Name_____**UW net ID** _____**@uw.edu**
last *first*

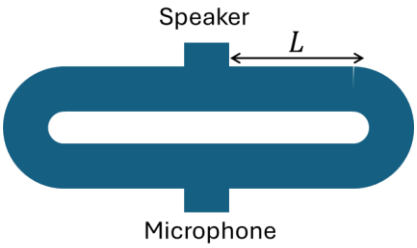
I. Lecture multiple choice (45 points – 9 questions)

1) (5 pts) 540-nm light passes through a single slit and produces a pattern on a distant screen. The first dark fringe (first minimum) is 35.0 degrees from the center of the interference pattern. What is the width of the slit?

A. 1.88×10^{-6} m
B. 4.71×10^{-7} m
C. 5.40×10^{-7} m
D. 8.84×10^{-7} m
E. 9.41×10^{-7} m

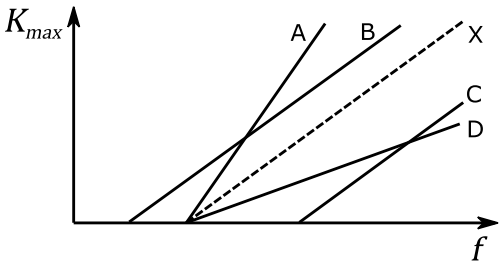
---

2) (5 pts) A sound wave generated at a speaker can travel down one of two paths to reach a microphone, as shown. Initially both paths are the same length, and therefore the sound detected by the microphone is maximum. By pulling on the right side of the setup you increase the length of the top and bottom parts of the path on the right. If the wavelength of the sound wave is λ = 0.32m, by how much do you need to increase L until the sound detected by the microphone is minimum for the first time?



A. 0.040 m
B. 0.080 m
C. 0.16 m
D. 0.32 m
E. 0.64 m

3) (5 pts) You fire photons with different frequencies at a piece of metal and measure the maximum kinetic energy of the electrons emitted at each frequency. On the graph, line X (dashed line) shows the best fit to the results you obtained. If you fired photons at a piece of metal with half the work function, which line would you expect to obtain?



A. Line A
B. Line B
C. Line C
D. Line D
E. The same result, line X

---

4) (5 pts) A beam of electrons traveling at a constant speed pass through a double slit and produce an interference pattern on a distant screen. Which of the following changes could increase the spacing between the fringes in the interference pattern?

i. Decrease the spacing between the slits.
ii. Decrease the distance to the screen.
iii. Decrease the speed of the electrons.

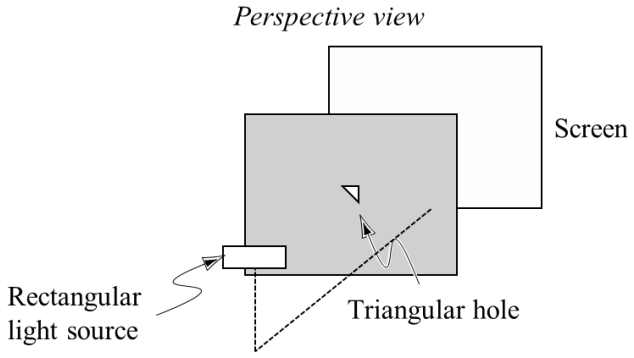
A. i. only
B. iii. only
C. i. and ii.
D. i. and iii.
E. ii. and iii.

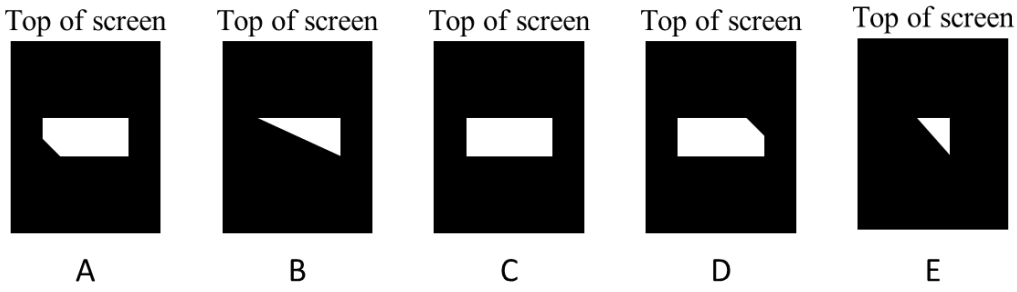
---

5) (5 pts) A thin glass rod is submerged in water. What is the critical angle for light traveling inside the rod? The index of refraction of water is 1.33, and the index of refraction of the glass rod is 1.50.

