Phys 341 Final   Name_____

Wednesday 2017.04.18   15:30-18:00

Attempt all 20 questions. Write on this paper.

This final examination is "closed book", except you may have one page of *handwritten* notes. Both sides OK.

Obey all UBC's usual examination rules.

For questions 1 to 3, fill in the gaps in each paragraph, choosing from the set of words/phrases at the start of each question (each of which may be used more than once) to form the most correct, precise statements. [5 marks each]

For questions 4 to 13, circle all statements that are correct. [2 marks each]

For questions 14-17: Short answer questions – respond in *no more than* 30 words, the more concise the better. [5 marks each]

For questions 18-20, draw a simple diagram to illustrate your answer, as clearly and precisely as you can. [5 marks each]

For questions 1 to 3, fill in the gaps in each paragraph, choosing from the set of words/phrases at the start of each question (each of which may be used more than once) to form the most correct, precise statements.

1. **amplitude, constant, frequencies, frequency, gas, liquid, longitudinal, medium, random, solid, transverse, wavelength.**

A sound wave propagating through air is a _____ disturbance, generated by something vibrating. The speed of the wave is _____ so _____ and _____ are inversely proportional (i.e. if one doubles, the other halves). Our perception of the pitch depends on the _____ present in the wave. Our perception of loudness, depends on the _____ and the _____ of the wave.

2. **acoustic pressure, acoustic velocity, amplitude, energy, frequency spectrum, integers, pattern, pressure, sound waves, velocity, voltage**, **wavelength.**

The output of a microphone is a _____that is proportional to _____. The analog-digital converter in a computer converts this signal into a time-ordered sequence of _____, which a Fast Fourier Transform (FFT) code converts into another sequence that represents the _____ of the original signal.

3. **acoustic energy, acoustic pressure, acoustic velocity, amplitude, decreases, even, frequency, half, increases, integer, numbers, odd, quarter, radiate, signal, sound waves, spectrum, voltage, wavelength, whole.**

An acoustic standing wave exists in a uniform tube that is closed rigidly at one end, and open at the other. At the closed end there must be an_____ node and an_____ antinode. Close to the open end there must be an_____ node and an_____ antinode; these are not precisely located at the open end because the open end of the tube can now

_____   _____ to the environment.

Thus the length of the tube closed at one end must be approximately an _____ number of _____wavelengths of the standing wave.

For questions 4 to 13, circle all statements that are correct.

4. A siren in the middle of an open field produces a pure tone at 3 kHz, the frequency at which our hearing is most acute. You listen at the edge of the field. Now the tone changes frequency to 10 kHz with no change in acoustic power. What you hear is:

   (a) Quieter

   (b) Louder

   (c) Neither quieter nor louder

The tone changes back to the original 3 kHz, and then moves to 100 Hz, again with no change in acoustic power. What you hear is:

(d) Quieter

(e) Louder

(f) Neither quieter nor louder

5. (One correct answer). A taut uniform string, length L, is held rigidly at each end, mounted on a sound board. The string is plucked with a plectrum at a point 1/3 of length of the string from one end. The sound spectrum:

(a) has three harmonics.

(b) has one frequency, three times the fundamental frequency.

(c) has one frequency, a third of the fundamental frequency.

(d) has a harmonic spectrum of frequencies 3,6,9,12... times the fundamental frequency.

(e) has a harmonic spectrum of frequencies 1,2,4,5,7,8... times the fundamental frequency.

6. Circle all true statements about the concept of acoustic velocity in a wind instrument:

(a) It is the speed of airflow caused by a player blowing into a wind instrument.

(b) It is caused by the thermal motion of air molecules which is why wind instruments are out of tune if played cold.

(c) It is the small collective motion of air molecules at audible frequencies superimposed on motions (a) and (b).

(d) It has to be zero at the rigid end of a pipe.

(e) It has to be zero at the open end of a pipe.

7. Circle all true statements concerning room modes:

(a) there are acoustic velocity nodes at the walls, ceiling and floor.

(b) there are acoustic velocity antinodes at the walls, ceiling and floor.

(c) there are acoustic pressure nodes at the walls, ceiling and floor.

(d) there are acoustic pressue antinodes at the walls, ceiling and floor.

8. A blind person, deaf in one ear, can obtain some information about the direction of a sound source from which of the following cues?

(a) frequency of the pinna notch

(b) amplitude of the signal reaching the ear

(c) timing of the signal reaching the ear

(d) listening to the change in signal as the head is moved

(e) such a person cannot deduce any direction information

9. (One correct answer). If a woodwind instrument is played with only the first three holes and register hole covered, the pressure node of the standing wave inside will be -

(a) at the third hole, precisely.

(b) a little way upstream of the third hole.

(c) a little way downstream of the third hole.

(d) at the fourth hole, precisely.

(e) a little way upstream of the fourth hole.

(f) a little way downstream of the fourth hole.

10. (One correct answer). What is the fundamental frequency of a note that is three octaves above A♭2 (100 Hz)?

(a) 300 Hz

(b) 400 Hz

(c) 600 Hz

(d) 800 Hz

(e) 1000 Hz

11. (One correct answer). Wood is an orthotropic material, which means

(a) its mechanical properties vary from sample to sample

(b) its mechanical properties vary with humidity

(c) its mechanical properties vary with the direction in which they are measured

(d) its mechanical properties vary with thickness

(e) its mechanical properties vary with length

12. (One correct answer). The cello plays an octave and a fifth lower than the violin, so naively one might expect it to be three times larger than the violin in all external dimensions. However, it is only about twice the size in all external dimensions, except that the soundbox is much deeper (i.e. the ribs are much wider). The main reason for extra the depth is:

(a) to make the cello easier to hold

(b) to increase the frequency of the main wood resonance

(c) to decrease the frequency of the main wood resonance

(d) to increase the frequency of the main air resonance

(e) to decrease the frequency of the main air resonance

13. (One correct answer). "Equal temperament" means that the octave is divided into 12 semitone intervals and -

(a) each interval is a ratio of small integers

(b) each interval is a ratio of the square root of two

(c) each interval is a ratio of the square root of twelve

(d) each interval is a ratio of the twelfth root of two

(e) each interval is one twelfth

Questions 14-17: Short answer questions – respond in *no more than* 30 words.

14. What are the valves on a trumpet for, and how do they do their job?

15. What does the bell of a brass instrument do?

16. How would you reduce the reverberation time of a room (whose size and geometry you cannot change)?

17. The erhu sounds like a human voice because:

For questions 18-20, draw a simple diagram to illustrate your answer, as clearly and precisely as you can.

18. Two sound sources (labelled A and B below) radiating identical pure tones, in phase with each other, are placed in an open field, half a wavelength apart. Draw a diagram to illustrate where you would be likely to hear a loud sound, and where you would hear a much quieter sound.

A   B

19. Draw a diagram to illustrate the relationship between the main air and wood modes of a string instrument sound box.

20. Draw three vibration modes of a uniform circular drum head. Show the nodal lines.