UNIVERSITY OF SASKATCHEWAN

Department of Physics and Engineering Physics

Physics 115.3
MIDTERM EXAM

October 17, 2019 Time: 90 minutes

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

LECTURE SECTION (please check):

- ❑ 01 Dr. M. Ratzlaff
- ❑ 02 A. Qamar
- ❑ 03 B. Zulkoskey
- ❑ 97 Dr. A. Farahani
- ❑ C15 Dr. A. Farahani

INSTRUCTIONS:

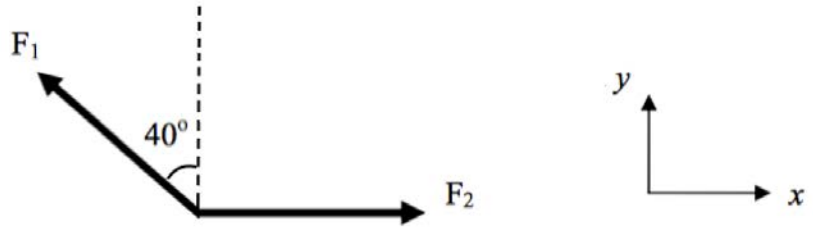
1. This is a closed book exam.
2. The test package includes a test paper (this document), an exam booklet, a formula sheet, a scratch card and an OMR sheet. The test paper consists of 8 pages, including this cover page. **It is the responsibility of the student to check that the test paper is complete**.
3. Only a basic scientific calculator may be used. Graphing or programmable calculators, or calculators with communication capability, or calculators in smart phones 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 name on the exam booklet and scratch card.
5. Enter your name and NSID on the OMR sheet.
6. The test paper, the exam booklet, the formula sheet, the scratch card, and the OMR sheet must all be submitted.
7. No test materials will be returned.

QUESTION NUMBER	MAXIMUM MARKS	MARKS OBTAINED
A1-12	12	
B1-4	8	
B5-8	8	
B9-12	8	
B13-16	8	
MARK	out of 36:	

PART A

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

A1. Forces F_1 and F_2 act on an object, with force F_2 acting in the positive x direction. From the free body diagram and coordinate system shown, which one of the following is the correct expression for the y component of $\vec{F}_1 + \vec{F}_2$?



(A) $F_1 \cos 40°$ (B) $-F_1 + F_2 \cos 40°$ (C) $F_1 \sin 40° + F_2 \cos 40°$
(D) $-F_1 \sin 40°$ (E) $F_1 \sin 40°$

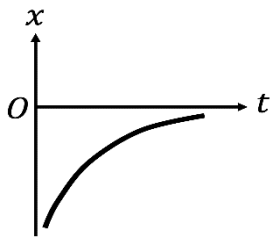
A2. Which one of the following choices is correct for the units of α in the expression $\alpha = \sqrt{\frac{Fx}{4m}}$, where F is force in Newtons, x is displacement in meters, and m is mass in kilograms

(A) m/s^2 (B) m/s (C) m^2/s (D) m^2/s^2 (E) kg m/s

A3. Which one of the following values is a reasonable order-of-magnitude estimate of the volume of a medium-sized orange?

(A) 1 cm^3 (B) 10 cm^3 (C) 100 cm^3 (D) 10 m^3 (E) 100 m^3

A4. The position versus time graph of an object moving in one dimension is shown below.



Which one of the following statements about the motion of this object is correct?

(A) The object is moving with constant velocity in the positive direction.
(B) The object is moving with constant velocity in the negative direction.
(C) The object is moving in the positive direction and speeding up.
(D) The object is moving in the negative direction and slowing down.
(E) The object is moving in the positive direction and slowing down.

A5. A package is released by a plane flying with a constant horizontal velocity. A truck is directly below the plane at this time. The truck is driving on a flat road in the same direction as the plane is flying. Assume there is no wind or air resistance. Which one of the following statements is correct?

(A) Whether or not the package lands on the truck depends on the mass of the package.
(B) If the truck initially has the same velocity as the plane and an acceleration in the same direction as its velocity, the package will land on the truck.
(C) Whether or not the package lands on the truck depends on the altitude of the plane.
(D) If the truck has the same constant velocity as the plane, the package will land on the truck.
(E) If the truck initially has the same velocity as the plane and an acceleration in the opposite direction to its velocity, the package will land on the truck.

