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Physics 125, Analytical Physics II **Section 99**

Date Thr, Feb 19, 2009 at 09:00 *Exam 1*

1. [6pt] For each statement, write in T for True, F for False. If the first is for True and the rest for False, enter TFFFFF).

A) When light is reflected off of an interface between two media with different indices of refraction, the reflected light ray always experiences a 180 degree phase shift with respect to the incident ray.

B) Sound waves are transverse waves.

C) Light travels slower in glass than it does in a vacuum.

D) When two sound waves combine, in order for them to destructively interfere everywhere, they must be travelling in the same direction.

E) Wave pulses in strings are transverse waves.

F) The speed of a wave on a rope is the same for all wave frequencies.

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2. [4pt] Waves travel on five identical strings. Four of the strings have tha same tension, but the fifth has a different tension. Use the mathematical forms of the waves given below to identify the string with the different tension. In each of the expressions x and y are measured in centimeters and t in seconds.

A) $y(x,t) = 2\sin(4x - 10t)$
B) $y(x,t) = 2\sin(-10x - 20t)$
C) $y(x,t) = 4\sin(2x + 4t)$
D) $y(x,t) = 4\sin(8x - 16t)$
E) $y(x,t) = 2\sin(-6x + 12t)$

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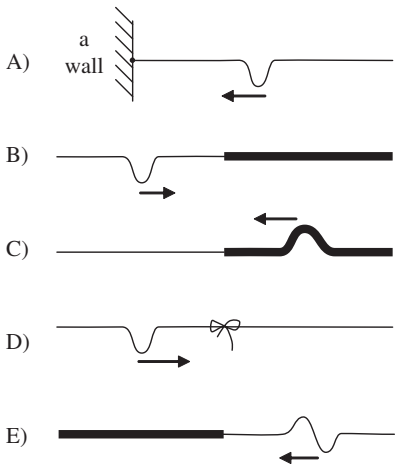
3. [3pt] Each of the following pictures shows a rope with a wave pulse that is heading for a junction (either a wall, or a knot to another rope). The thicknesses of the ropes are shown.



This question is about what reflections will happen when the pulse reaches the junction. For each case, enter one of these letters into the answer box: N if there will not be any reflected pulse, U if there will be an "upright" reflected pulse, or I if there will be an "inverted" reflected pulse.

4. [3pt] Now for the same situations, consider what transmitted pulses may occur. Again, enter N for no transmitted pulse, U for an upright transmitted pulse, or I for an inverted transmitted pulse.

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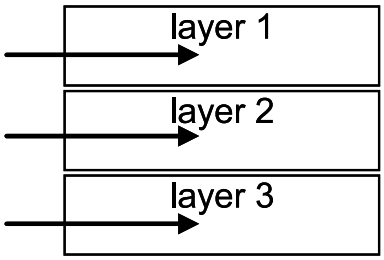
5. [4pt] The light waves represented by the three rays shown in the diagram all have the same frequency. 4.7 wavelengths fit into layer 1, 3.2 wavelengths fit into layer 2, and 5.3 wavelengths fit into layer 3. Rank the layers according to their indices of refraction, least to greatest.



A) 1, 3, 2 B) 2, 3, 1 C) 1, 2, 3
D) 3, 2, 1 E) 2, 1, 3 F) 3, 1, 2

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6. [4pt] An air wedge is formed from two glass plates which are in contact at their left edges. There are ten dark bands when viewed from above. The left edge of the top plate is now slowly lifted until the plates are parallel. During this process:

A) the dark bands remain stationary.
B) the dark bands crowd toward the right edge.
C) the dark bands spread out, disappearing off the right edge.
D) the dark bands spread out, disappearing off the left edge.
E) the dark bands crowd towards the left edge.

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7. [3pt] An electrical insulator is a material

A) that must be a crystal.
B) cannot be a pure chemical element.
C) through which electrons do not flow very easily.
D) in which Coulomb's law is not valid.
E) which has more electrons than protons on its surface.
F) containing no electrons.

