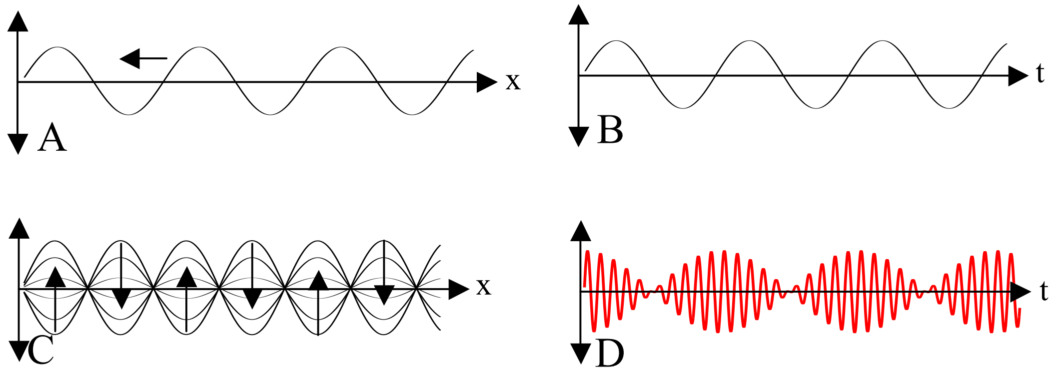
MT1 132 S15 Schwartz Name______________________________

All waves pass through the origin – even if it doesn't look like it.



1. This waveform results when two identical waves of amplitude A, wave number k, and frequency ω, approach each other from opposite directions.

a) What is the name of the resulting wave form? Standing Waves

b) Which graph above represents this wave form? C

c) What is the mathematical function of the resulting wave form in terms of things we know like A, ω, k?

It's a stationary wave in space that oscillates up and down in time: $y = A\sin(\omega t + \delta)\sin(kx + \phi)$, where δ, ϕ are just phase constants, and either or both of the "sin" could be "cos", because the difference is only a shift in δ, ϕ.

2. This waveform results from the interference of two waves of amplitude A, and slightly different frequencies, 99 Hz and 101 Hz.

a) What is the name of the resulting phenomenon? Beats

b) Describe what I hear. The sound of 100 Hz oscillating in loudness 2 times each second.

c) Which graph best represents this wave form? D, except there should be 50 oscillations in each bunch instead of only 10.

d) What is the mathematical function of the resulting wave form in terms of things we know like A, and ω?

Refer to letter b) above: we should have an oscillation at 100 Hz that oscillates in amplitude at 2 Hz:

$y = A\sin(4\pi t / s + \delta)\sin(200\pi t / s + \phi)$, where δ, ϕ are constants… and could just be left out as well

3. This waveform represents the motion of a mass on a spring

a) What is the name of the resulting motion? SHO

b) Which graph above represents this motion? B

c) What is the mathematical function of the resulting wave form in terms of things we know like A, and ω?

Something oscillating in time, not in space: $y = A\sin(\omega t + \phi)$, or cos…

4. My friend has an old car with a mass of 2000 kg, and it has 30 cm of clearance (between the road and the floor of the car). However, when we all get in (250 kg of us), the car has only 25 cm of clearance!

a) What is the effective spring constant of the car's suspension?

k_e=____$5\text{x}10^4$ N/m

b) If we decided to bounce the car up and down (empty), what would be the period of our oscillations?

T=____~1.3s

5. I am floating in the ocean waves. The form of the wave is $3m\cos\left[\left(0.05\pi/m\right)x + \left(0.4\pi/s\right)t + \pi/6\right]$

a) calculate the wavelength.

λ=____40 m

b) What is the period of the wave?

T=____5s

c) calculate the speed of the wave v_w=____8 m/s

5. I am floating in the ocean waves. The form of the wave is $3m\cos\left[\left(0.05\pi/_m\right)x+\left(0.4\pi/_s\right)t+\pi/6\right]$

a) calculate the wavelength.

λ=____

b) What is the period of the wave?

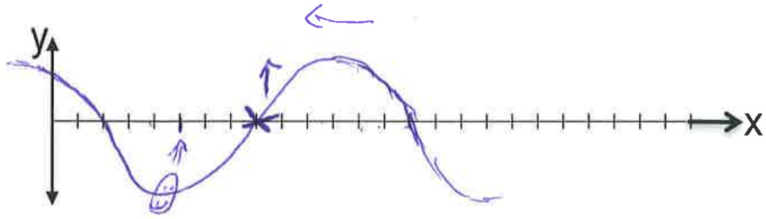
T=____

c) calculate the speed of the wave

v_w=____

π/6 = 1/3 of a rt angle

d) At right make a snapshot of the wave, (at t = 0s), showing at least one wavelength with correct phase and mark the x and y axis with the appropriate numbers and units.



