

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

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

February 11, 2009

Time: 90 minutes

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

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

LECTURE SECTION (please check):

- 01 B. Zulkoskey
- 02 Dr. A. Robinson
- 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 30S or Texas Instruments TI-30X series calculators 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	
<b>TOTAL</b>		45	

**PART A**

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

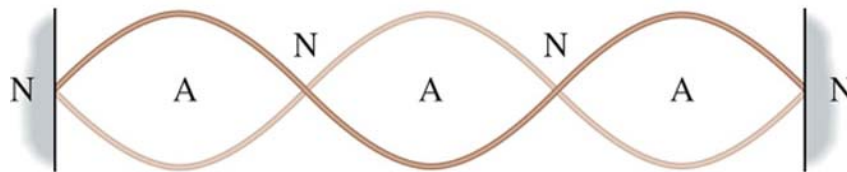
- A1. Consider two objects: a solid wood disk and a metal hoop. The disk and the hoop have the same mass and radius. If the two objects have the same velocity as they roll along a horizontal surface, which one of the following statements is correct?
- (A) Their translational kinetic energies are the same but the rotational kinetic energy of the disk is less than that of the hoop.
  - (B) Their translational kinetic energies are the same but the rotational kinetic energy of the disk is greater than that of the hoop.
  - (C) Both their translational kinetic energies and their rotational kinetic energies are the same.
  - (D) Their rotational kinetic energies are the same but the translational kinetic energy of the disk is less than that of the hoop.
  - (E) Their rotational kinetic energies are the same but the translational kinetic energy of the disk is less than that of the hoop.
- A2. Solid disk 1 has a mass of  $M$  and a radius of  $R$ . Solid disk 2 has a mass of  $2M$  and a radius of  $R$ . The same torque is applied to each of the disks. The angular acceleration of disk 2, compared to that of disk 1, is
- (A)  $\alpha_2 = \frac{1}{4} \alpha_1$
  - (B)  $\alpha_2 = \frac{1}{2} \alpha_1$
  - (C)  $\alpha_2 = \alpha_1$
  - (D)  $\alpha_2 = 2\alpha_1$
  - (E)  $\alpha_2 = 4\alpha_1$
- A3. When a spinning figure skater pulls her arms in closer to her body her rotation rate increases. Which one of the following statements is correct? (You may ignore any frictional effects.)
- (A) As the skater pulls her arms in, her rotational inertia decreases and her angular momentum remains constant.
  - (B) As the skater pulls her arms in, both her rotational inertia and her angular momentum decrease.
  - (C) As the skater pulls her arms in, her rotational inertia decreases and her angular momentum increases.
  - (D) As the skater pulls her arms in, her rotational inertia increases and her angular momentum remains constant.
  - (E) As the skater pulls her arms in, her rotational inertia increases and her angular momentum decreases.
- A4. A compact disc (CD) with a rotational inertia of  $5.28 \times 10^{-5} \text{ kg}\cdot\text{m}^2$  spins at a speed of 41.9 radians/s. How much work must be done to bring it to rest?
- (A)  $-1.01 \times 10^{-2} \text{ J}$
  - (B)  $-1.99 \times 10^{-2} \text{ J}$
  - (C)  $-2.23 \times 10^{-2} \text{ J}$
  - (D)  $-4.63 \times 10^{-2} \text{ J}$
  - (E)  $-8.34 \times 10^{-2} \text{ J}$
- A5. Consider a large rectangular block of wood that has a weight of  $1.8 \times 10^4 \text{ N}$  and dimensions of  $1 \text{ m} \times 2 \text{ m} \times 3 \text{ m}$ . Which one of the following statements is correct concerning the pressure(s) that the block of wood can exert on a flat horizontal floor.
- (A) The pressure exerted by the block can be 9000 Pa, 6000 Pa, or 3000 Pa, depending on its orientation.
  - (B) The pressure exerted by the block can only be 9000 Pa.
  - (C) The pressure exerted by the block can only be 6000 Pa.
  - (D) The pressure exerted by the block can only be 3000 Pa..
  - (E) The pressure exerted by the block can be 9000 Pa or 6000 Pa, but not 3000 Pa.