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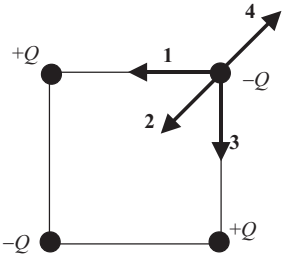
8. [3pt] Four point charges, each of the same magnitude, with varying signs are arranged at the corners of a square as shown. Which of the arrows labeled 1, 2, 3, and 4 gives the correct direction of the net force that acts on the charge at the upper right corner?



A) 4
B) 1
C) 2
D) 3
E) The net force on that charge is zero

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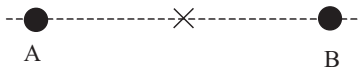
9. [4pt] Two point charges, A and B, lie along a line separated by a distance L. The point "x" is at the midpoint of their separation.



Which combination of charges would yield the greatest repulsive force between the charges?"

A) $+1q$ and $-3q$
B) $+1q$ and $+7q$
C) $-2q$ and $+4q$
D) $-1q$ and $-4q$
E) $-2q$ and $-4q$

10. [5pt] A sinusoidal wave of frequency 595 Hz has a velocity of 265 m/s. How far apart (along the direction of wave propagation and in meters) are two points that differ in phase by $\pi/5$?

A) 8.05×10^{-3} B) 1.07×10^{-2} C) 1.42×10^{-2} D) 1.89×10^{-2}
E) 2.52×10^{-2} F) 3.35×10^{-2} G) 4.45×10^{-2} H) 5.92×10^{-2}

11. [5pt] Two observers are listening to a trombone player. One is distance 3.2 m away, and the other is distance 16.64 m away. What is the ratio of the intensity heard by the more distant observer to that heard by the closer observer?

A) 3.16×10^{-2} B) 3.70×10^{-2} C) 4.33×10^{-2} D) 5.06×10^{-2}
E) 5.92×10^{-2} F) 6.93×10^{-2} G) 8.11×10^{-2} H) 9.49×10^{-2}

12. [5pt] A certain sound level is increased by 7.42 dB. What is the ratio of the new intensity to the original intensity?

A) 2.63 B) 3.81 C) 5.52 D) 8.01
E) 1.16×10^{1} F) 1.68×10^{1} G) 2.44×10^{1} H) 3.54×10^{1}

13. [5pt] An ambulance driver traveling at 30.0 m/s honks his horn as he sees a motorist ahead on the highway, going in the same direction. The motorist hears a frequency of 371 Hz, and notices that his own speedometer reads 20.0 m/s. Calculate the frequency that the ambulance driver hears. The speed of sound in air is 340 m/s.

Enter your answer (with units) on the answer sheet.

14. [5pt] A physics student walks down a long hall carrying a vibrating 472.0 Hz tuning fork. The end of the hall is closed so that the sound reflects from it. The student hears 5.0 beats per second. How fast is the student walking, in m/s? Assume that the velocity of sound is 343.0 m/s.

A) 9.08×10^{-1} B) 1.14 C) 1.44 D) 1.81
E) 2.27 F) 2.86 G) 3.60 H) 4.52

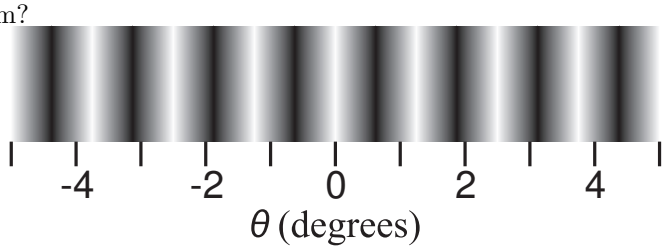
15. [6pt] A string is tied to a sinusoidal oscillator and runs a distance L =1.55 m to a support. The string is stretched over the support by a hanging block of mass m. The frequency f of the oscillator is fixed at 120 Hz. The amplitude of the oscillator is negligible compared to the motion of the string. A standing wave appears when the mass of the hanging block is 276.0 g or 349.3 g, but not for any intermediate mass. What is the linear density of the string, in g/m?

A) 8.45×10^{-1} B) 9.89×10^{-1} C) 1.16 D) 1.35
E) 1.58 F) 1.85 G) 2.17 H) 2.54

16. [4pt] A tube with a cap on one end, but open at the other end, produces a standing wave whose fundamental frequency is 125.8 Hz. The speed of sound is 343 m/s. If the cap is removed, what is the new fundamental frequency (in Hz)?

