Name _____**Student ID** _____ **Score**_____

last *first*

Part I. [29 points] The transverse displacement of a traveling harmonic wave on a stretched rope is $D(x,t) = 0.03\cos(3.4x - 6.8t)$, where x and $y=D(x,t)$ are in meters and t is in seconds.

1. [3 points] What is the amplitude of this wave?
   - **A.** 0.03 m
   - **B.** 0.06 m
   - **C.** 3.4 m
   - **D.** 6.8 m
   - **E.** 6.8 m
2. [3 points] What is the wavelength of this wave?
   - **A.** 0.29 m
   - **B.** 0.92 m
   - **C.** 1.9 m
   - **D.** 105 m
   - **E.** 209 m
3. [3 points] What is the speed with which this wave travels?
   - **A.** 0.32 m/s
   - **B.** 1.0 m/s
   - **C.** 2.0 m/s
   - **D.** 113 m/s
   - **E.** 227 m/s
4. [3 points] In what direction is this wave propagating?
   - **A.** $+x$
   - **B.** $-x$
   - **C.** $+y$
   - **D.** $-y$
   - **E.** None of the above
5. [3 points] What is the frequency (NOT the angular frequency) of this wave?
   - **A.** 0.00475 Hz
   - **B.** 0.0095 Hz
   - **C.** 0.54 Hz
   - **D.** 1.1 Hz
   - **E.** 6.8 Hz

Name _____**Student ID** _____ **Score**_____

last *first*

6. [3 points] Consider the piece of rope located at x = 2 m. What is the velocity v of this piece of rope at the time t = 3 s in the **x** direction?

A. -0.18 m/s

B. -0.03 m/s

C. 0.0 m/s

D. 0.015 m/s

E. 0.20 m/s

7. [4 points] And in the **y** direction?

A. -0.18 m/s

B. -0.03 m/s

C. 0.0 m/s

D. 0.015 m/s

E. 0.20 m/s

8. [4 points] Consider the piece of rope located at x = 2 m. What is the acceleration of this piece of rope at the time t = 3 s?

A. -0.71 m/s^2

B. -0.18 m/s^2

C. 0.0 m/s^2

D. 0.016 m/s^2

E. 0.71 m/s^2

9. [3 points] If the tension in the rope were increased by a factor of 3, how would the wave speed change?

A. The wave speed would increase by a factor of 3.

B. The wave speed would decrease by a factor of 3.

C. The wave speed would increase by a factor of $\sqrt{3}$

D. The wave speed would decrease by a factor of $\sqrt{3}$

E. The wave speed would not change.

Name _____**Student ID** _____ **Score**_____

last *first*

Part II. [21 points] Consider a guitar string, 50 cm long. Its left most end is at x=0 m.

10. [3 points] What is the wavelength of the first excited mode (natural mode)?

A. 25 cm

B. 50 cm

C. 100 cm

D. 125 cm

E. 150 m

11. [3 points] What is the wavelength of the second excited mode?

A. 25 cm

B. 50 cm

C. 100 cm

D. 125 cm

E. 150 m

The string is under 75 N of tension, and has a mass per unit length of 20 g/m.

12. [4 points] What is the natural frequency, f_1?

A. 1.94 Hz

B. 3.87 Hz

C. 40.8 Hz

D. 61.2 Hz

E. 122 Hz

13. [3 points] What is the second natural frequency, f_2?

A. 1.94 Hz

B. 3.87 Hz

C. 40.8 Hz

D. 61.2 Hz

E. 122 Hz

14. [4 points] Which of the following is the most accurate mathematical description of the guitar string's oscillation in the second excited mode (assume D_M, k, and w are set to the correct values)?

A. $D(x,t) = D_M \sin(kx + wt)$

B. $D(x,t) = D_M \sin(kx - wt)$

C. $D(x,t) = D_M \cos(kx - wt)$

D. $D(x,t) = D_M \sin(kx)\cos(wt)$

E. $D(x,t) = D_M \cos(kx)\sin(wt)$

Name _____**Student ID** _____ **Score**_____

last *first*

Two guitar strings are placed next to each other. The first one resonates at 2010 Hz, and the second one at 2020 Hz.

