

**UNIVERSITY OF SASKATCHEWAN**  
**Department of Physics and Engineering Physics**

**Physics 117.3**  
**MIDTERM TEST**

February 13, 2014

Time: 90 minutes

NAME: \_\_\_\_\_  
(Last) **Please Print** (Given)

STUDENT NO.: \_\_\_\_\_

LECTURE SECTION (please check):

- 01 B. Zulkoskey
- 02 Dr. J-P St. Maurice
- C15 F. Dean

**INSTRUCTIONS:**

1. This is a closed book exam.
2. The test package includes a test paper (this document), a formula sheet, and an OMR 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, 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 student number in the top right-hand corner of each page of the test paper.
5. Enter your name and 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
A1-15	<input checked="" type="checkbox"/>	15	
B1	<input type="checkbox"/>	10	
B2	<input type="checkbox"/>	10	
B3	<input type="checkbox"/>	10	
B4	<input type="checkbox"/>	10	
TOTAL		45	

continued on page 2...

**PART A**

**FOR EACH OF THE FOLLOWING QUESTIONS IN PART A, ENTER THE MOST APPROPRIATE RESPONSE ON THE OMR SHEET.**

- A1. Two objects of exactly the same size and shape, one made of wood and the other made of steel, are placed in a container of water. The wood object floats and the steel object sinks to the bottom of the container. Which one of the following statements is **TRUE**?
- (A) Both objects experience the same magnitude of buoyant force.
  - (B) The buoyant force on the wood object is directed upward and the buoyant force on the steel object is directed downward.
  - (C) The buoyant force on both objects is directed downward.
  - (D) The magnitude of the buoyant force on the wood object is greater than on the steel object.
  - (E) The magnitude of the buoyant force on the steel object is greater than on the wood object.
- A2. If the pressure at a depth  $d$  below the surface of a lake is  $2P_{atm}$  (twice atmospheric pressure), the pressure at a depth  $2d$  is
- (A)  $P_{atm}$ .      (B)  $2 P_{atm}$ .      (C)  $3 P_{atm}$ .      (D)  $4 P_{atm}$ .      (E) zero
- A3. Which one of the following statements regarding Stress and Strain is **FALSE**?
- (A) Stress is the force per unit area causing a deformation; Strain is a measure of the amount of the deformation.
  - (B) Provided the stress does not exceed the elastic limit of the material, a solid object returns to its original length when the stress is removed.
  - (C) A solid object will break as soon as the stress exceeds the elastic limit of the material.
  - (D) The maximum stress that a non-ductile object can withstand without breaking is called the ultimate strength.
  - (E) If the tensile or compressive stress exceeds the proportional limit then the strain is no longer proportional to the stress.
- A4. Choose the phrase that best completes the following sentence: "Bernoulli's equation applies to..."
- (A) any fluid."
  - (B) an incompressible fluid, whether viscous or non-viscous."
  - (C) an incompressible, non-viscous fluid, whether the flow is turbulent or not."
  - (D) an incompressible, non-viscous fluid in which the flow is non-turbulent."
  - (E) a static fluid only."
- A5. An object is in simple harmonic motion with a period of  $T$ . If the object was displaced in the positive direction and released at time  $t = 0$ , which one of the following statements correctly describes the motion of the object at time  $t = \frac{3}{4} T$ ?
- (A) The object is momentarily at rest at maximum negative displacement.
  - (B) The object is passing through the equilibrium position, moving in the negative direction.
  - (C) The object is passing through the equilibrium position, moving in the positive direction.
  - (D) The object is halfway between the equilibrium position and the position of maximum negative displacement.
  - (E) The object is halfway between the equilibrium position and the position of maximum positive displacement.
- A6. Which one of the following statements is **FALSE** regarding a mass-spring system that moves with simple harmonic motion in the absence of friction?
- (A) The total energy of the system remains constant.
  - (B) The energy of the system is continually transformed between kinetic and potential energy.
  - (C) The total energy of the system is proportional to the square of the amplitude.
  - (D) The velocity of the oscillating mass has its maximum value when the mass passes through the equilibrium position.
  - (E) The potential energy stored in the system is greatest when the mass passes through the equilibrium position.

