UNIVERSITY OF SASKATCHEWAN

Department of Physics and Engineering Physics

Physics 117.3

MIDTERM EXAM – Alternative Sitting

February 2019 Time: 90 minutes

NAME: _____ STUDENT NO.: _____
(Last) **Please Print** (Given)

LECTURE SECTION (please check):

- ❑ 01 Dr. Y. Yao
- ❑ 02 Mr. B. Zulkoskey

INSTRUCTIONS:

1. This is a closed book exam.
2. The test package includes a test paper (this document), an exam booklet, a formula sheet, a scratch card and an OMR (OpScan / bubble) sheet. The test paper consists of 8 pages, including this cover page. **It is the responsibility of the student to check that the test paper is complete**.
3. Only a basic scientific calculator (e.g. Texas Instruments TI-30X series, Hewlett-Packard HP 10s or 30S) may be used. Graphing or programmable calculators, or calculators with communication capability, or calculators in smart phones are **not** allowed.
4. Enter your name and student number on the cover of the test paper and check the appropriate box for your lecture section. Also enter your name on the exam booklet and scratch card.
5. Enter your name and NSID on the OMR (OpScan / bubble) sheet.
6. The test paper, the exam booklet, the formula sheet, the scratch card, and the OMR (OpScan / bubble) sheet must all be submitted.
7. No test materials will be returned.

QUESTION NUMBER	MAXIMUM MARKS	MARKS OBTAINED
A1-12	12	
B1-4	8	
B5-8	8	
B9-12	8	
B13-16	8	
MARK	out of 36:	

PART A

For each of the following questions in Part A, enter the most appropriate response on the OMR (OpScan / bubble) sheet. Use the exam booklet for your rough work.

A1. Let h be the depth below the surface of the ocean at which the absolute pressure is twice atmospheric pressure (i.e. $2P_{atm}$). The pressure at a depth of $2h$ below the surface of the ocean is

(A) $2.5P_{atm}$ (B) $3P_{atm}$ (C) $4P_{atm}$ (D) $5P_{atm}$ (E) $9P_{atm}$

A2. Two objects of identical volume are placed in a container that is filled with an unknown liquid. One object floats and the other sinks to the bottom. Which one of the following is a true statement concerning the masses of the objects?

(A) Both objects have the same mass.
(B) The floating object's mass is greater than the mass of the object that sinks.
(C) The floating object's mass is less than the mass of the object that sinks.
(D) Nothing can be said about the masses without knowing the densities of the objects.
(E) Nothing can be said about the masses without knowing the density of the unknown liquid.

A3. An ideal incompressible fluid is flowing through a horizontal pipe with a constriction. One section of the pipe has a radius of R and the other section of the pipe has a radius of ½ R. Which one of the following statements is **TRUE**?

(A) Both the flow speed and pressure are higher at the larger end.
(B) The flow speed is the same throughout the pipe but the pressure is lower at the larger end.
(C) The flow speed at the larger end is half the flow speed at the narrower end.
(D) The flow speed at the narrower end is four times the flow speed at the larger end.
(E) The pressure is the same throughout the pipe.

A4. A spherical object of radius r falls with a terminal speed υ through a fluid with viscosity η. Which one of the following statements is **TRUE**?

(A) The net force on the object has magnitude mg.
(B) The object has an acceleration of magnitude g.
(C) The viscous drag force causes the net force on the object to be zero.
(D) The viscous drag force is in the same direction as the force of gravity on the object.
(E) The viscous drag force is the only force acting on the object.

A5. If one could transport a simple pendulum of constant length from the Earth's surface to the Moon's, where the acceleration due to gravity is one-sixth (1/6) of that on Earth, by what factor would the pendulum frequency be changed?

(A) $f_M \approx 6f_E$ (B) $f_M \approx 2.5f_E$ (C) $f_M \approx 0.41f_E$ (D) $f_M \approx 0.17f_E$ (E) $f_M = 3.5f_E$

A6. Consider two rigid bars. The shear modulus of bar 1 is larger than the shear modulus of bar 2. Which one of the following statements **must** be **TRUE**?

(A) Bar 1 is longer than bar 2.
(B) Bar 1 has a larger surface area than bar 2.
(C) Bar 1 is heavier than bar 2.
(D) The net force acting on bar 1 is larger than the net force acting on bar 2.
(E) Bar 1 and bar 2 are made of different materials.

A7. A horizontal pipe is replaced by one of the same length but half of the radius. If the pressure difference between the ends of the pipe is doubled, by what factor is the volume flow rate of a viscous liquid through the new pipe changed from the volume flow rate through the original pipe?

