UNIVERSITY OF SASKATCHEWAN
Department of Physics and Engineering Physics

Physics 115.3
<u>MIDTERM TEST</u>

October 22, 2015   Time: 90 minutes

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

LECTURE SECTION (please check):

❑   01   Dr. M. Ghezelbash

❑   02   Dr. D. Janzen

❑   03   B. Zulkoskey

❑   C15   Dr. A. Farahani

❑   97   Dr. A. Farahani

<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, 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 **<u>not</u>** 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 <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.   Which one of the following options correctly expresses the result for b when
      $b = (4.905 \text{ m/s}^2)(2.10 \text{ s})^2$?

   (A) 21.6 m/s   (B) 21.6 m   (C) 21.63 m   (D) 21.63 m/s   (E) 22 m/s

A2.   Newton's law of universal gravitation is represented by $F = G\dfrac{Mm}{r^2}$, where F is the gravitational

      force, M and m are masses, and r is a distance. What are the SI units of the proportionality
      constant G?

   (A) $\text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$ (B) $\text{m}^2\,\text{kg}^{-1}\,\text{s}^{-2}$ (C) $\text{m}^3\,\text{kg}^{-1}\,\text{s}^{-3}$ (D) $\text{m}^2\,\text{kg}^{-1}\,\text{s}^{-3}$ (E) $\text{m}^2\,\text{kg}^{-2}\,\text{s}^{-2}$

A3.   Based on its apparent size, you estimate that a hot air balloon is a distance ℓ from your eyes.
      You also estimate that when looking directly at the distant balloon, your line of sight is at an
      angle of θ above the horizontal. Which one of the following expressions is correct for the
      altitude of the balloon above your eyes?

   (A) $\ell \tan\theta$ (B) $\dfrac{\ell}{\tan\theta}$ (C) $\ell \sin\theta$ (D) $\ell \cos\theta$ (E) $\dfrac{\ell}{\cos\theta}$

A4.   In which one of the following scenarios does an object in straight-line motion have a positive
      acceleration?

   (A)   Object moving in positive direction at constant speed.
   (B)   Object moving in negative direction at constant speed.
   (C)   Object moving in positive direction with decreasing speed.
   (D)   Object moving in negative direction with decreasing speed.
   (E)   Object moving in negative direction with increasing speed.

A5.   A ball is thrown over level ground at an angle of 60° above the horizontal with an initial speed of
      v_0. Which one of the following statements is **TRUE** when the ball is at maximum height?

   (A)   Both the velocity and acceleration of the ball are zero.
   (B)   The speed of the ball is v_0 and its acceleration is g downward.
   (C)   The speed of the ball is $\frac{1}{2}v_0$ and its acceleration is g downward.
   (D)   The speed of the ball is zero and its acceleration is g downward.
   (E)   The speed of the ball is $\frac{1}{2}v_0$ and its acceleration is zero.

A6.   The graph below shows the velocity versus time for an object moving in one dimension. What is
      the object's average acceleration between $t = 0$ s and $t = 6$ s?
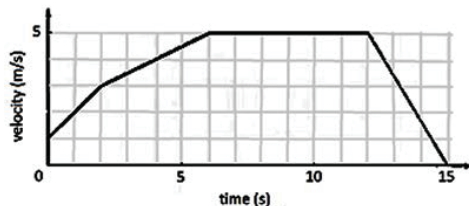

   (A) 3.0 m/s^2 (B) 1.5 m/s^2 (C) 0.83 m/s^2 (D) 0.67 m/s^2 (E) 0.50 m/s^2

A7. A bowling ball accidently falls out of the cargo bay of an airliner as it flies in a horizontal
     direction. As observed by a person standing on the ground and viewing the plane as in the figure
     below, which of the paths 1-5 would the bowling ball most closely follow after leaving the
   airplane?
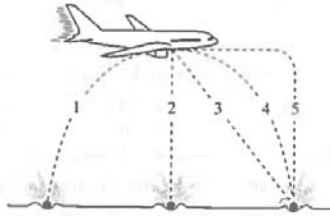
(A) 1   (B) 2   (C) 3   (D) 4   (E) 5