- A7. A simple pendulum oscillates with a small amplitude. Its length is doubled and its mass is halved. What happens to the frequency of its motion? (Choose the correct answer.)
- (A) It becomes  $1/\sqrt{2}$  as large. (B) It doubles.  
(C) The frequency is unchanged. (D) It becomes  $\sqrt{2}$  as large.  
(E) It becomes half as large.
- A8. A string is strung horizontally with a fixed tension. A wave of frequency 100 Hz is sent along the string, and it has a wave speed of 50.0 m/s. Then a second wave, of frequency 200 Hz, is sent along the string. What is the wave speed of the second wave?
- (A) 25.0 m/s (B) 50.0 m/s (C) 70.7 m/s (D) 100 m/s (E) 125 m/s
- A9. As you travel down the highway in your car, an ambulance approaches you from the rear at a high speed sounding its siren at a frequency of 500 Hz. Which one of the following statements is **TRUE**?
- (A) You hear a frequency less than 500 Hz.  
(B) You hear a frequency equal to 500 Hz.  
(C) You and the ambulance driver both hear a frequency greater than 500 Hz.  
(D) You hear a frequency greater than 500 Hz, whereas the ambulance driver hears a frequency lower than 500 Hz.  
(E) You hear a frequency less than 500 Hz, whereas the ambulance driver hears a frequency of 500 Hz.
- A10. A point source broadcasts sound into a uniform medium. An observer moves away from the source at a certain speed. If the power is increased by a factor of 3 and the distance from the source is also tripled, what is the resulting change in decibel level?
- (A) The decibel level goes down by more than 10 dB.  
(B) The decibel level goes up by less than 10 dB.  
(C) There is no change in the decibel level.  
(D) The answer cannot be determined because the speed of the observer is not known.  
(E) The decibel level goes down by less than 10 dB.
- A11. During a fine Saskatoon winter, the temperature goes from 0 °C one day to -35 °C the next day. You hear a loud noise coming from 1 km away. Which one of the following statements is **TRUE**?
- (A) The noise reaches you more quickly by 0.21 seconds during the cold day.  
(B) The noise reaches you more slowly by 0.21 seconds during the cold day.  
(C) The noise reaches you more quickly by 0.44 seconds during the cold day.  
(D) The noise reaches you more slowly by 0.44 seconds during the cold day.  
(E) There is no difference in the arrival times of the noise.
- A12. Two speakers are producing identical in-phase sound waves of intensity  $I$  and wavelength  $\lambda$ . 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 arriving from the speaker at a distance  $r - \lambda$  is greater than the intensity of the sound from the other speaker."  
(B) you are at a position of constructive interference and the intensity of the sound arriving from each speaker is the same."  
(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 arriving from the speaker at a distance  $r$  is greater than the intensity of the sound from the other speaker."  
(E) you are at a position of destructive interference and you hear sound of low intensity."
- A13. A standing wave is set up in a 200-cm string fixed at both ends. The string vibrates in 5 distinct segments when driven by a 120-Hz source. What is the wavelength of the standing wave?
- (A) 10 cm (B) 20 cm (C) 40 cm (D) 80 cm (E) 100 cm

- A14. A hollow pipe (such as an organ pipe open at both ends) is made to go into resonance at frequency  $f_{\text{open}}$ . One end of the pipe is now covered and the pipe is again made to go into resonance, this time at frequency  $f_{\text{closed}}$ . Both resonances are first harmonics (fundamentals). How do these two resonances compare?
- (A) They are the same.
  - (B)  $f_{\text{closed}} = \frac{1}{2} f_{\text{open}}$
  - (C)  $f_{\text{closed}} = 2 f_{\text{open}}$
  - (D)  $f_{\text{closed}} = \sqrt{2} f_{\text{open}}$
  - (E)  $f_{\text{closed}} = (3/2) f_{\text{open}}$
- A15. I stretch a rubber band and “plunk” it to make it vibrate at its fundamental frequency. I then stretch it to twice its length and make it vibrate at the fundamental frequency once again. The rubber band is made so that doubling its length doubles the tension and reduces the mass per unit length to half of its original value. The new frequency will be related to the old by a factor of:
- (A) 1.0            (B) 1.4            (C) 2.0            (D) 2.5            (E) 4.0

**PART B**

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

FOR EACH OF YOUR CHOSEN **PART B** QUESTIONS ON THE FOLLOWING PAGES, GIVE THE COMPLETE SOLUTION AND ENTER THE FINAL ANSWER IN THE BOX PROVIDED.