Enter your answer (with units) on the answer sheet.

17. [5pt] Light of wavelength 490 nm passes through a double slit, yielding a pattern whose intensity I versus angular position θ is shown below. What is the separation between the slits, in mm?



A) 1.55×10^{-2} B) 2.25×10^{-2} C) 3.26×10^{-2} D) 4.73×10^{-2}
E) 6.86×10^{-2} F) 9.94×10^{-2} G) 1.44×10^{-1} H) 2.09×10^{-1}

18. [4pt] A thin film of soap (n =1.34) is hanging in the air. It is observed that this film reflects dominantly red light (674 nm). What is the minimum thickness (in nm) of the film?

A) 6.29×10^{1} B) 1.26×10^{2} C) 1.89×10^{2} D) 2.51×10^{2}
E) 3.14×10^{2} F) 3.77×10^{2} G) 4.40×10^{2} H) 5.03×10^{2}

19. [4pt] Now, a soap film of thickness 504 nm is placed on a sheet of glass, (n =1.48). The index of refraction of the soap film is the same as stated in the previous problem. What is the longest wavelength (in nm) that will be predominantly reflected?

A) 9.00×10^{2} B) 1.35×10^{3} C) 2.70×10^{3} D) 5.40×10^{3}
E) 9.95×10^{2} F) 1.49×10^{3} G) 2.98×10^{3} H) 5.97×10^{3}

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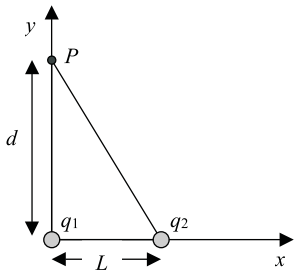
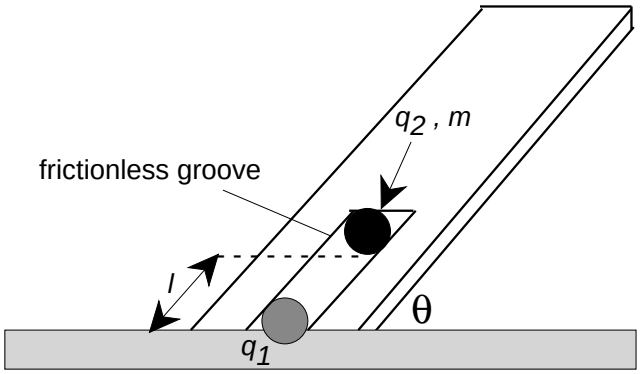
A point charge $q_1 = $ -5.9 μC is placed at the origin. Another point charge $q_2 = 14.3\,\mu$C is placed a distance $L = 4.0$ m along the x-axis, as shown in the figure. Consider the point P, located a distance $d = 8.1$ m from the origin along the y-axis.



20. [6pt] A third point charge of -2.9 μC is placed at point P. What is the magnitude of the force felt by this particle (in N)?

A) 2.14×10^{-3} B) 2.68×10^{-3} C) 3.34×10^{-3} D) 4.18×10^{-3}
E) 5.22×10^{-3} F) 6.53×10^{-3} G) 8.16×10^{-3} H) 1.02×10^{-2}

21. [6pt] A single charge $q_1 = 1.00 \times 10^{-7}$ C is fixed at the base of a plane that makes an angle θ with the horizontal direction. A small ball of mass $m = 1.80$ g and a charge $q_2 = 3.75 \times 10^{-8}$ C is placed into a smooth frictionless groove in the plane that extends directly to the fixed charge (as in the diagram below). It is allowed to move up and down until it finds a stable position $l = 11.5$ cm from the fixed charge. What is the value of θ?



A) 5.76 B) 6.51 C) 7.35 D) 8.31
E) 9.39 F) 1.06×10^{1} G) 1.20×10^{1} H) 1.35×10^{1}

22. [6pt] A transverse wave is traveling in the $-x$ direction on a string that has a linear density of 0.007 kg/m. The tension in the string is 14.7 N. The amplitude of the wave is 1.5 cm and its wavelength is 2.3 m. Write the equation for this wave in the space provided on the answer sheet. All quantities must be in SI units.