(A) $Q_2 = \frac{1}{16} Q_1$ (B) $Q_2 = \frac{1}{8} Q_1$ (C) $Q_2 = \frac{1}{2} Q_1$
(D) $Q_2 = Q_1$ (E) $Q_2 = 2Q_1$

A8. A source is producing sound energy at a constant rate. You detect a sound intensity level of 60.0 dB. If you reduce your distance from the sound source by a factor of 2, how does the sound intensity level at your new location compare to the sound intensity level at your original location?

(A) The sound intensity level doubles.
(B) The sound intensity level increases by a factor of 4.
(C) The sound intensity level increases by a factor of 10.
(D) The sound intensity level increases by a factor of 100.
(E) The sound intensity level increases by a factor less than 2.

A9. The speed of a wave in a stretched string is initially 50 m/s. What will be the new wave speed if the tension in the string is increased by 18%?

(A) 50 m/s (B) 54 m/s (C) 21 m/s (D) 59 m/s (E) 45 m/s

A10. Given that the strings of a guitar are the same length, is it possible for the strings to have the same tension but have different fundamental frequencies of vibration?

(A) Yes, and the lower the desired fundamental frequency, the smaller the required linear mass density of the string.
(B) Yes, and the lower the desired fundamental frequency, the larger the required linear mass density of the string.
(C) No, this is not possible because all strings at the same tension must have the same fundamental frequency.
(D) Yes, and the higher the desired fundamental frequency, the larger the required linear mass density of the string.
(E) No, this is not possible because all strings of the same length must have the same fundamental frequency.

A11. The standing wave pattern in a pipe is NANA, where N stands for node and A for antinode. Which one of the following statements is **TRUE**?

(A) The pipe is open at both ends.
(B) The pipe is closed at both ends.
(C) The pipe is open at one end and closed at the other end.
(D) The pipe is vibrating at the fundamental frequency.
(E) The pipe is vibrating at the second harmonic frequency.

A12. Which one of the following statements is true regarding electromagnetic waves traveling through a vacuum?

(A) All waves have the same wavelength.
(B) All waves have the same frequency.
(C) The electric and magnetic fields associated with the waves are parallel to each other and perpendicular to the direction of wave propagation.
(D) The electric and magnetic fields associated with the waves are perpendicular to each other and to the direction of wave propagation.
(E) The speed of the waves depends on their frequency.

PART B

Work out the answers to the following Part B questions.

Before scratching any options, be sure to double-check your logic and calculations.

You may find it advantageous to do as many of the parts of a question as you can before scratching any options.

When you have an answer that is one of the options and are confident that your method is correct, scratch that option on the scratch card. if you reveal a star on the scratch card then your answer is correct (full marks, 2/2).

If you do not reveal a star with your first scratch, try to find the error in your solution. If you reveal a star with your second scratch, you receive 1.2 marks out of 2.

Revealing the star with your third, fourth, or fifth scratches does not earn you any marks, but it does give you the correct answer.

You may answer all four Part B question groupings (B1-4, B5-8, B9-12, and B13-16) and you will receive the marks for your best 3 groupings.

Use the provided exam booklet for your rough work.

B1. The density of wood is less than the density of water. Which one of the following statements is correct for the situation of a piece of wood that is held so that it is completely submerged?

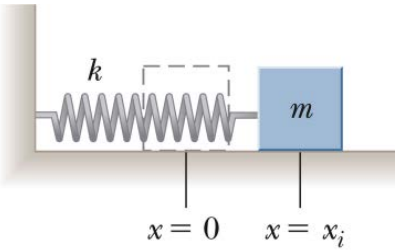
(A) The water exerts an upward force on the piece of wood. The magnitude of this force is the weight of a volume of water that is equal to the volume of the piece of wood.
(B) The water exerts a downward force on the piece of wood. The magnitude of this force is the weight of a volume of water that is equal to the volume of the piece of wood.
(C) The water exerts a downward force on the piece of wood. The magnitude of this force is the weight of a mass of water that is equal to the mass of the piece of wood.
(D) The water exerts an upward force on the piece of wood. The magnitude of this force is the weight of a mass of water that is equal to the mass of the piece of wood.
(E) The water exerts a force equal and opposite to the weight of the piece of wood.

B2. A person has a mass of 70.2 kg. When the person is completely submerged in a swimming pool and suspended from a scale, the scale reads 33.3 N. Calculate the volume of water displaced by the person.

B3. Assume that, when submerged, the person's body contains a residual volume of $V_R = 1.30 \times 10^{-3}$ m^3 of air in the lungs. Ignoring the mass of this air, calculate the average density of the tissue of this person's body.

B4. 11.75% of the person's mass is body fat. Calculate the percentage of the person's **tissue volume** that is comprised of fat-free tissue. The density of body fat is 0.900×10^3 kg/m^3 and the density of fat-free tissue is 1.10×10^3 kg/m^3.

