UNIVERSITY OF SASKATCHEWAN
Department of Physics and Engineering Physics

Physics 117.3
<u>MIDTERM TEST</u>

February 17, 2011   Time: 90 minutes

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

LECTURE SECTION (please check):

❑   01   B. Zulkoskey

❑   02   Dr. J-P St. Maurice

❑   C15   F. Dean

<u>INSTRUCTIONS:</u>

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 <u>NOT</u> be returned.

ONLY THE <u>THREE</u> PART B QUESTIONS THAT <u>YOU INDICATE</u> WILL BE MARKED

PLEASE <u>INDICATE</u> WHICH <u>THREE</u> PART B QUESTIONS ARE TO BE MARKED

| QUESTION NUMBER	TO BE MARKED	MAXIMUM MARKS	MARKS OBTAINED
A1-15	-	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.

A1.   A uniform solid cylinder rolls without slipping down an incline. At the bottom of the incline the speed, υ, 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 υ'. How does the speed of the cylinder compare with its original value?

(A) $\upsilon' < \upsilon$ (B) $\upsilon' = \upsilon$ (C) $\upsilon' > \upsilon$
(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?
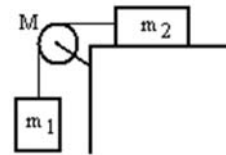
(A) $a_1 = g$
(B) $a_1 = \left(\dfrac{m_1}{m_1 + m_2}\right)g$
(C) $a_1 = \left(\dfrac{m_1 + m_2}{m_1}\right)g$

(D) $a_1 = \left(\dfrac{m_1 + m_2 + {I_P}/{R^2}}{m_1}\right)g$
(E) $a_1 = \left(\dfrac{m_1}{m_1 + m_2 + {I_P}/{R^2}}\right)g$

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 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.

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) $\omega = \sqrt{\dfrac{YA}{LM}}$ (B) $\omega = \sqrt{\dfrac{YA}{\Delta LM}}$ (C) $\omega = \sqrt{\dfrac{LM}{YA}}$

     (D) $\omega = \sqrt{\dfrac{YL}{AM}}$ (E) $\omega = \sqrt{\dfrac{YM}{AL}}$

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 ½L
      when the force F is applied to it?

     (A) ¼ ΔL (B) ½ ΔL (C) ΔL (D) 2 ΔL (E) 4 ΔL

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) $\dfrac{I}{9}$ (B) $\dfrac{I}{3}$ (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 <u>THREE</u> 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.

<u>SHOW AND EXPLAIN YOUR WORK</u> – 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 rotating star collapses under the influence of its own gravitational forces to form a pulsar. The radius of the star after collapse is 1.00×10^{-4} times the radius before collapse. There is no change in mass. In both cases, the mass of the star is uniformly distributed in a spherical shape.

(a) Calculate the ratio of the angular momentum of the star after collapse to the value before collapse. (2 marks)

(b) Calculate the ratio of the angular velocity of the star after collapse to the value before collapse. (2 marks)

(c) Calculate the ratio of the kinetic energy of the star after collapse to the value before collapse. (2 marks)

(d) If the period of the star's rotation before collapse is 1.00×10^{7} s, calculate its period after collapse. (4 marks)

B2. The cardiac output of a small dog is 4.12×10^{-3} m^3/s, the radius of its aorta is 0.512 cm, and the length of its aorta is 40.0 cm. The viscosity of blood is 4.05×10^{-3} Pa·s and the density of blood is 1.06×10^3 kg/m^3.

(a) Calculate the flow speed of blood in the aorta. (4 marks)

(b) Calculate the pressure difference across the aorta. (6 marks)

B3. A tightrope walker who weighs 641 N is standing in the middle of a steel cable. The cable makes an angle of 0.0400 rad below the horizontal. The Young's modulus of steel is 2.00×10^{11} Pa.

0.040 rad   0.040 rad
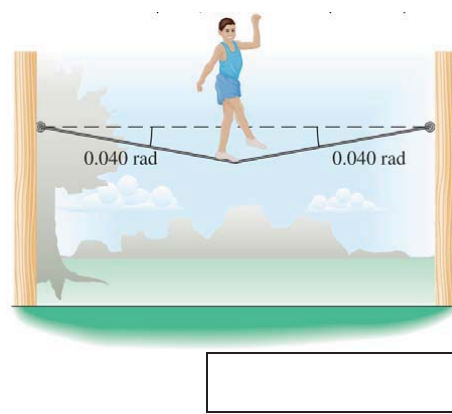
(a) Calculate the strain in the cable. (Assume that the cable is horizontal before the walker steps onto it and ignore the weight of the cable itself.)
(3 marks)

(b) Calculate the tension in the cable when the tightrope walker is standing at the mid-point.
(3 marks)

(c) Calculate the cross-sectional area of the cable. If you did not obtain answers for (a) and (b), use values of 7.50×10^{-4} and 7.50×10^3 N respectively. (2 marks)

(d) Has the cable been stretched beyond its elastic limit of 2.50×10^8 Pa? Circle your choice and provide calculations that support your choice. (2 marks)

YES   NO

B4. The A string on a guitar has length 64.0 cm and fundamental frequency 110 Hz. The tension in the string is 133 N. It is vibrating in its fundamental standing wave mode with a maximum displacement from equilibrium of 2.30 mm.

(a) Calculate the wavelength of the fundamental mode of vibration. (2 marks)

(b) Calculate the wave speed on the string. If you did not obtain an answer for (a), use a value of 1.20 m. (2 marks)

(c) Calculate the linear mass density of the string. If you did not obtain an answer for (b), use a value of 132 m/s. (3 marks)

(d) Calculate the maximum speed of a point on the oscillating string. (3 marks)

END OF EXAMINATION