

UNIVERSITY OF SASKATCHEWAN
Department of Physics and Engineering Physics

Physics 117.3
MIDTERM TEST – Alternative Sitting

February 2011

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. **It is the responsibility of the student to check that the test paper is complete.**
3. Only Hewlett-Packard hp 10S or 30S or Texas Instruments TI-30X series calculators, or a calculator approved by your instructor, may be used.
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 STUDENT NUMBER on the OMR sheet.
6. The test paper, the formula sheet and the OMR sheet must all be submitted.
7. The 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	-	15	
B1	<input type="checkbox"/>	10	
B2	<input type="checkbox"/>	10	
B3	<input type="checkbox"/>	10	
B4	<input type="checkbox"/>	10	
TOTAL		45	

PART A

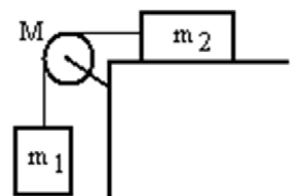
FOR EACH OF THE FOLLOWING QUESTIONS IN PART A, ENTER THE MOST APPROPRIATE RESPONSE ON THE OMR SHEET.

- A1. A uniform solid cylinder rolls without slipping down an incline. At the bottom of the incline the speed, v , of the cylinder is measured. A hole is drilled through the cylinder along its axis and the experiment is repeated; at the bottom of the incline the cylinder now has speed v' . How does the speed of the cylinder compare with its original value?
- (A) $v' < v$ (B) $v' = v$ (C) $v' > v$
 (D) The answer depends on the radius of the hole.
 (E) The answer depends on the height of the incline.

- A2. Chris and Jamie are carrying Wayne on a horizontal stretcher. The uniform stretcher has length L and weight W_L . Wayne weighs W_W . Wayne's centre of gravity is a distance of $(1/3)L$ from Chris. Chris and Jamie are at the ends of the stretcher. The force, F_C , that Chris is exerting to support the stretcher, with Wayne on it, compared to the force, F_J , that Jamie is exerting, is
- (A) $F_C < F_J$ (B) $F_C = F_J$ (C) $F_C > F_J$
 (D) dependent on the value of L .
 (E) dependent on the value of W_L .

- A3. Which one of the following statements is **TRUE**?
- (A) If the net force on an object is zero then the net torque on the object must also be zero.
 (B) If the net torque on an object is zero then the net force on the object must also be zero.
 (C) If the net force on an object is zero then the object cannot be rotating.
 (D) If the net torque on an object is zero then the centre of mass of the object must be stationary.
 (E) If the net force on an object is zero and the net torque on the object is zero then the object is in rotational equilibrium (no translational acceleration and no angular acceleration)

- A4. A mass m_1 is connected by a light string that passes over a pulley of mass M to a mass m_2 sliding on a frictionless horizontal surface as shown in the figure. There is no slippage between the string and the pulley. The pulley has a radius of R and a moment of inertia of I_P . Which one of the following is the correct expression for a_1 , the acceleration of m_1 ?



- (A) $a_1 = g$ (B) $a_1 = \left(\frac{m_1}{m_1 + m_2} \right) g$ (C) $a_1 = \left(\frac{m_1 + m_2}{m_1} \right) g$
 (D) $a_1 = \left(\frac{m_1 + m_2 + I_P/R^2}{m_1} \right) g$ (E) $a_1 = \left(\frac{m_1}{m_1 + m_2 + I_P/R^2} \right) g$

- A5. The absolute pressure at a depth d below the ocean surface is 2 atm. The pressure at a depth of $2d$ below the surface of the ocean is
- (A) 1 atm. (B) 2 atm. (C) 3 atm. (D) 4 atm. (E) 5 atm.
- A6. When an object is suspended from a spring scale, the scale reads 12 N when the object is in air and 8 N when the object is fully submerged in a liquid. The magnitude of the buoyant force exerted by the liquid on the object is
- (A) 4 N. (B) 20 N. (C) 10 N. (D) 16 N. (E) 2 N.

