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Directions: No books or notes may be used during this exam.

Multiple-choice Questions. 10 points each. Circle the letter corresponding to your answer for each question. If you don't know the answer, then make your best guess.

1. Which wind instruments are unique because they have the closed-cylindrical harmonic structure?
(A) the brass family
(B) the saxophone family
(C) the flute family
(D) the clarinet family
(E) the recorder family.
2. The relationship between the distance from the source of a sound wave and its amplitude is called
(A) The Inverse Square Law
(B) Doppler's Law
(C) The Principle of Superposition
(D) Mersenne's Law
(E) The Characteristic Equation of a Wave.
3. A sound wave's amplitude decreases with time primarily due to
(A) resonance
(B) damping
(C) diffraction
(D) refraction
(E) none of the above.

Definitions/Short Answers. 10 points each. For full credit, use proper grammar, spelling and complete sentences. (A complete sentence has both a subject and a predicate.)

4. Describe how bowing can produce a wave on a string.

First, the bow sticks to the string and pulls it sideways. Then, the string slips because the force of friction is not big enough to stretch the string any further. This process repeats resulting in the string vibrating back and forth.

5. What is the difference between force and pressure?

Force is a push or pull. pressure is the amount of push or pull divided by the area over which it is applied.

6. Define infrasound. Infrasound is sound that has a frequency lower than about 20 Hz.

7. Define frequency. Frequency is the number of occurrences per unit time.

Numerical Problems. 10 points each. If the temperature is not given, then assume that the speed of sound is 345 m/sec. If the answer is incorrect, then partial credit may be awarded.

8. A sound wave has a length of 5 meters. What is its period?

$$v = \lambda f \quad T = \frac{1}{f} \quad f = \frac{1}{T} \quad v = \lambda \frac{1}{T} \quad T = \frac{\lambda}{v}$$

$$T = \frac{5}{345} = 0.0145 \text{ sec}$$

9. A guitar string has an effective length of 0.25 m. The speed of the wave on the string is equal to 100 m/sec. What is the frequency of its fifth harmonic?

$$f_n = \frac{nv}{2L} = \frac{(5)(100)}{2(0.25)} = 1000 \text{ Hz}$$

10. Two ambulances are moving toward each other. The siren on each creates a sound wave with a frequency of 115 Hz that moves through the air. The ambulances are moving in a straight line at a constant speed of 15 m/sec with respect to the air. The drivers hear both sirens. What beat frequency do the drivers hear?

$$f_o = f_s \left(\frac{v \pm v_o}{v \mp v_s} \right) = 115 \left(\frac{345 + 15}{345 - 15} \right) = 115 \left(\frac{360}{330} \right)$$

$$f_o = 115 \left(\frac{12}{11} \right)$$

$$f(\text{beat}) = f_1 - f_2 = 115 \left(\frac{12}{11} \right) - 115 = 115 \frac{1}{11} = 10.5 \text{ Hz}$$

If you have extra time, then check over your answers and make sure that you have printed your name, signed your name and printed your student ID # on the first page. Thanks.