

Name _____ Student ID: _____
Last First

1. [5 pts] How does the width of the central maximum in a single-slit diffraction pattern change if the slit width is halved? Consider this problem in the small angle limit.

A) The width is halved.
B) The width is doubled.
C) The width is quadrupled.
D) The width remains the same.
E) The pattern splits into two distinct maxima.

2. [5 pts] A diffraction grating with 500 lines/mm is illuminated by light from a red laser ($\lambda = 600$ nm). What is the angle (from the central axis) to the first-order ($m = 1$) bright fringe

A) 10.4°
B) 17.5°
C) 20.0°
D) 30.0°
E) No first-order maximum exists.

3. [5 pts] The work function of sodium metal is 2.36 eV. What is the maximum kinetic energy (in eV) of an electron ejected by a photon with a wavelength of 420 nm?

A) 0.60 eV
B) 1.00 eV
C) 2.36 eV
D) 2.96 eV
E) 5.32 eV

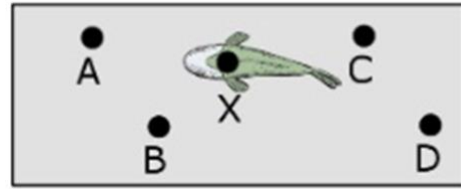
Name _____ Student ID: _____
Last First

4. [5 pts] A 100-watt microwave emitter operates at a frequency of 2.45 GHz. How many photons does it emit per second?
- A) 6.16×10^{18}
 - B) 6.16×10^{24}
 - C) 6.16×10^{27}
 - D) 6.16×10^9
 - E) 6.16×10^{25}
5. [5 pts] A proton and an electron are accelerated from rest through the same potential difference. Which particle has the shorter de Broglie wavelength?
- A) The electron.
 - B) The proton.
 - C) They both have the same de Broglie wavelength.
 - D) It depends on the magnitude of the potential difference.
 - E) Neither has a de Broglie wavelength.
6. [5 pts] The headlights of a car are 1.5 m apart. What is the approximate maximum distance (in km) you could be from the car and still resolve the two headlights as separate sources? Assume your eye has a pupil diameter of 5.0 mm at night, and the effective wavelength of the light is 550 nm. Use the Rayleigh criterion.
- A) 0.5 km
 - B) 1.1 km
 - C) 5.0 km
 - D) 11 km
 - E) 50 km

Name _____
Last First

Student ID: _____

7. [5 pts] You take a photo of a fish in a fish tank. The figure shows a top view of your camera and the tank. The fish is located at position X and **imagine that the medium outside the fish tank has an index of refraction higher than that of water.** Where does the fish appear to be located in your photo?



- A) A
B) B
C) C
D) D
E) X
8. [5 pts] What is the critical angle for total internal reflection when light travels from glass ($n_{\text{glass}} = 1.60$) into water ($n_{\text{water}} = 1.33$)?
- A) 38.7°
B) 48.8°
C) 56.2°
D) 28.0°
E) Total internal reflection cannot occur in this situation.
9. [5 pts] Which of the following statements about the image formed by a diverging lens is correct?
- A) The image must be virtual, and the size of image must be smaller than the size of the object.
B) The image must be virtual, and the size of image must be larger than the size of the object.
C) The image must be virtual, and the size of image can be smaller or larger than the size of the object.
D) The image can be virtual or real, and the size of image can be smaller or larger than the size of the object.
E) None of the above.

Lab Multiple Choice Questions

10. [5 pts] In lab A3, a group of students explored how modifying the simulation affects wave propagation on a string. Originally, each non-end ball has a force due to the springs on the left and the right, but one modification you could make to the code was to add friction, which depended on the speed v_{ball} of the ball in the form $F_{\text{fric}} = -fv_{\text{ball}}$. Keeping the initial height above equilibrium, h_i , and the initial width w_i of the pulse the same, the group varies the values of f and measures the new height h_2 after a certain amount of time. Which of the following represents their dependent variable?

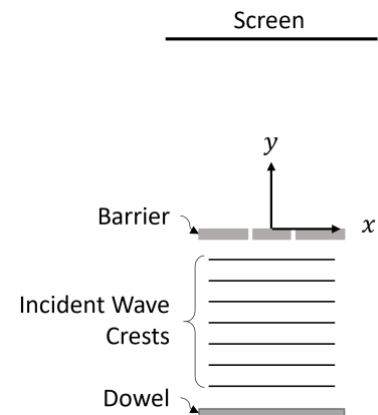
- A) F_{fric}
- B) w_i
- C) h_2
- D) f
- E) h_i

11. [5 pts] A pan of water contains a dowel that moves up and down at a constant rate producing straight wavefronts that propagate towards a barrier. The barrier contains two very narrow slits through which the waves can pass. Consider a coordinate system with the origin at the center of the barrier, as shown in the diagram at the right.