e) which way is the wave moving? Show with an arrow: ←

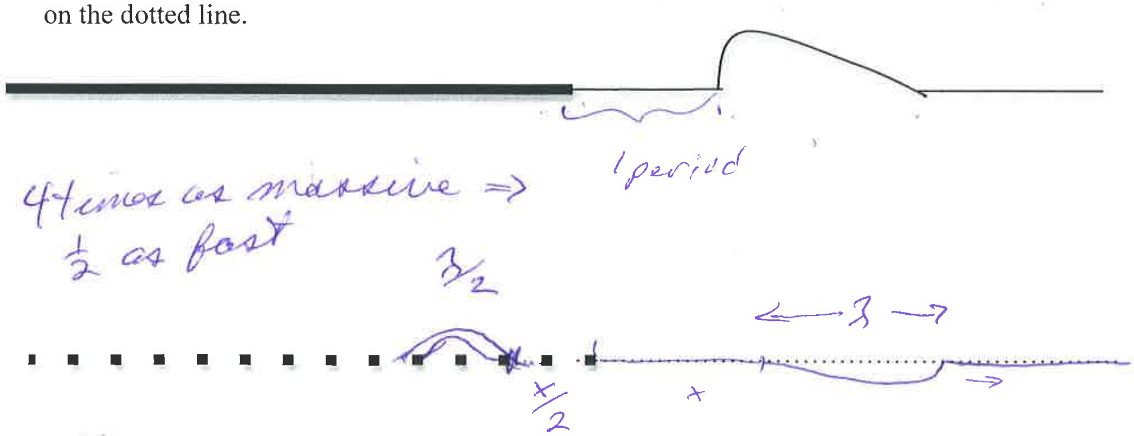
f) Calculate the maximum acceleration I experience as the waves go past.

a_{max}= ____ 4.7 m/s

g) Put a "☺" *at one place* where I would have maximum acceleration and show with an arrow the direction of my acceleration.

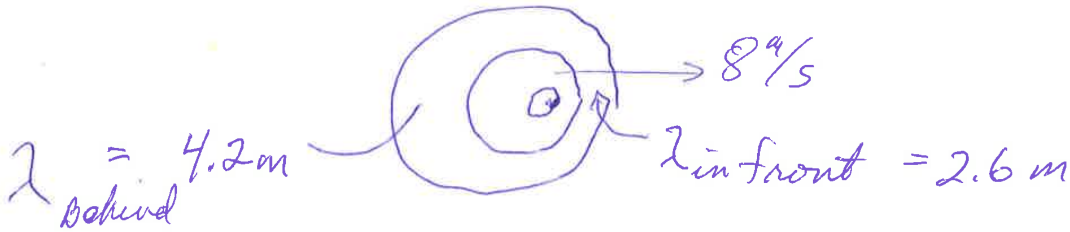
h) Put a "X" *at one place* where I would have maximum velocity and show with an arrow the direction of my velocity.

6. Below, you see a wave moving *to the left* on a string incident on a boundary with a string that has 4 times the mass density. Please draw the strings 3 full periods in the future as exactly as possible, below on the dotted line.



7. I'm driving a car at 80 m/s (very fast), and I pass you as you travel at 40 m/s *in the opposite direction*. I lay on my (100 Hz) horn to say "hello" as we pass.

a) Briefly qualitatively describe what you hear as we pass each other. Feel free to draw a picture.



b) What is the frequency of the sound you hear from my horn *after* we pass?

f_{after} = 71.4 Hz f_{Before} = 146 Hz

6. I pluck a 1 m guitar string exactly in the middle. 2 m of the string has a mass of 1 g, and is under a tension of 20 N. Please find the pitches of the *two lowest frequencies* produced when I let the string go. This is a multistep problem. If you can't find the answer, find what you can.

f_1 = 100 Hz
f_2 = 300 Hz   why is 1st overtone not allowed?

7. I am oscillating the end of a string up and down at a *constant frequency, tension, and amplitude* as the wave travels away. Then, suddenly, the string's mass density is quadrupled: $\mu \Rightarrow \underline{4}\, \mu_o$, what happens to the:

a) Velocity of the wave? $v_w \Rightarrow \underline{\tfrac{1}{2}}\, v_{wo}$

b) Wavelength: $\lambda \Rightarrow \underline{\tfrac{1}{2}}\, \lambda_o$

c) Power I put out: $P \Rightarrow$ _2_ P_o

d) Angle that the string makes when it crosses the equilibrium position: $\theta \Rightarrow$ _2_ θ_o, in the small angle approximation

e) Maximum acceleration of a piece of a tiny (~1 mm) length of string: $a \Rightarrow$ _1_ a_o