- A6. Which one of the following statements best describes the situation in a hydraulic lift.
- (A) A small pressure change in a small cylinder produces a large pressure change in a large cylinder.
  - (B) A small pressure change in a large cylinder produces a large pressure change in a small cylinder.
  - (C) A small force applied to a small piston produces a large force on a large piston.
  - (D) A small force applied to a large piston produces a large force on a small piston.
  - (E) A small displacement of a small piston produces a large displacement of a large piston.
- A7. A liquid with a viscosity of  $\eta$  is flowing through a pipe of radius  $R$  and length  $L$ . A pressure difference of  $\Delta P$  is required to maintain a volume flow rate  $Q$ . If the radius of the pipe is reduced to  $\frac{1}{2}R$  then the pressure difference required to maintain the same volume flow rate is:
- (A)  $16 \Delta P$
  - (B)  $8 \Delta P$
  - (C)  $4 \Delta P$
  - (D)  $2 \Delta P$
  - (E)  $\frac{1}{2} \Delta P$
- A8. A spherical object of radius  $r$  falls with a terminal speed  $v$  through a fluid with viscosity  $\eta$ . 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  $g$ .
  - (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.
- A9. A tensile force  $F$  stretches a wire of original length  $L$  by an amount  $\Delta L$ . Consider another wire of the same composition and thickness as the first wire, but of length  $2L$ . If a force of  $2F$  is applied to this wire of length  $2L$ , then the amount that it stretches is
- (A)  $\frac{1}{4} \Delta L$
  - (B)  $\frac{1}{2} \Delta L$
  - (C)  $\Delta L$
  - (D)  $2 \Delta L$
  - (E)  $4 \Delta L$
- A10. Which one of the following statements concerning an object in simple harmonic motion is **false**?
- (A) The maximum speed of the object is at the point of zero displacement from the equilibrium position.
  - (B) The maximum magnitude of acceleration of the object occurs at positions of maximum magnitude of displacement from equilibrium.
  - (C) The speed of the object is zero at positions of maximum magnitude of displacement.
  - (D) The angular frequency of oscillation depends on the amplitude of vibration.
  - (E) The acceleration is zero at the point of zero displacement from the equilibrium position.
- A11. Two masses,  $m_1$  and  $m_2$ , are hung on identical springs with spring constant  $k$  and set in simple harmonic motion. The ratio of the periods of oscillation,  $T_1/T_2$ , is given by:
- (A)  $\frac{T_1}{T_2} = \sqrt{\frac{m_1}{m_2}}$
  - (B)  $\frac{T_1}{T_2} = 2\pi$
  - (C)  $\frac{T_1}{T_2} = \frac{m_2}{m_1}$
  - (D)  $\frac{T_1}{T_2} = 2\pi k$
  - (E)  $\frac{T_1}{T_2} = \frac{m_1 + m_2}{m_1 - m_2}$
- A12. A periodic wave passes by an observer who notices that the time between two consecutive wave crests is 2 seconds. Which one of the following statements about the wave is **true**?
- (A) The frequency is 2 Hz.
  - (B) The period is 2 seconds.
  - (C) The wavelength is 2 metres.
  - (D) The amplitude is 2 metres.
  - (E) The wave speed is 2 m/s.

A13. Two speakers are separated by a distance of  $d$ . They are vibrating in phase and they both produce sound with identical frequency  $f$  and wavelength  $\lambda$ . A listener is a distance  $L$  from one of the speakers. Which one of the following distances from the other speaker will ensure the listener is at a position of constructive interference?

- (A)  $L + d$       (B)  $L - \frac{1}{2}\lambda$       (C)  $L + \lambda$       (D)  $L + \frac{1}{2}\lambda$       (E)  $d + \lambda$

A14. The diagram shows the third harmonic of a standing wave on a string of length  $L$  that is fixed at both ends. Which one of the equations correctly describes the wavelength  $\lambda_3$  of this harmonic?



- (A)  $\lambda_3 = \frac{L}{2}$       (B)  $\lambda_3 = \frac{L}{3}$       (C)  $\lambda_3 = \frac{2L}{3}$       (D)  $\lambda_3 = \frac{3L}{2}$       (E)  $\lambda_3 = \frac{L}{6}$

A15. The intensity of the sound of an aircraft taking off is measured as  $3.50 \times 10^2 \text{ W/m}^2$  at a distance of 10.0 metres. Calculate the intensity at a distance of 125 metres. You may assume that the aircraft acts as an isotropic source of sound and you may ignore any absorption of sound energy by the air.