Consider water waves with a wavelength of 0.20 m, and a barrier with slit L at (-0.50 m, 0.00 m) and slit R at (0.50 m, 0.00 m).

Consider a point P on the screen with (x,y) coordinate of (-1.05 m, 4.00 m). Will the interference of the two waves from the left and right slit at point be maximum constructive, complete destructive interference or something in between?

- A) Maximum constructive interference
- B) Complete destructive interference
- C) Something in between
- D) Not enough information

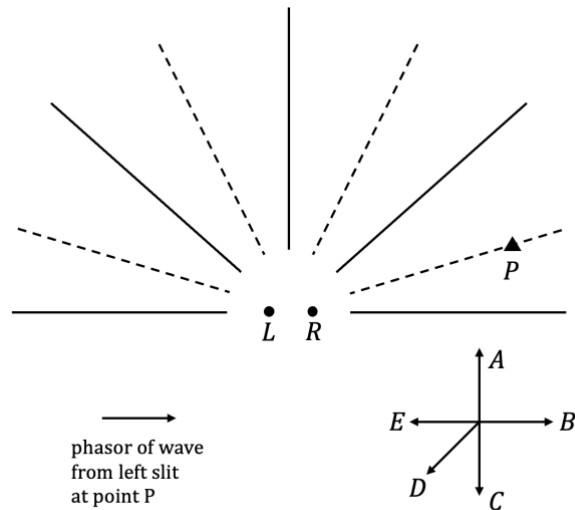


Name _____
Last First

Student ID: _____

12. [5 pts] Consider two in-phase point-sources of water waves, L and R . The top view diagram at right shows the nodal lines (dashed) and antinodal lines (solid) due to these two sources. Consider point P on the diagram. The phasor of the wave from the left slit at point P is also shown at right. Which of the arrows (A to E) represent the phasor of the wave from the right slit at point P at the same instant?

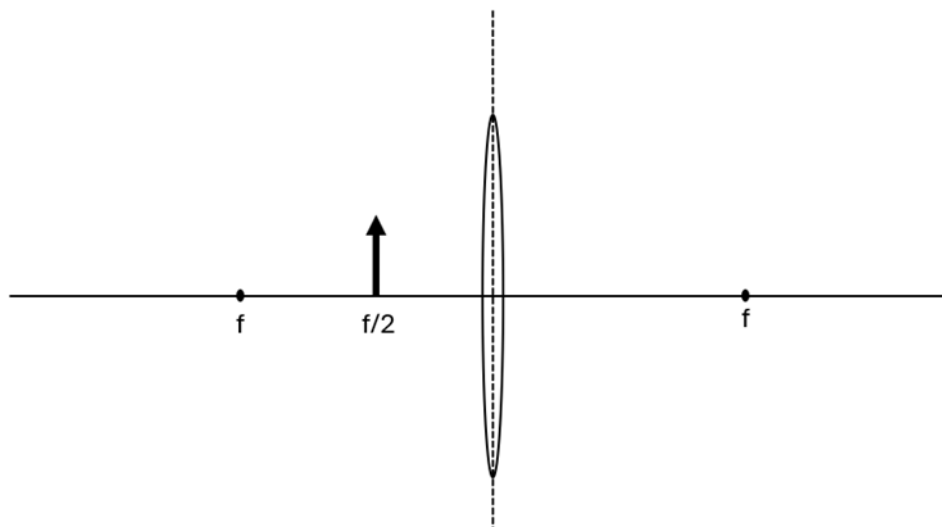
- A) Arrow A
- B) Arrow B
- C) Arrow C
- D) Arrow D
- E) Arrow E