A8. A person pulls a block across a rough horizontal surface at a constant speed by applying a force
     F. The arrows in the diagram below correctly indicate the directions, but not necessarily the
     magnitudes, of the various forces on the block. Which one of the following relations among the
     force magnitudes w, f_k, n, and F must be true?
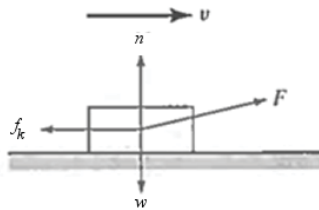
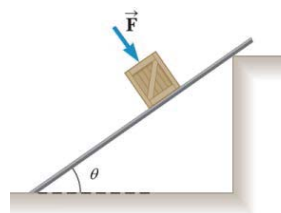(A) $F = f_k$ and $n = w$ (B) $F = f_k$ and $n > w$ (C) $F = f_k$ and $n < w$
(D) $F > f_k$ and $n < w$ (E) $F > f_k$ and $n = w$

A9. The velocity of an object as a function of time is shown in the graph directly below. Which one
     of the force versus time graphs best represents the net force vs. time relationship for this object?

(A)   (B)   (C)   (D)   (E)
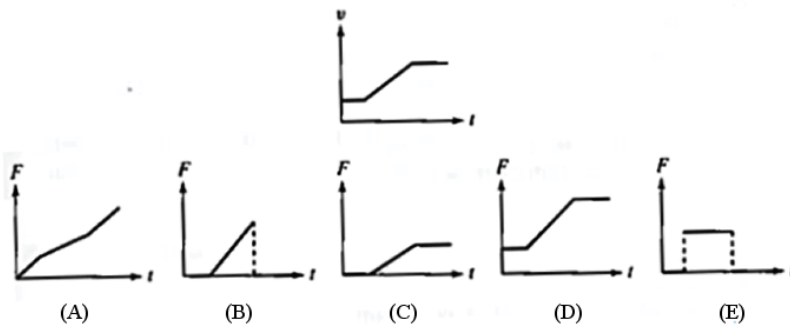
A10. Three identical 6.0-kg cubes are placed on a horizontal surface in contact with one another. The
     cubes are lined up from left to right and a 36-N force is applied to the left side of the left cube,
     causing all three cubes to accelerate to the right. If the cubes are each subject to a frictional force
     of 6.0 N, what is the magnitude of the force exerted on the middle cube by the left cube?

(A) 12 N   (B) 24 N   (C) 36 N   (D) 30 N   (E) 6.0 N

A11.   A crate of mass m is on a ramp that is inclined at an angle θ as shown in the diagram. The coefficient of static friction between the crate and the ramp is μ_s. A force of magnitude F is applied to the crate perpendicular to the ramp. Which one of the following expressions is correct for the minimum value of F that is required to prevent the crate from sliding down the ramp?

(A) $\dfrac{mg(\sin\theta - \mu_s \cos\theta)}{\mu_s}$

(B) $\dfrac{mg(\sin\theta + \mu_s \cos\theta)}{\mu_s}$

(C) $\dfrac{mg(\cos\theta - \mu_s \sin\theta)}{\mu_s}$

(D) $\dfrac{mg(\cos\theta + \mu_s \sin\theta)}{\mu_s}$

(E) $\dfrac{mg(\tan\theta - \mu_s \cot\theta)}{\mu_s}$

A12.   The work required to accelerate an object on a frictionless surface from a speed v to a speed $2v$ is

(A)   twice the work required to accelerate the object from $v = 0$ to v.
(B)   three times the work required to accelerate the object from $v = 0$ to v.
(C)   four times the work required to accelerate the object from $2v$ to $3v$.
(D)   not known without knowledge of the acceleration.
(E)   equal to the work required to accelerate the object from $v = 0$ to v.

A13.   Three projectiles with different masses are launched from the top of a building each at different angles of elevation. Each particle has the same initial kinetic energy. Which particle has the greatest speed just as it impacts with the ground?

(A)   The projectile launched at the highest angle of elevation has the greatest speed.
(B)   The projectile launched at the lowest angle of elevation has the greatest speed.
(C)   The projectile with the highest mass has the greatest speed.
(D)   The projectile with the lowest mass has the greatest speed.
(E)   They all have the same speed on impact with the ground.

A14.   If two particles have equal kinetic energies, are their momenta equal?