- (A)  $2.24 \text{ W/m}^2$       (B)  $3.04 \text{ W/m}^2$       (C)  $4.11 \text{ W/m}^2$       (D)  $4.87 \text{ W/m}^2$       (E)  $5.05 \text{ W/m}^2$

### **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.

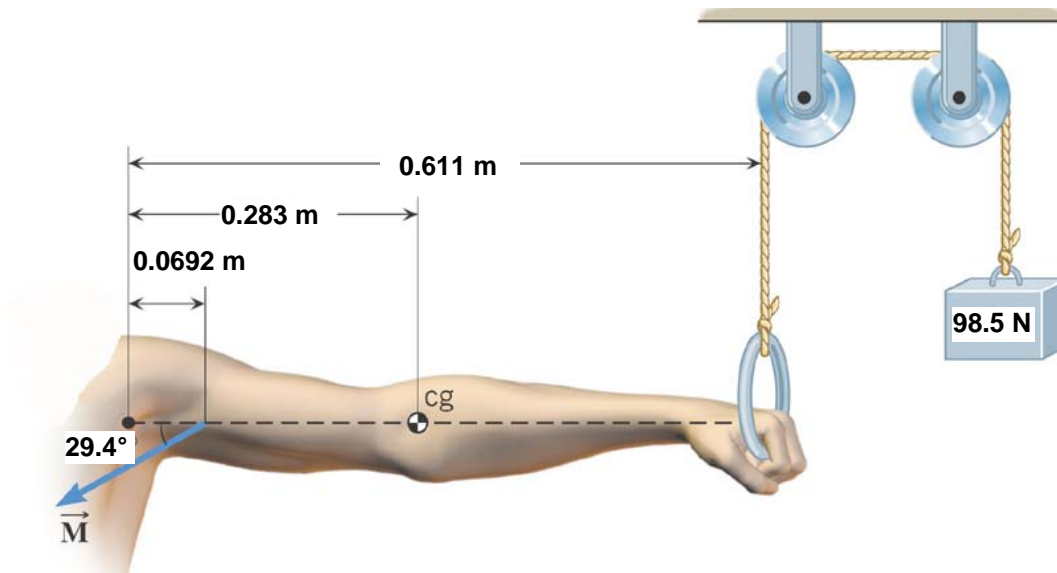
THE ANSWERS MUST CONTAIN THREE SIGNIFICANT FIGURES AND THE UNITS MUST BE GIVEN.

**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. The drawing shows an outstretched arm (0.611 m in length) that is parallel to the floor. The arm is pulling downward against the ring attached to the pulley system, in order to hold the 98.5-N weight stationary. The latissimus dorsi muscle applies the force  $\mathbf{M}$  at a point that is 0.0692 m from the shoulder joint and oriented at an angle of  $29.4^\circ$  as shown. The arm has a mass of 4.86 kg and a centre of gravity that is located 0.283 m from the shoulder joint.



- (a) Calculate the magnitude of  $\mathbf{M}$ .

- (b) Calculate the vertical component of the force on the shoulder joint.

B2. When a solid object is suspended at rest from a spring scale and completely submerged in ethyl alcohol the reading on the spring scale is 15.2 N. When the same object is completely submerged in water the reading on the spring scale is 13.7 N. The density of ethyl alcohol is  $806 \text{ kg/m}^3$  and the density of water is  $1.00 \times 10^3 \text{ kg/m}^3$ .

Calculate the density of the object.

- B3. A monkey, hanging onto a horizontal tree branch with one arm, swings in simple harmonic motion. The centre of mass of the monkey is 0.425 m from the branch. Its mass is 9.50 kg.



- (a) Calculate the rotational inertia of the monkey, assuming it can be modelled as a thin rod of length 0.850 m.

- (b) Calculate the frequency with which the monkey swings.

B4. Light of wavelength 556 nm in air enters the water in a swimming pool. The speed of light in the water is 0.750 times the speed in air. The light hits the water at an angle of incidence of  $35.0^\circ$  with respect to the surface normal. Some of the light is reflected at the air-water interface, and some is refracted as it passes into the water.

(a) Calculate the wavelength of the light in the water.

(b) Calculate the angle of refraction of the light at the air-water boundary.

(c) Draw a diagram and clearly label the incident, reflected and refracted rays and the angle of incidence, the angle of reflection and the angle of refraction.

Calculate the angle between the reflected light and the refracted light.