A. 27.5°
B. 41.8°
C. 45.0°
D. 48.8°
E. 62.5°

6) (5 pts) A mask with a triangular hole is placed between a rectangular light source and screen as shown. Which choice below is most like what you observe on the screen? A





---

7) Consider a **concave (converging)** mirror with a focal length of 1.0 m. If an object is placed 0.5 m in front of the mirror, which of the following statements about the image formed are correct?

i. It is real.
ii. It is enlarged.
iii. It is inverted.

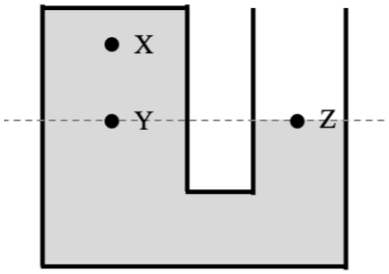
A. i. only.
B. ii. only.
C. iii. only.
D. i. and iii.
E. All of these are correct.

8) (5 pts) The size of the smallest things that can be seen with an optical microscope is **limited by diffraction**. Which of the following could help a microscopist see smaller things? Select all that apply.

A. A microscope with a higher magnification could be used.
B. The microscope could have an eyepiece lens with a shorter focal length.
C. The diameter of the lens could be larger.
D. Light with a longer wavelength could be used.
E. None of the above.

---

9) (5 pts) A U-tube containing water has one side open to the air, as shown in the figure. Which of the following is a correct ranking of the pressures at points X, Y and Z?

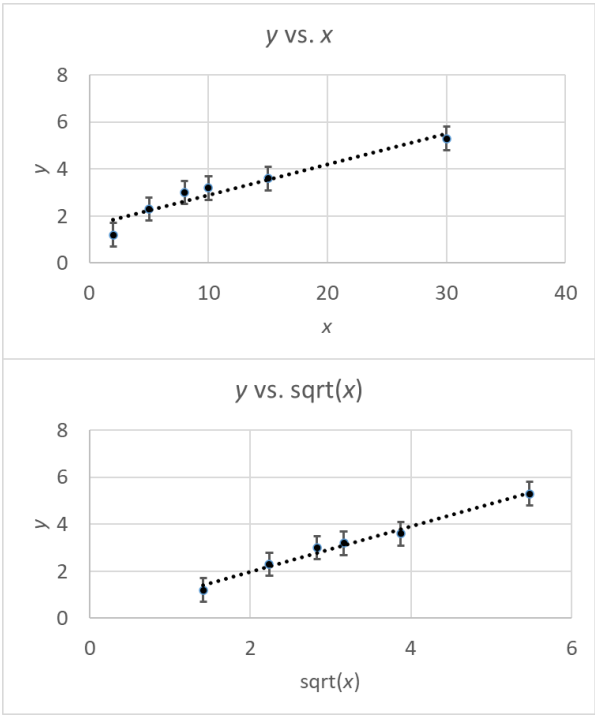


A. Z > Y > X
B. Z = Y > X
C. Z = Y < X
D. X = Y = Z
E. None of the above.

Name_____**UW net ID** _____**@uw.edu**
last *first*

II. Lab multiple choice (15 points)

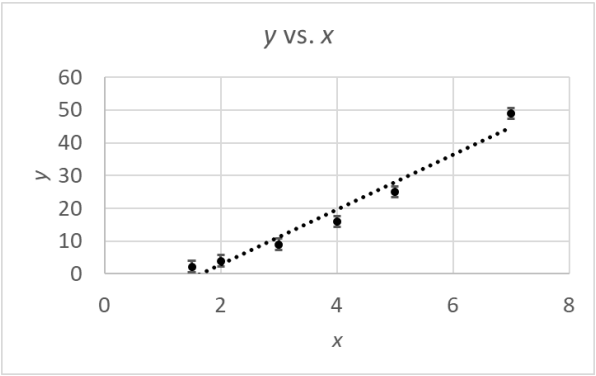
10) (5 pts) To develop a model relating variables x and y, a lab team measured y as they varied x and graphed y vs. x (top graph) and y vs. $\sqrt{x}$ (bottom graph), each with a best-fit line. Which of the following statements is/are correct based on their data? **Select all that apply**.



A. The best-fit line for the top graph is a good fit.
B. The best-fit line for the bottom graph is a good fit.
C. This experiment is **invalid** since it shows that two different models are consistent with the data simultaneously.
D. This experiment is **valid** even though it shows that two different models are consistent with the data simultaneously.
E. None of the above is correct.

