UNIVERSITY OF SASKATCHEWAN
Department of Physics and Engineering Physics

Physics 125.3
MIDTERM EXAMINATION

Feb 17, 2022 Instructor: Y. Yao Time: 120 minutes

NAME: _____ STUDENT NUMBER: _____
(Last) **Please Print** (Given)

INSTRUCTIONS:

1. This is a closed book exam.
2. The test package includes a test paper (this document), a formula sheet, and an OMR (OpScan) sheet. The test paper consists of 7 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 may be used. Graphing or programmable calculators, or calculators with communication capability, are **not** allowed.
4. Enter your name and student number on the cover of the test paper.
5. Enter your name and code your NSID on the OMR sheet.
6. The test paper, the formula sheet and the OMR sheet must all be submitted.
7. The marked test paper will be returned. The formula sheet and the OMR sheet will NOT be returned.

ONLY THE THREE PART B QUESTIONS THAT YOU INDICATE WILL BE MARKED

PLEASE INDICATE WHICH THREE PART B QUESTIONS ARE TO BE MARKED

QUESTION NUMBER	TO BE MARKED	MAXIMUM MARKS	MARKS OBTAINED
A1-10	☑	15	
B1	❑	10	
B2	❑	10	
B3	❑	10	
B4	❑	10	
TOTAL		45	

PART A

FOR EACH OF THE FOLLOWING QUESTIONS IN PART A, ENTER THE MOST APPROPRIATE RESPONSE ON THE OMR SHEET. EACH QUESTION IS WORTH 1.5 MARKS.

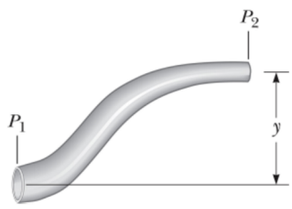
A1. For some bizarre reason you are adding pieces of wood to a rubber raft that is floating in the middle of your swimming pool. Provided the raft remains floating, what happens to the level of the water in your pool as you add more wood to the raft?

(A) It always increases.
(B) It remains the same.
(C) It always decreases.
(D) It will increase if the density of the wood is greater than the density of water, but will decrease if the density of the wood is less than the density of water.
(E) It is impossible to tell without knowing more information about the size of the raft and the size of the pool.

A2. When the atmospheric pressure increases, the pressure at the bottom of a lake

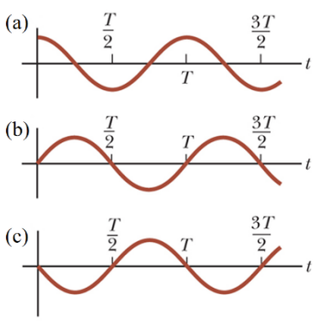
(A) increases by the same amount.
(B) increases by an amount proportional to the depth of the lake.
(C) increases by an amount greater than the atmospheric pressure change.
(D) increases by an amount less than the atmospheric pressure change.
(E) does not change.

A3. Water moves through the pipe shown right in steady, ideal flow. Which one of the following statements is correct concerning the pressure and flow speed in region 2 compared to region 1?



(A) Both the pressure and flow speed are higher in region 2 than in region 1.
(B) Both the pressure and flow speed are lower in region 2 than in region 1.
(C) The pressure is lower in region 2 but the flow speed is higher than in region 1.
(D) The pressure is higher in region 2 but the flow speed is lower than in region 1.
(E) The pressure is lower in region 2 than in region 1 but the flow speed is the same.

A4. A block is attached to a light spring at rest on a frictionless horizontal surface. At t = 0, you hit the block toward positive direction (+x), sending it to simple harmonic motion. The following three graphs describe the motion of the block as functions of time. What quantities do the three graphs describe?



(A) (a) for velocity, (b) for displacement, and (c) for acceleration.
(B) (a) for displacement, (b) for acceleration, and (c) for velocity.
(C) (a) for acceleration, (b) for velocity, and (c) for displacement.
(D) (a) for velocity, (b) for acceleration, and (c) for displacement.
(E) (a) for acceleration, (b) for displacement, and (c) for velocity.

