Problem 3. A 1200 eV electron standing wave is excited in an infinite square well of length L at the third harmonic. What is L? What is the wavelength of the electron? What is the probability of finding the electron in a region of length L/20 centered at a distance L/4 away from one of the sides? The electron decays into the second harmonic state, emitting a photon. What is the wavelength of the photon?

Problem 4.
Belinda has a light emitter and a mirror 2.0 m apart (in Belinda's frame). She and her apparatus are moving at speed 0.95 c with respect to Bridget on the ground. Her motion is <u>parallel</u> to the line connecting the emitter and mirror.

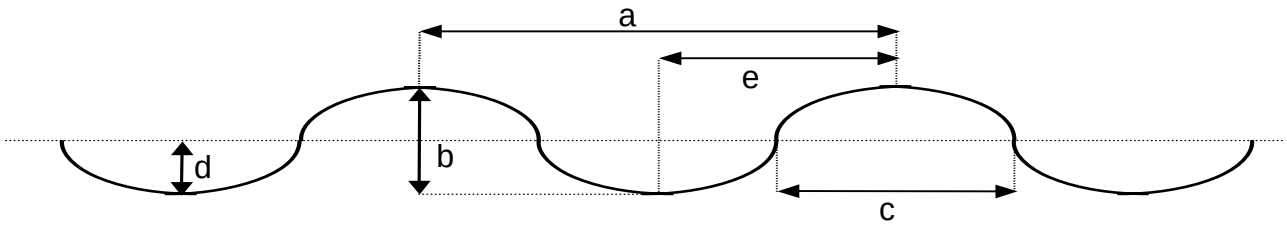


(a) What does Bridget observe for the time it takes light to travel from the emitter to the mirror?

(b) What does Bridget observe for the time it takes light to travel from the mirror back to the emitter?

Multiple Choice And Short Answer Questions.

(1) A sinusoidal wave is traveling toward the right as shown. Which letter correctly identifies the wavelength of the wave? _____

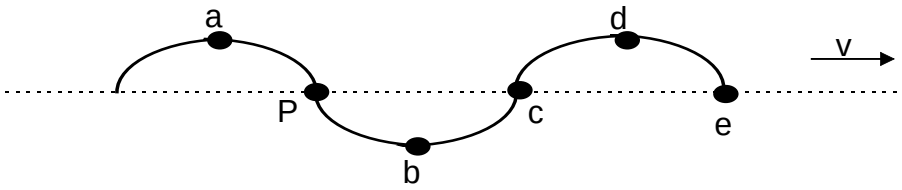


(2) Standing waves are produced by the interference of two waves each of frequency 100 Hz. The distance from the 2nd node to the 5th node is 60 cm. What is the wavelength of the original waves?

(3) A transverse traveling sinusoidal wave on a string has a frequency of 100 Hz, a wavelength of 0.040 m, and an amplitude of 2.0×10^{-3} m. What is the maximum transverse velocity in m/s for any point on the string?

(4) A wave is described by: $y = (1.0 \times 10^{-3}\ \text{m}) \sin[(3\ \text{m}^{-1})\, x + (10\ \text{s}^{-1})\, t]$ where x and y are in meters and t is in seconds. What is the period in seconds?

(5) A traveling wave is shown below. At which point on the wave is the motion π out of phase with the motion at point P? _____



(6) A string has length L, linear mass density μ and it is stretched between two walls. If its fundamental frequency is f, what is its tension?

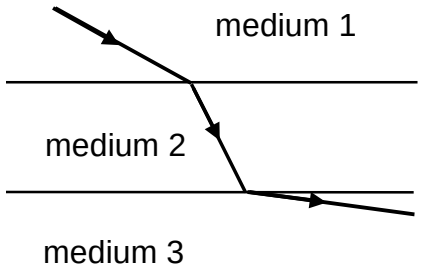
(7) A stationary source generates 5.0 Hz water waves. The water wave speed is 2.0 m/s. A boat is approaching the source at 10 m/s. What is the frequency of these waves, as observed by a person in the boat?

(8) The electric field of a plane EM wave traveling along +y points along +z at $y = y_0$ and $t = t_o$. What are the directions of the electric and magnetic fields at $y = y_o + \lambda/2$, $t = t_o$?

(9) A ray of light passes through three media as shown.

The medium with the fastest speed of light is _____

The medium with the slowest speed of light is _____



(10) The object-lens distance for a converging lens is 400 mm. The lens forms a real image that is 3 times larger than the object. What is the focal length?

(11) Considering the uncertainty principle alone, will an electron have a larger uncertainty in its momentum in:

(a) a large box (b) a small box (c) neither a large or small box, the uncertainty is the same

(12) For a Young's two slit interference experiment using light, consider the following changes to the experiment:

I. decrease the frequency
II. increase the frequency
III. increase the width of both slits
IV. increase the separation between the slits
V. decrease the separation between the slits

figure 1

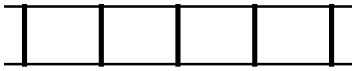
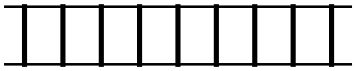


figure 2



Which of the above could change figure (1) into figure (2)? (There may be more than one answer.)

(13) As a simple harmonic oscillator passes through equilibrium:

(a) $v = 0, a = 0$.
(b) $v < 0, a > 0$.
(c) $v > 0, a > 0$.
(d) $v \neq 0, a = 0$.
(e) none of the above.

(14) If the kinetic energy of a free, non-relativistic electron quadruples, by how much does its wavelength change?

(15) How many kilograms of matter would have to be totally destroyed to run a 100 W light bulb for one year? One year equals 3.2×10^7 s.

(16) A double slit apparatus is immersed in a liquid with index of refraction 3.5. For yellow light, the m=3 interference maximum overlaps the m=2 diffraction minimum. The slit width is 800 nm. What is the separation between slits?