A block is attached to a spring and vibrates on a frictionless, horizontal surface with an amplitude of x_i = 20.0 cm and a total energy of 0.300 J. The maximum speed of the block is 0.250 m/s.



B5. Which one of the following statements is **TRUE**?

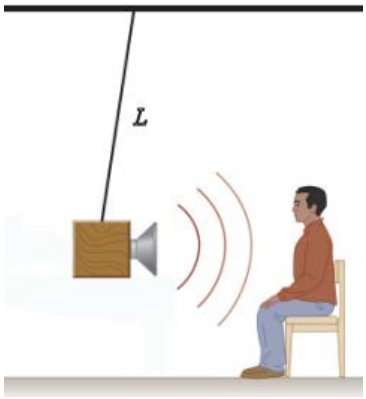
(A) The acceleration of the block is greatest when the block passes through the equilibrium position.
(B) The kinetic energy of the block remains constant.
(C) The potential energy stored in the spring is greatest when the block passes through the equilibrium position.
(D) The speed of the block is greatest when the block is at maximum displacement from equilibrium.
(E) The total energy of the system is proportional to the square of the amplitude.

B6. Calculate the spring constant.

B7. Calculate the angular frequency of the oscillation of the block.

B8. Calculate the kinetic energy of the block when it is at a position of $x = \frac{2}{3} x_i$.

A speaker of mass 2.60 kg is suspended from a rope that is attached to the ceiling. The speaker-rope system can be considered to be a simple pendulum of length L = 1.80 m. The speaker is continually producing sound of frequency 442 Hz as the speaker oscillates back and forth. The maximum height of the speaker above its equilibrium position is h = 4.00 cm. A man is seated in front of the speaker, as shown in the diagram. The speed of sound is 343 m/s.



B9. At which point in the speaker's motion will the man hear the highest frequency of sound from the speaker?

(A) when the speaker is momentarily at rest and closest to the man
(B) when the speaker is passing through its equilibrium position and moving away from the man
(C) when the speaker is momentarily at rest and furthest from the man
(D) when the speaker is passing through the equilibrium position and moving toward the man
(E) The man hears a frequency of 442 Hz throughout the speaker's motion.

B10. Calculate the period of the speaker's motion.

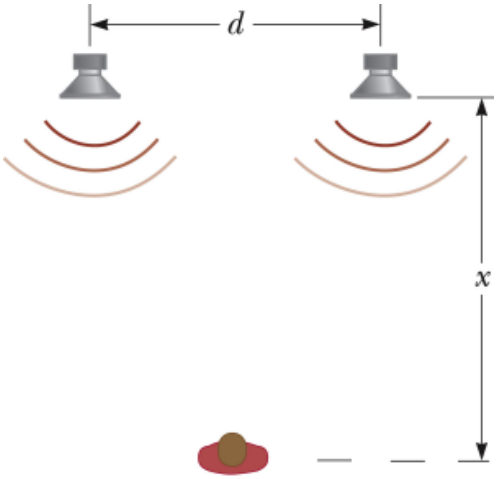
B11. Calculate the maximum speed of the speaker.

B12. Calculate the change in the frequency of the speaker's sound, as detected by the man, as the speaker moves back and forth.

B13. Two speakers are producing identical in-phase sound waves of equal power P and wavelength λ. Choose the phrase that best completes the following sentence: "If you are a distance r from one speaker and a distance $r - \lambda$ from the other speaker, then…

(A) you are at a position of constructive interference and the intensity of the sound due to the speaker at a distance r is greater than the intensity of the sound due to the other speaker."
(B) you are at a position of destructive interference and you hear sound of low intensity."
(C) you are at a position of destructive interference and you hear no sound at your location."
(D) you are at a position of constructive interference and the intensity of the sound due to the speaker at a distance $r - \lambda$ is greater than the intensity of the sound due to the other speaker."
(E) you are at a position of constructive interference and the intensity of the sound due to each speaker is the same."

Two speakers, separated by a distance d = 0.700 m, are driven by the same oscillator. A person is standing a distance x = 1.55 m from the midpoint of the line joining the two speakers, as shown in the figure. The person is the same distance from each speaker.



B14. The power output of each speaker is the same. If the sound intensity level at the person's position is 82.6 dB, calculate the sound intensity due to **one** speaker at the person's location.

B15. Calculate the speed of the sound produced by the speakers. The air temperature is 25.0°C.

B16. The person now moves to the right, a distance of 0.246 m along the dashed line that is parallel to a line joining the two speakers, and reaches the first position of destructive interference. Calculate the frequency of sound that the speakers are producing.

END OF EXAMINATION