A5. A simple pendulum clock on Earth has a period of 1.0 s. The clock is then transported to a planet where the acceleration due to gravity on its surface is one-quarter what it is on Earth. On that planet the period of the clock would be

(A) 0.25 s (B) 0.5 s (C) 1.0 s (D) 2.0 s (E) 4.0 s

A6. A wave moving along a string is described by the equation,

$$y(x,t) = (8\text{ cm})\sin[(10\text{ cm}^{-1})x - (6\text{ s}^{-1})t],$$

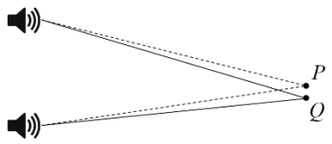
where y is the transverse displacement of the string at position x and at time t. What is the speed and direction of propagation of this wave?

(A) 0.6 cm/s, +x direction
(B) 0.75 cm/s, +x direction
(C) 1.33 cm/s, –x direction
(D) 1.67 cm/s, +x direction
(E) 48 cm/s, –x direction

A7. 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.

A8. Two speakers are being driven by the same oscillator so that they are in phase (coherent). The wavelength of the sound is λ. At a point P the path length difference to the two speakers is λ. At a point Q the path length difference is $3\lambda/2$. Which one of the following statements is correct?



(A) There will be a sound intensity minimum at P and a maximum at Q.
(B) There will be a sound intensity minimum at Q and a maximum at P.
(C) There will be a sound intensity minimum at both P and Q.
(D) There will be a sound intensity maximum at both P and Q.
(E) Neither of the points P and Q is at intensity maximum.

A9. Which one of the following sets of resonant frequencies **cannot** apply to a pipe that is open at one end and closed at the other?

(A) 100 Hz, 300 Hz, 500 Hz, and no other frequencies between 100 Hz and 500 Hz.
(B) 20 Hz, 60 Hz, 100 Hz, and no other frequencies between 20 Hz and 100 Hz.
(C) 100 Hz, 200 Hz, 300 Hz, and no other frequencies between 100 Hz and 300 Hz.
(D) 50 Hz, 150 Hz, 250 Hz, and no other frequencies between 50 Hz and 250 Hz.
(E) 30 Hz, 90 Hz, 150 Hz, and no other frequencies between 30 Hz and 150 Hz.

A10. Which one of the following statements is a correct description of 'beats' ?

(A) It is a periodic variation of the frequency of a sound which is heard when two sources produce sounds of slightly different frequency.
(B) It is a periodic variation of the loudness of a sound which is heard when two sources produce sounds of slightly different frequency.
(C) It is a periodic variation of the frequency of a sound which is heard when two sources produce sounds of slightly different loudness.
(D) It is a periodic variation of the loudness of a sound which is heard when two sources produce sounds of slightly different loudness.
(E) It is a periodic variation of the speed of a sound which is heard when two sources produce sounds of slightly different frequency.

PART B

ANSWER THREE OF THE PART B QUESTIONS ON THE FOLLOWING PAGES AND INDICATE YOUR CHOICE OF QUESTIONS ON THE COVER PAGE.

FOR EACH OF YOUR CHOSEN PART B QUESTIONS, GIVE THE COMPLETE SOLUTION AND ENTER THE FINAL ANSWERS IN THE BOXES PROVIDED.

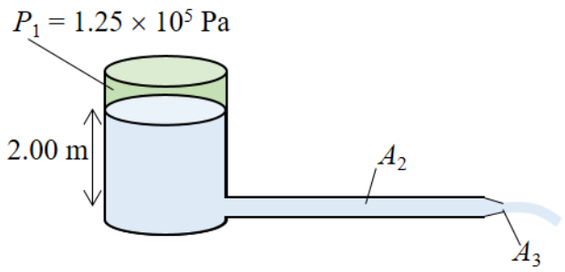
THE ANSWERS MUST CONTAIN THREE SIGNIFICANT FIGURES.