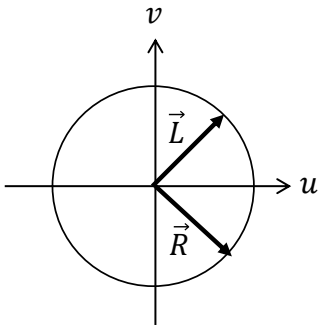
---

11) (5 pts) Suppose that a lab team measured variable y as they varied variable x and graphed y vs. x with a best-fit line as shown at right. Which of the following should they attempt to create a properly linearized graph with a good fit? **Select only <u>one</u> best choice from below**.



A. Try increasing the uncertainty bars for the data points so that the best-fit line becomes a better fit.
B. Try decreasing the uncertainty of the data points by measuring the variables more carefully.
C. Try graphing y vs. x^2.
D. Try graphing y vs. $\sqrt{x}$.
E. The graph is already properly linearized, so there is nothing they should attempt.

12) (5 pts) Monochromatic light is normally incident on a mask containing two very narrow identical slits. The interference pattern is viewed on a distant screen. The diagram at right illustrates two phasors that represent the light from the left slit, $\vec{L}$, and the right slit, $\vec{R}$, arriving at a point on the screen. Which <u>one</u> of the following points could these phasors represent?



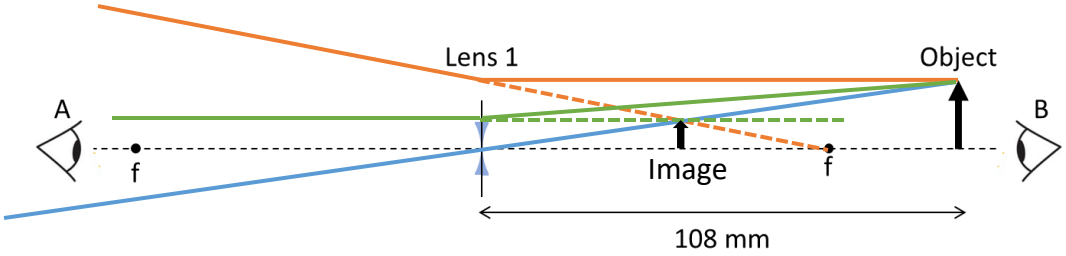
A. The center of the central bright fringe
B. The center of a bright fringe other than the central bright fringe
C. The center of a dark fringe
D. Somewhere between the centers of a bright fringe and a dark fringe
E. Not enough information to determine

Name_____**UW net ID** _____**@uw.edu**
last *first*

III. Lecture free response (25 points)

An object is placed 108 mm to the right of lens 1, which has a focal length of -78.0 mm.

13) (7 pts) On the diagram below draw the <u>three</u> "special" rays to determine the location of the imaged formed by this lens. <u>Clearly indicate where the image is formed</u>.



14) (5 pts) Two people, A and B, are located and looking in the directions shown. Can A, B, both or neither see the image? <u>Explain</u>.

Only person A can see the image as they see rays that have been bent by the lens and appear to originate at the image. The rays that are bent by the lens do not reach person B, so they only see rays directly from the object.

15) (5 pts) What is image distance relative to lens 1? <u>Show your work and be sure to indicate if it is on the left or right of lens 1.</u>

$\frac{1}{s}+\frac{1}{s\prime}=\frac{1}{f}$ Therefore $s'=\frac{sf}{s-f}=\frac{(108\text{mm})(-78\text{mm})}{(108\text{mm})-(-78\text{mm})}=-45.3\text{mm}$. Because it is negative it is on the same side of the object, so is to the right of the lens

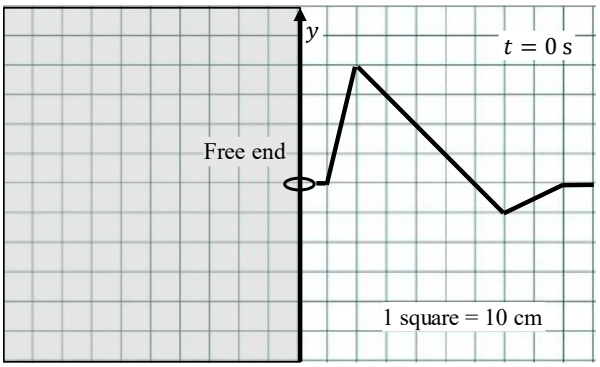
16) (8 pts) Now lens 2, which has a focal length of +98.0 mm, is placed 250 mm to the left of lens 1, as shown below. Where is the image for the lens combination located relative to lens 2? <u>Show your work and be sure to indicate if it is on the left or right of lens 2.</u>