(A)   Yes, always.
(B)   Yes, as long as their masses are equal.
(C)   Yes, if both their masses and directions of motion are the same.
(D)   No, never.
(E)   No, unless they are moving perpendicular to each other.

A15.   Water flows over a section of Niagara Falls at a rate of 1.20×10^6 kg/s and falls 50.0 m. How much power is available at the bottom of the waterfall? (Ignore any frictional effects.)

(A) 588 MW   (B) 294 MW   (C) 147 MW   (D) 60.0 MW   (E) 74.0 MW

PART B

ANSWER <u>THREE</u> OF THE PART B QUESTIONS ON THE FOLLOWING PAGES AND <u>INDICATE ON THE COVER PAGE</u> WHICH THREE PART B QUESTIONS ARE TO BE MARKED.

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 rock is thrown upward from level ground with initial velocity v_0 directed at an angle θ, and eventually lands a horizontal distance R from where it was thrown.

(a) By analysing the rock's horizontal motion, find an expression for the time of flight in terms of R, v_0 and θ. (*2 marks*)

(b) By analysing the rock's vertical motion, find an expression for the time of flight in terms of v_0, θ and g. (*2 marks*)

(c) Use your answers to (a) and (b) to write an expression for R in terms of v_0, θ and g. *(2 marks)*

(d) What is the maximum horizontal distance R_{max} that the rock can reach? Express your answer in terms of v_0 and g. Hint: You may find the trig. identity $\sin 2\theta = 2\sin\theta\cos\theta$ useful. (*2 marks*)

(e) For what angle θ does $R = R_{max}$? Hint: You may find the trig. identity $\sin 2\theta = 2\sin\theta\cos\theta$ useful. (*2 marks*)

B2. Two packing crates of masses 9.00 kg and 5.00 kg are connected by a light string that passes over a frictionless pulley as shown. The 5.00-kg crate is on an incline surface of angle 40.0°. The coefficient of friction between the 5.00-kg crate and the incline surface is 0.200.
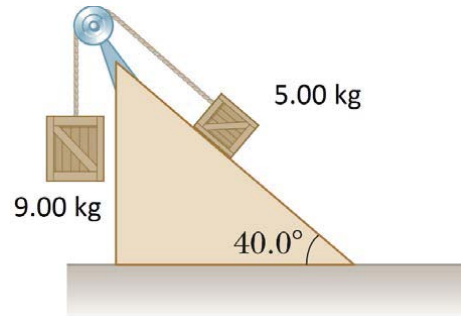
(a) On the above diagram, show all the forces on the 5.00-kg crate. Show your choice of coordinate system. (Air resistance can be ignored.) (*3 marks*)

(b) Calculate the acceleration of the 5.00-kg crate. (*4 marks*)

(c) Calculate the tension in the string. If you did not obtain an answer for (b), use a value of 0.350 m/s². (*3 marks*)
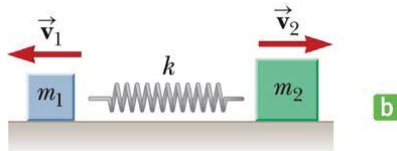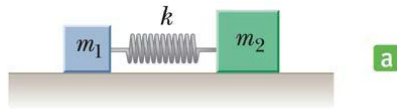
B3. A crane is used to lift a 193-kg steel beam straight up at a constant speed to a work site that is 12.0 m above the ground. The crane produces a constant power of 378 W.

(a) Calculate the work done by gravity. (*3 marks*)

(b) Calculate the net work done by all the forces acting on the beam. (*3 marks*)

(c) Calculate the time required to lift the beam from the ground to the work site. (Ignore any frictional effects.) If you did not obtain an answer for (a), use a value of -2.20×10^4 J. (*4 marks*)

B4. Two objects of masses $m_1 = 1.00$ kg and $m_2 = 2.00$ kg are placed on a horizontal frictionless surface and a compressed spring of force constant 6.00×10^2 N/m is placed between them. Neglect the mass of the spring. The spring is not attached to either object and is compressed a distance of 20.5 cm. If the objects are released from rest, find the final velocity of each object as shown in the figure. (*10 marks*)

$$\vec{v}_1 =$$

$$\vec{v}_2 =$$

END OF EXAMINATION