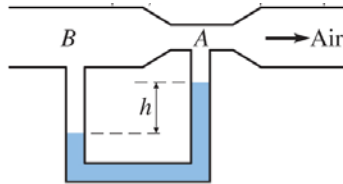
THE ANSWERS MUST CONTAIN THREE SIGNIFICANT FIGURES AND THE UNITS MUST BE GIVEN.

**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. For the purposes of this question, you may assume that air is an ideal, incompressible fluid. Air is flowing into a Venturi meter (see diagram). The narrow section of the pipe at point  $A$  has a radius that is  $\frac{1}{2}$  of the radius of the larger section of the pipe at point  $B$ . You may assume that the density of the air is constant. The U-shaped tube is filled with water.



- (a) If the air speed at  $B$  is  $v$ , how fast is the air moving at point  $A$ , in terms of  $v$ ? (3 marks)

- (b) The density of air is  $1.29 \text{ kg/m}^3$  and the density of water is  $1.00 \times 10^3 \text{ kg/m}^3$ . The difference in the height,  $h$ , of the water in the arms of the manometer (the U-shaped tube) is 1.75 cm. Calculate the numerical value of  $v$ . If you did not obtain an answer for (a), use a value of  $2v$ . (4 marks)

- (c) The radius of the larger section of pipe is 5.00 cm. Calculate the volume flow rate (in  $\text{m}^3/\text{s}$ ) of air through the pipe. If you did not obtain an answer for (b), use a value of 4.50 m/s. (3 marks)

- B2. Consider an object with a mass of 375 g sitting on a horizontal, frictionless surface. The object is attached to an ideal, horizontal spring that is attached to the wall at its other end. The object is pulled away from its equilibrium position, in the positive direction, and released. The resulting motion of the object is described by the following equation:

$$x = (5.00 \text{ cm}) \cos (35.3 t) \text{ where } t \text{ is in seconds}$$

- (a) Calculate the position (distance and sign) of the object relative to its equilibrium position at  $t = 0.0950 \text{ s}$ . (3 marks)

- (b) Calculate the magnitude of the force of the spring on the object at  $t = 0.095 \text{ s}$ . If you did not obtain an answer for (a), use a value of 0.0475 m for the magnitude of the displacement. (4 marks)

- (c) Calculate the velocity (speed and sign) of the object at  $t = 0.0950 \text{ s}$ . (3 marks)

- B3. A microphone is attached to a spring suspended from a ceiling (see diagram). Directly below on the floor is a stationary 441 Hz source. The microphone vibrates up and down in SHM with a period of 2.00 s. The difference between the maximum and minimum sound frequencies detected by the microphone is 2.10 Hz. The speed of sound is 343 m/s. *Hint: The maximum sound frequency is detected when the microphone is moving toward the source at maximum speed and the minimum sound frequency is detected when the microphone is moving away from the source at maximum speed. Also, you are given that  $f_{\text{max}} - f_{\text{min}} = 2.10$  Hz.*



- (a) Calculate the maximum speed of the microphone. (6 marks)

- (b) Calculate the amplitude of the simple harmonic motion of the microphone. If you did not obtain an answer for (a), use a value of 0.850 m/s. (4 marks)

B4. An underground train station is connected to the outside through a tunnel. Some machinery is producing noise at a frequency dominated by 62.00 Hz and a second machine operating nearby has a strong noise peak at 58.00 Hz. The resulting beat is greatly amplified by the tunnel through resonance. That is, the beat frequency corresponds to one of the resonance modes of the tunnel. This makes a very annoying low frequency vibration for the passengers awaiting the next train.

- (a) Consider the tunnel to be an air pipe open at both ends and derive an expression for the possible natural (resonance) frequencies. (3 marks)

- (b) Calculate the frequency of the beats produced by the machinery. (2 marks)

- (c) You know that the tunnel is at least 100 m long, and knowing that the speed of sound was 344 m/s on that particular day, you figured that you could get a better estimate for the length of the tunnel, given the resonance condition. From the beat frequency and the knowledge that the tunnel is behaving like an air pipe open at both ends and is somewhat longer than 100 m, calculate which harmonic of the tunnel (air pipe) is being excited (i.e. which harmonic corresponds to the beat frequency) and calculate a more precise estimate for the length of the tunnel. If you did not obtain an answer for (b), use a value of 5 Hz. (5 marks)

harmonic:	<input type="text"/>
length:	<input type="text"/>