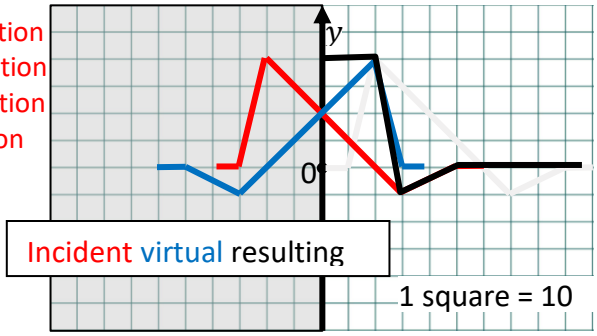
The image formed by lens 1 becomes the object for lens 2. This is 250mm+45.3mm=295.3mm to the right of lens 2.

$\frac{1}{s}+\frac{1}{s\prime}=\frac{1}{f}$ Therefore $s'=\frac{sf}{s-f}=\frac{(295.3\text{mm})(98\text{mm})}{(295.3\text{mm})-(98\text{mm})}=146.7\text{mm}$. Because it is positive it is on the opposite side of the object, so is to the left of lens 2.

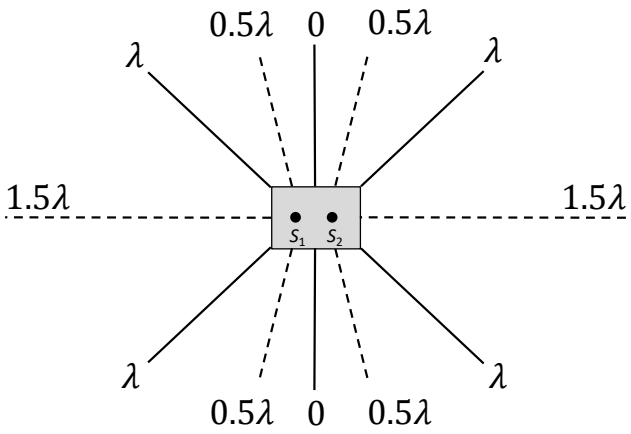
IV. Tutorial free response (15 points)

17) (7 pts) A pulse with a wave speed of 1.0 m/s is approaching the free end of a spring. The shape of the pulse at t = 0 s is shown on the top right figure.
On the bottom right diagram, draw the shape of the pulse at t = 0.4 s. Be sure to include and label any pulses you use to determine your answer. The shape of the pulse at t = 0 s is shown in gray for your reference.
[1 point] correct incident pulse shape
[1 point] correct incident pulse horizontal position
[1 point] correct virtual pulse up-down orientation
[1 point] correct virtual pulse right-left orientation
[1 point] correct virtual pulse horizontal position
[2 points] correctly applying superposition



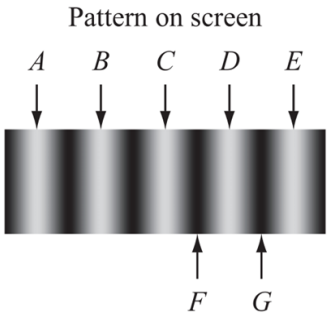


18) (4 pts) Two point-sources, S_1 and S_2, are oscillating in phase in water and each producing periodic circular waves of wavelength λ. S_1 and S_2 are separated by 1.5λ. The top-view of the sources are shown below. In the space below, draw qualitatively accurate nodal (dashed) and antinodal (solid) lines. You do not need to draw any lines inside the gray box near the sources. Label each line with path length difference, δs, in terms of λ.
[1 point] alternating nodal and antinodal lines
[1 point] correct number of lines.
[0.5 points] Both horizontal lines are labeled 1.5λ.
[0.5 points] Both horizontal lines are nodal
[0.5 points] both vertical lines are labeled 0.
[0.5 points] Both vertical lines are antinodal



Continued on next page.

19) (4 pts) Monochromatic light from a distant point source is incident on a mask with two identical, very narrow vertical slits. The diagram at right illustrates the pattern that appears at the center of a distant screen. If the left slit is now covered, which of the points labeled A through G would appear brighter? Explain your reasoning.



F and G will be brighter. Positions F and G are initially dark due to the destructive interference of the light waves from two slits. If one is covered, there would be no interference anymore, so the light from the other slit will shine at Positions F and G.

[1 point] Point F
[1 point] Point G
[1 point] why it was initially dark
[1 point] no more interference
[-1 point] Stated other incorrect locations