SHOW AND EXPLAIN YOUR WORK – NO CREDIT WILL BE GIVEN FOR ANSWERS ONLY.

EQUATIONS NOT PROVIDED ON THE FORMULAE SHEET MUST BE DERIVED.

USE THE BACK OF THE PREVIOUS PAGE FOR YOUR ROUGH WORK.

B1. Water flows from a large enclosed tank through a horizontal pipe, which has a cross-sectional area of $A_2 = 2.00 \times 10^{-2}$ m^2, and out through a nozzle which has an opening of area $A_3 = 1.00 \times 10^{-2}$ m^2. The upper part of the tank is maintained at an absolute pressure of $P_1 = 1.25 \times 10^5$ Pa by pumping compressed air into it. The tank is large so you may assume that, as the water flows out of the horizontal pipe, the rate at which the water level in the tank goes down is negligible. Assume that the atmospheric pressure is 1.01×10^5 Pa.



(a) When the water level in the tank is 2.00 m above the horizontal pipe, what is the speed of the water flowing out of the nozzle? [5 marks]

m/s

(b) When the water level in the tank is 2.00 m above the horizontal pipe, what is the gauge pressure in the horizontal section of pipe where its cross-sectional area is A_2? If you did not get an answer for part (a) use a value of 10.0 m/s. [5 marks]

Pa

B2. A block on a frictionless horizontal surface is connected to a spring which is attached to the wall. The equilibrium position of the block is chosen to be $x = 0$. The block is pulled over, stretching the spring, until the block is at the $x = +8.00$ cm position, and then it is released from rest at time $t = 0$. It is observed that the block oscillates back and forth with a period T of 2.00 s.

(a) What is the speed of the block when it passes through the $x = 0$ position? [3 marks]

m/s

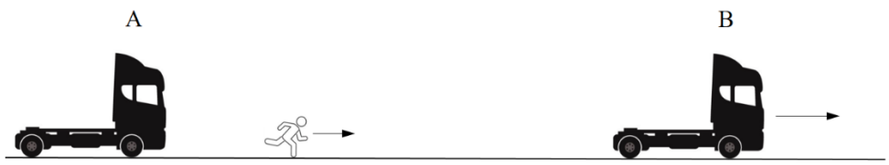
(b) If the block has mass 65.0 g, what is the spring constant of the spring? [3 marks]

N/m

(c) What is the speed of the block when it passes through the $x = +4.00$ cm position? [4 marks]

m/s

B3. Two trucks are separated by a distance of 255 m. Truck A is stationary and truck B is moving away from truck A at a speed of 40.0 m/s. The horns on both trucks are identical and are both producing sounds with a frequency of 375 Hz. The average power produced by one horn is 80.0 W. A listener is between the two trucks, 85.0 m away from truck A, and running toward truck B with a speed of 8.00 m/s. Assume that the speed of sound in air is 343 m/s.



(a) Calculate the **intensity**, due just to the horn on truck A, received by the listener. [3 marks]

W/m^2

(b) Calculate the **intensity level** of the total sound (due to both horns) received by the listener. [3 marks]

dB

(c) Calculate the frequency of the sound of truck B's horn, as heard by the listener. [4 marks]

Hz

B4. A stretched string fixed at each end has a mass of 50.0 g and a length of 9.00 m. The tension in the string is 60.0 N.

(a) Calculate the speed of a wave on the string. [3 marks]

m/s

(b) Assume that the string is vibrating at its third harmonic. Choosing the left-hand end of the string to be at $x = 0$, calculate the positions of **all the antinodes** that occur along the length of the string. [4 marks]

m

(c) Calculate the frequency of vibration when the string is vibrating at its third harmonic. If you did not get an answer for part (a) use a value of 102 m/s. [3 marks]

Hz