

**CLOSED BOOK TEST**

**TIME: 100minutes**

**Part 1. In the scantron sheet to answer all MC questions below.  
(Best 6 count towards 48% of your test mark)**

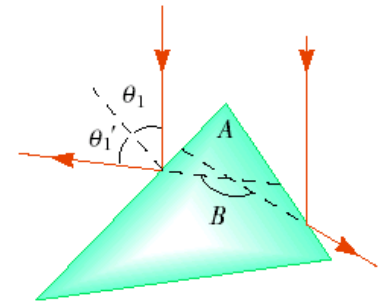
- A piano string of density 0.0050 kg/m is under a tension of 1350 N. Find the velocity with which a wave travels on the string.  
a) 260 m/s                      b) 520 m/s                      c) 1040 m/s  
d) 2080 m/s                      e) 4160 m/s
- A point source emits sound waves with a power output of 100 watts. What is the sound level (in dB) at a distance of 10 m?  
a) 139                              b) 119                              c) 129  
d) 109                              e) 10
- A car approaches a stationary police car at 36 m/s. The frequency of the siren (relative to the police car) is 500 Hz. What is the frequency (in Hz) heard by an observer in the moving car as he approaches the police car? (Assume the velocity of sound in air is 343 m/s.)  
a. 220  
b. 448  
c. 5264  
d. 552  
e. none of the above
- The actual depth of a shallow pool 1.0 m deep is not the same as the apparent depth seen when you look straight down at the pool from above. How deep (in cm) will it appear to be? ( $n_{\text{water}} = 1.33$ .)  
a) 133                      b) 75                      c) 90                      d) 117                      e) 100
- A concave mirror has a focal length of 20 cm. What is the position (in cm) of the resulting image if the image is inverted and four times smaller than the object?  
a) 15                      b) 25                      c) 50                      d) 100                      e) -15
- A laser beam ( $\lambda = 694 \text{ nm}$ ) is incident on two slits 0.100 mm apart. Approximately how far apart (in m) will the bright interference fringes be on the screen 5.00 m from the double slits?  
a.  $3.47 \times 10^{-3}$                       b.  $3.47 \times 10^{-2}$   
c.  $3.47 \times 10^{-4}$                       d.  $3.47 \times 10^{-6}$   
e.  $3.47 \times 10^{-5}$
- A ruby laser beam ( $\lambda = 694.3 \text{ nm}$ ) is sent outwards from a 2.7-m diameter telescope to the moon, 384,000 km away. What is the radius of the big red spot on the moon?  
a) 500 m                      b) 250 m                      c) 120 m                      d) 1.0 km                      e) 2.7 km

1 A small speaker of mass  $M=1\text{kg}$  is swinging as a simple pendulum on the rope of length  $L=1\text{m}$  while emitting a sound of a single frequency  $f$  and power  $P = 120\text{W}$ . When the pendulum is at the end of its swing:  $12^\circ$  from vertical, (the furthest away from the equilibrium) the speaker sound is exactly matched by the sound produced by second harmonic of the string of length  $70\text{ cm}$ . Given the speed of sound in the air  $v=350\text{m/s}$  find the following .

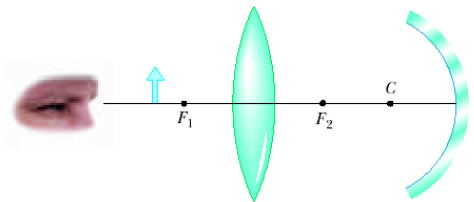
- find the frequency of the sound emitted from the speaker when the pendulum is at the position of the maximum deviation.
- find the maximum and minimum loudness of the sound detected by a person  $10\text{ meters}$  away from the pendulum suspension point.
- Find the maximum and minimum frequency heard by this observer.

The observer position long the plane of the pendulum oscillations

2 One technique for measuring the angle of a prism is shown: a parallel beam of light is directed on the angle so that parts of the beam reflect from opposite sides. Find the angular separation of the two reflected beams ( $B$ ) in terms of the apex angle  $A$  .



3 Figure below shows a thin converging lens for which the radii of curvature are  $R_1 = 9.00\text{ cm}$  and  $R_2 = -11.0\text{ cm}$ . The lens is in front of a concave spherical mirror with the radius of curvature  $R = 8.00\text{ cm}$ . The lens focal points  $F_1$  and  $F_2$  are  $5.00\text{ cm}$  from the center of the lens.



- Determine lens' index of refraction.
- The lens and mirror are  $20.0\text{ cm}$  apart, and an object is placed  $8.00\text{ cm}$  to the left of the lens. Determine the position of the final image.
- Find its magnification as seen by the eye in the figure. Is the final image inverted or upright? Explain.

4 An oil film ( $n = 1.45$ ) floating on water ( $n=1.3$ ) is illuminated by white light at normal incidence. The film is  $280\text{ nm}$  thick. Find:

- the wavelength of the color of the light in the visible spectrum most strongly reflected
- the wavelength of the color of the light in the spectrum most strongly transmitted.

5 A spy satellite can consist essentially of a large-diameter concave mirror forming an image on a digital-camera detector and sending the picture to a ground receiver by radio waves. In effect, it is an astronomical telescope in orbit, looking down instead of up. Can a  $1\text{-m}$  diameter spy satellite  $100\text{km}$  above the earth, read a license plate made of letters having distinct features of the  $5\text{cm}$  size? Hint: pick the blue end of the spectrum ( $400\text{nm}$ ) as the observation wavelength.