

Question 1 [16 marks]

A 50.0 g object connected to a spring with a force constant at 35.0 N/m oscillates on a horizontal frictionless surface with an amplitude of 4.00 cm. Find:

- (a) the total energy of the system
- (b) the speed of the object when it is 1.0 cm from its equilibrium position
- (c) the kinetic energy when the object is 3.0 cm from its equilibrium position.
- (d) the potential energy when the object is 3.0 cm from its equilibrium position.

Question 2 [16 marks]

When an open metal pipe is cut into two pieces, the lowest resonance for the air column in one piece is 256 Hz and that for the other is 440 Hz.

- (a) What resonant frequency would have been produced by the original pipe?
- (b) How long was the original pipe?
- (c) If we take the two new pieces and close one end of each, what are the lowest frequencies at which they will now resonate?

Note: Assume that the speed of sound is $v = 343$ m/s.

Question 3 [16 Marks]

A thin sheet of mica ($n = 1.58$) is used to cover one slit of a double-slit arrangement. The central point on the screen is now occupied by the fringe that corresponds to the $m = 7$ fringe in the absence of the mica. If $\lambda = 550$ nm, what is the thickness of the mica?

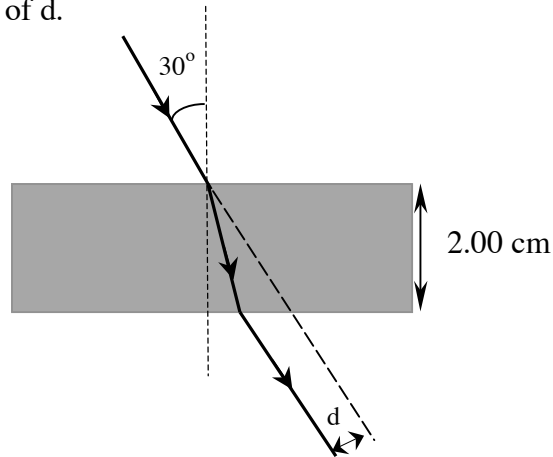
Question 4 [16 Marks]

Silicon has a refractive index of $n = 3.5$ for visible light. To minimize reflective losses at the surface, a silicon solar cell is coated with a thin layer of silicon monoxide ($n = 1.45$).

- (a) Determine the minimum thickness of this layer that will produce the least reflection at a wavelength of 550 nm.
- (b) At what wavelength between 200 and 800 nm will this thin layer produce maximum reflection?

Question 5 [20 Marks]

When light passes through a 2.00 cm thick glass block as shown, it is shifted laterally by the distance d . Taking $n = 1.50$, find the value of d .

**Question 6 [16 Marks]**

- (a) A circular radar antenna has a diameter of 2.10 m and operates at a frequency of 15.0 GHz. Two small boats are located 9.00 km away from the radar station. How close together could the boats be and still be detected as two separate objects?
- (b) The angle of incidence of a light beam onto a reflective surface can be varied through a range of angles. When the angle of incidence is set to 48.0° , the reflected ray is found to be completely polarized. What is the index of refraction of the reflecting material?