WAVES, FYSA13

Wednesday, August 25, 2021

Allowed material: The formula sheets from the exam webpage (printed!) and a calculator.

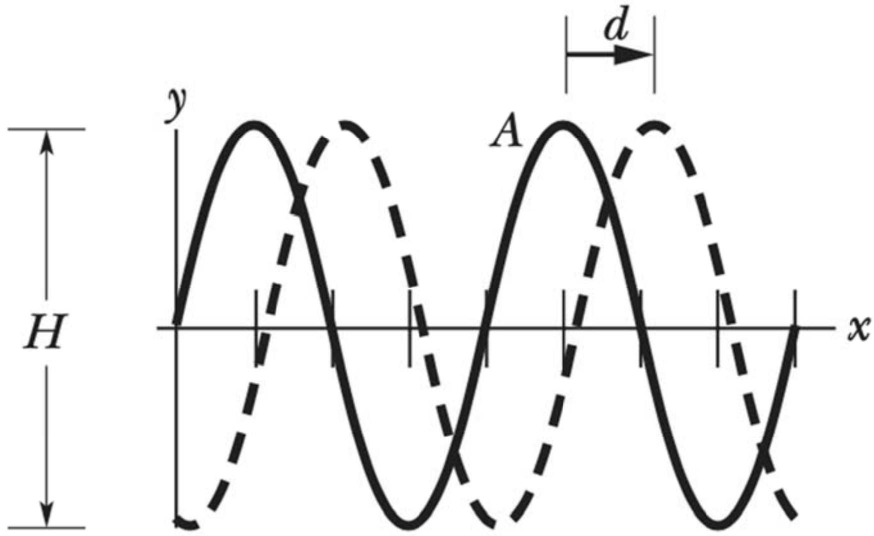
Total number of points: 20. Points required to pass: 10

<u>The following values can be used in the problems below:</u>

The speed of sound in air is 340 m/s and the density of air is 1.20 kg/m^3. The speed of sound in water is 1484 m/s and the density of water is 997 kg/m^3. The speed of light is 3.00x10^8 m/s. The gravitational acceleration is 9.82 m/s^2 and 1 m/s = 3.6 km/h.

<u>V1</u>

A sinusoidal wave moving along a string is shown twice in the figure below, as crest *A* travels in the positive direction of an *x* axis by distance *d* = 8.0 cm in 5.0 ms. The tick marks along the *x* axis are separated by 10 cm; height *H* = 6.00 mm. The equation for the wave is in the form $y(x,t) = y_m \sin(kx \pm \omega t)$. What are y_m, *k*, ω and the correct choice of sign in front of ωt? (3 p)



<u>V2</u>

Two identical mass-spring systems consist of 430-g masses on springs of constant *k* = 2.2 N/m. Both are displaced from equilibrium, and the first is released at time *t* = 0. How much later should the second be released so their oscillations differ in phase by $\pi/2$? (3 p)

V3

The 4600 Swedish civil defense sirens (“Hesa Fredrik”) are tested 4 times a year at 15:00. The sirens can produce 130 dB at a distance of 30m.

a) What will be the sound intensity level at a distance of 1.00 km from the siren (assume the sound from the siren is sinusoidal and is going out equally in all directions)? (2 p)

b) You drive past a siren at the side of a motorway at 110 km/h during a test. With how many percent will the frequency change when you pass it? (2 p)

V4

a) Give the mathematical expression for how the displacement amplitude depends on the distance to the siren in the previous problem. (2 p)

b) How will the pressure function for the siren change when going from a distance of 30 m to 1000 m to the siren? (2 p)

Both in (a) and (b) above, you can assume that the soundwave is sinusoidal with a frequency of 572 Hz.

V5

In a double-slit experiment with narrow slits, the separation of the dark bands on a screen becomes 2.00 mm when the light's wavelength is 632.8 nm. The angles to the dark bands in the interference pattern on the screen are so small that one can make the approximation $\sin(\theta) = \tan(\theta)$ where θ is the angle between the normal to the plane of the slits and a line from the slits to a point on the screen.

a) How does the separation of the dark bands change if the wavelength changes to 400 nm? (4 p)

b) How does the separation of the dark bands change if the slit distance is changed from 200 µm to 300 µm and the wavelength is kept at 632.8 nm? (2 p)