- A7. An ideal incompressible fluid is flowing through a horizontal pipe with a constriction. One end of the pipe has a radius of R and the other end of the pipe has a radius of $\frac{1}{2}R$. 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.
- A8. Water undergoes viscous flow through two pipes with the same pressure difference between their ends. The radius of pipe 2 is twice the radius of pipe 1. The length of pipe 2 is three times the length of pipe 1. If the volume flow rate through pipe 1 is Q_1 , then the flow rate, Q_2 , through pipe 2 is
- (A) $\frac{4}{3}Q_1$. (B) $\frac{16}{3}Q_1$. (C) $8Q_1$. (D) $\frac{2}{9}Q_1$. (E) $48Q_1$.
- A9. A mass is suspended vertically from a spring so that it is at rest at the equilibrium position. The mass is pulled straight down to an extension x and released so that it oscillates about the equilibrium position. The speed of the mass is greatest when the mass is
- (A) at its maximum upward travel.
(B) at its maximum downward travel.
(C) at the equilibrium position.
(D) somewhere between the equilibrium position and the maximum upward travel.
(E) somewhere between the equilibrium position and the maximum downward travel.
- A10. A mass M is attached to the end of a thin steel wire of length L and cross-sectional area A . Let Y represent the Young's modulus for steel. The mass is pulled straight down so that the wire stretches a small amount ΔL and then the mass is released. Which one of the following expressions is correct for the angular frequency of the simple harmonic motion of the mass?
- (A) $\omega = \sqrt{\frac{YA}{LM}}$ (B) $\omega = \sqrt{\frac{YA}{\Delta LM}}$ (C) $\omega = \sqrt{\frac{LM}{YA}}$
(D) $\omega = \sqrt{\frac{YL}{AM}}$ (E) $\omega = \sqrt{\frac{YM}{AL}}$
- A11. Consider a material that is being stressed within its proportional limit. A wire made of this material has a length L and a cross-sectional area A and is subject to a tensile force F . As a result, the length of the wire changes by ΔL . The wire is now cut in half, and the same tensile force F is applied to one of the halves. What is the change of length of this wire of length $\frac{1}{2}L$ when the force F is applied to it?
- (A) $\frac{1}{4}\Delta L$ (B) $\frac{1}{2}\Delta L$ (C) ΔL (D) $2\Delta L$ (E) $4\Delta L$
- A12. Two simple pendula, A and B, have the same length, but the mass of A is twice the mass of B. Their amplitudes of oscillation are equal. Their periods are T_A and T_B , respectively, and their energies are E_A and E_B . Which one of the following statements is correct?
- (A) $T_A = T_B$ and $E_A > E_B$ (B) $T_A > T_B$ and $E_A > E_B$
(C) $T_A > T_B$ and $E_A < E_B$ (D) $T_A = T_B$ and $E_A < E_B$
(E) $T_A < T_B$ and $E_A > E_B$

- A13. A sound source radiates sound uniformly in all directions. The power of the source is constant. The sound intensity is I at a distance of R from the source. The intensity at a distance of $3R$ is
- (A) $\frac{I}{9}$ (B) $\frac{I}{3}$ (C) I (D) $3I$ (E) $9I$
- A14. Which one of the following statements regarding waves on a spring is **FALSE**?
- (A) In a longitudinal wave on a spring, the spring oscillates parallel to the direction of wave propagation.
(B) In a transverse wave on a spring, the spring oscillates perpendicular to the direction of wave propagation.
(C) The wave transfers energy between points in space.
(D) The speed of the wave along the spring is always equal to the speed of the individual coils.
(E) The speed of the wave depends on the mechanical properties of the spring.
- A15. Two speakers are placed a distance d apart and are vibrating in phase. The frequency and wavelength of the sound being produced are f and λ respectively. A person standing a distance L from one of the speakers hears no sound. Which one of the following expressions can possibly be correct for the person's distance from the other speaker?
- (A) $L + d$ (B) $L + \frac{1}{2}\lambda$ (C) $L - 2\lambda$ (D) $L + \lambda$ (E) $d + \lambda$

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.

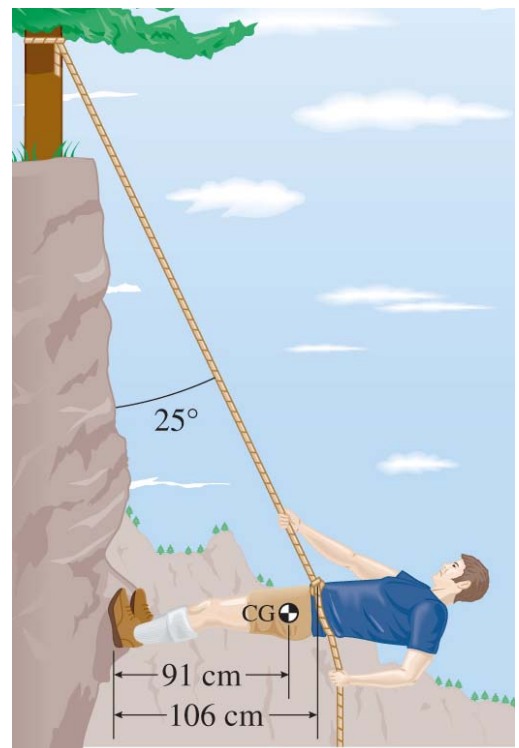
SHOW AND EXPLAIN YOUR WORK – NO CREDIT WILL BE GIVEN FOR ANSWERS ONLY.