15. [3 points] What is the beat frequency?

A. 5 Hz

B. 10 Hz

C. 2010Hz

D. 2015 Hz

E. 4030 Hz

16. [3 points] The frequency that best represents the tone you would hear?

A. 5 Hz

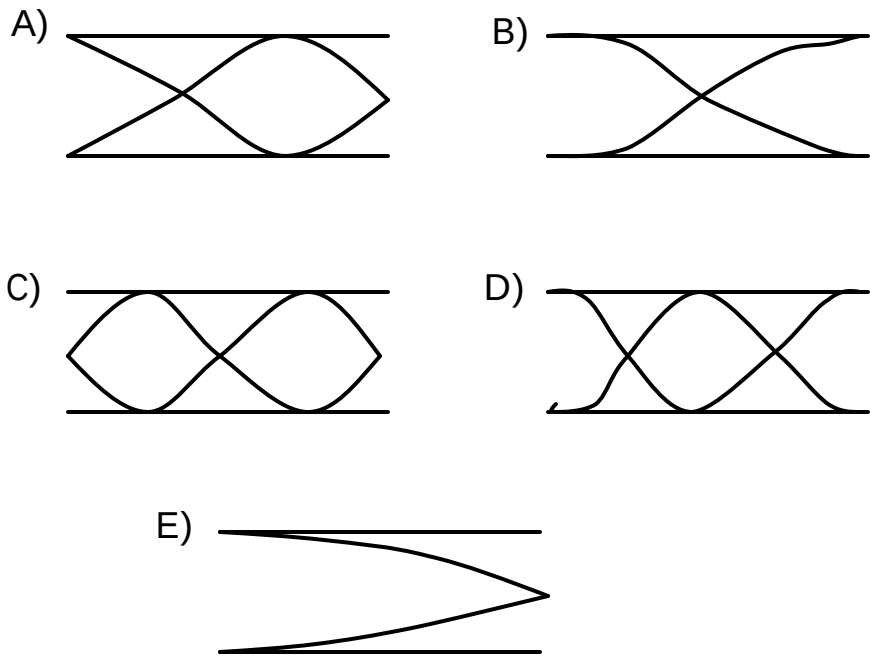
B. 10 Hz

C. 2010Hz

D. 2015 Hz

E. 4030 Hz

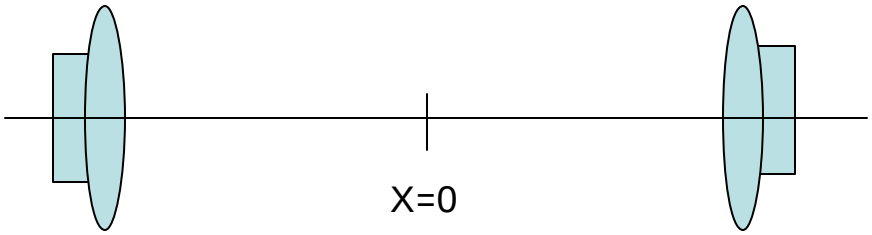
17. [4 points] Consider an open tube 100 cm long. Pick the picture that best represents the displacement of the air particles in a tube oscillating in its second harmonic mode.



Name _____ **Student ID** _____ **Score**_____

last *first*

Part III. [25 points] The two speakers emit a sound with pitch ***f*** (units Hz). The two speakers are in phase. The speakers are placed at ***+d*** and ***– d***. The speed of sound is **v**.



18. [5 points] Closest point to x=0, on the x-axis, that you can stand and get constructive interference? Destructive interference? Express your answers in terms of the quantities given.

19. [10 points] The sound level at x=0 is measured to be 10 db due to the two speakers. At a nearby point, $x=x_m$, the sound level due to the two speakers is measured to be 0 db. Calculate the ratio of amplitudes of the interfering sound wave at x=0 and the point x_m, D_{M0}/D_{Mxm}.

20. [10 points] Determine an expression for x_m in terms of the quantities given.