Name _____ Student ID: _____
Last First

Lecture Free Response

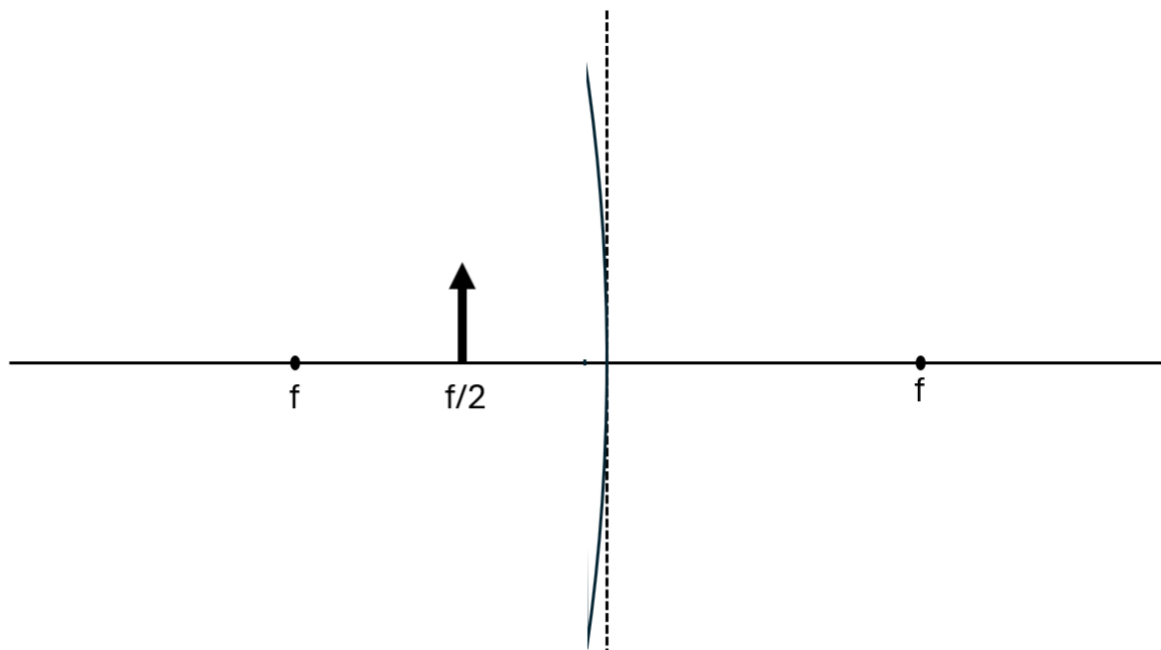
Use the figure below to answer Q13, 14 and 15. As shown, an object is located at a distance that is half of the focal length from a converging lens.



13. [5 pts] Please draw the three special rays and determine the location of the image.
14. [5 pts] Is the image real or virtual? Please explain.
15. [5 pts] What is the image distance, s' , in terms of focal length, f ? Show your work.

Name _____ Student ID: _____
Last First

Use the figure below to answer Q16 and 17. As shown, an object is located at a distance that is half of the focal length from a converging mirror.



16. [5 pts] Please draw the three special rays and determine the location of the image.

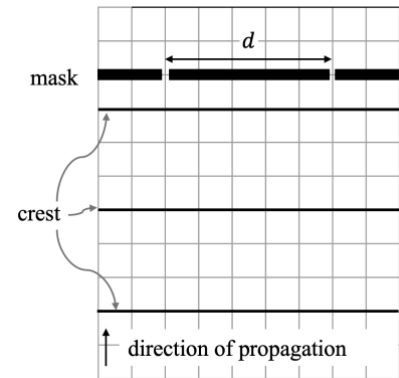
17. [5 pts] Is the image real or virtual? Please explain.

Tutorial Free Response Questions

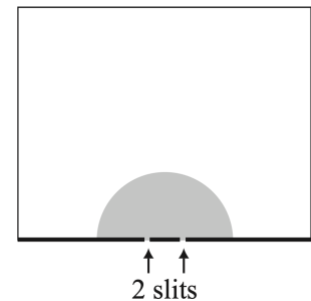
Note: In the diagrams representing interference patterns below, lines of **maximum constructive** interference are represented by **solid lines** and *nodal lines* are represented by *dashed lines*.

In Experiment 1, a periodic wave is generated by a dowel in a big tank of water. The diagram at right shows successive crests of the periodic wave incident on a mask with two very narrow slits.

18. [3 pts] Determine the distance between the slits, d , in terms of the wavelength λ . Briefly explain.

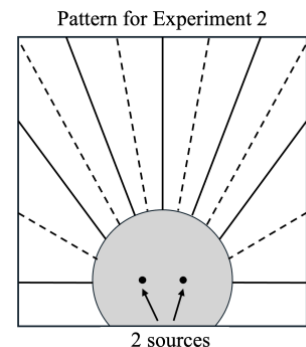


19. [4 pts] Sketch the approximate locations of all the lines of maximum constructive interference (solid) and nodal lines (dashed) in the region of the tank far away from the slits (the unshaded region in the box at right). You need not calculate angles. Explain briefly.



In Experiment 2, two point sources generate periodic waves by tapping the surface of the water. The diagram at right shows an interference pattern for Experiment 2 in the region far away from the sources (unshaded).

20. [4 pts] Determine the source separation, d , in terms of the wavelength λ . If an exact value cannot be determined, give the smallest range into which d must fall. Explain.



21. [4 pts] A single change is made to Experiment 2. As a result, the interference pattern is changed, as shown at right. Could increasing the frequency of the sources result in the change in the interference pattern? Explain.