EQUATIONS NOT PROVIDED ON THE FORMULAE SHEET MUST BE DERIVED.

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

B1. A mountain climber is rappelling down a vertical wall. The climber has stopped his descent, and so is currently at rest. The climber's centre of gravity is 91.0 cm from his feet. The rope is at an angle of 25.0° with the vertical and attaches to a buckle strapped to the climber's waist 15.0 cm to the right of his centre of gravity. The climber weighs 770 N.

(a) Calculate the magnitude of the tension in the rope.
(4 marks)



(b) Calculate the horizontal component of the contact force exerted by the wall on the climber's feet. If you did not obtain an answer for (a), use a value of 700 N. (3 marks)

(c) Calculate the vertical component of the contact force exerted by the wall on the climber's feet. If you did not obtain an answer for (a), use a value of 700 N. (3 marks)

B2. A cylindrical air duct has a length of 6.25 m and a radius of 7.25×10^{-2} m. A fan forces air of viscosity 1.80×10^{-5} Pa·s through the duct such that the air in a room of volume 265 m^3 is replenished every fifteen minutes.

- (a) Calculate the volume flow rate of air through the duct. (4 marks)

- (b) Calculate the difference in pressure between the ends of the air duct. If you did not obtain an answer for (a), use a value of $0.250 \text{ m}^3/\text{s}$. (6 marks)

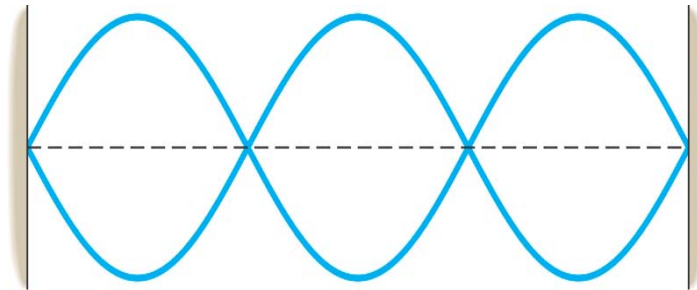
B3. A man has a mass of 75.0 kg. The average cross-sectional area of his femur is 8.12 cm^2 and the length of his femur when he is lying down is 44.5 cm. Young's modulus for compression of the femur is $9.40 \times 10^9 \text{ Pa}$ and the ultimate compressive strength of the femur is $1.70 \times 10^8 \text{ N/m}^2$.

- (a) Assuming that the compressive force on each femur is half the man's weight, calculate the compressive stress on each femur when the man is standing upright. (2 marks)

- (b) Calculate the amount that each femur is shortened when the man is standing upright compared to when he is lying down. If you did not obtain an answer for (a), use a value of $4.25 \times 10^5 \text{ Pa}$. (3 marks)

- (c) Consider a giant whose mass is $N^3 \times 75.0 \text{ kg}$ and whose femurs have cross-sectional areas of $N^2 \times (8.12 \text{ cm}^2)$ and lengths of $N \times (44.5 \text{ cm})$. The Young's modulus for compression and the ultimate compressive strength of the giant's femurs is the same as for the man. Calculate the maximum value of the factor N such that the giant's femurs are on the verge of crumbling under the giant's weight. (5 marks)

B4. A string has a linear mass density of $8.50 \times 10^{-3} \text{ kg/m}$ and is under a tension of 282 N. The string is 1.80 m long, is fixed at both ends, and is vibrating in the standing wave pattern shown in the diagram below.



(a) Calculate the wave speed. (4 marks)

(b) Use the diagram to determine the wavelength of the wave. Show your calculation/explain your work. (3 marks)

(c) Calculate the frequency of the standing wave. If you did not obtain answers for (a) and (b), use values of 150 m/s and 1.80 m respectively. (3 marks)