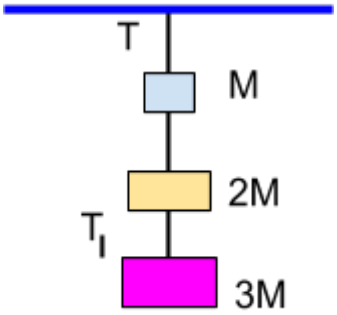
A6. A moving walkway at an airport has a speed υ and a length L. A woman stands on the walkway as it moves from one end to the other, while a man in a hurry to reach his flight walks on the walkway with a speed of 2υ relative to the moving walkway. Compared to the woman's time, how much sooner does the man reach the end of the walkway?

(A) $\frac{L}{\upsilon}$ (B) $\frac{L}{3\upsilon}$ (C) $\frac{2L}{3\upsilon}$ (D) $\frac{4L}{3\upsilon}$ (E) $\frac{L}{2\upsilon}$

A7. If an object is in equilibrium, which one of the following statements is FALSE?

(A) The object must be at rest.
(B) The acceleration of the object is zero.
(C) The net force acting on the object is zero.
(D) The speed of the object is constant.
(E) The velocity of the object is constant.

A8. Three blocks are suspended from the ceiling by strings as shown. The top block has mass M, the middle block has mass 2M, and the bottom block has mass 3M. The tension in the string between the top block and the ceiling is T. What is the tension, T_1, in the string connecting the bottom block and middle block?



(A) 3 T (B) $\frac{3}{5}$T (C) $\frac{1}{2}$T
(D) $\frac{2}{3}$T (E) 6 T

A9. A painter holds a paint brush, of mass *m*, against the ceiling by applying a vertical force of magnitude *F*. The magnitude of the normal force of the ceiling on the brush is

(A) $F + m$ (B) $F - m$ (C) $F - mg$
(D) $F + mg$ (E) 0

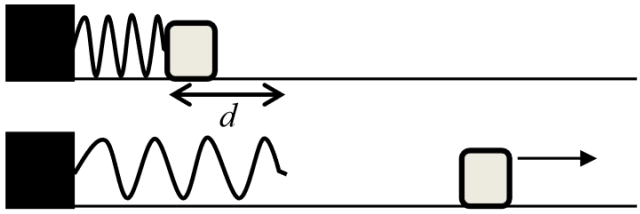
A10. A person is holding a stone of mass *m* in her hand. The stone is initially at rest. She then throws the stone straight up with a velocity υ. What is the net work done on the stone from the moment when she starts accelerating it to throw it upward until it reaches maximum height *h*?

(A) $+mgh$ (B) 0 (C) $-mgh$ (D) $-\frac{1}{2}m\upsilon^2$ (E) $+\frac{1}{2}m\upsilon^2$

A11. A mass tied to the end of a string swings from its highest point down to its lowest point along a semi-circular trajectory. Let W_g, W_T and W_a represent work done by gravity, tension, and air resistance, respectively. Which one of the following statements is correct?

(A) $W_g > 0, W_T = 0, W_a > 0$ (B) $W_g > 0, W_T > 0, W_a < 0$
(C) $W_g = 0, W_T = 0, W_a < 0$ (D) $W_g < 0, W_T = 0, W_a < 0$
(E) $W_g > 0, W_T = 0, W_a < 0$

A12. An object on a frictionless surface is pushed against a horizontal ideal spring, so that the spring is compressed a distance *d*. The object is released, and it has a kinetic energy of KE_1 when it loses contact with the spring. The object is then pushed against the spring so that it is now compressed a distance of 2*d*. Which one of the following expressions is correct for the kinetic energy, KE_2, of the object when it loses contact with the spring?



(A) $KE_2 = 2KE_1$ (B) $KE_2 = 4KE_1$ (C) $KE_2 = KE_1$ (D) $KE_2 = 8KE_1$ (E) $KE_2 = 1.41KE_1$

PART B

WORK OUT THE ANSWERS TO THE FOLLOWING PART B QUESTIONS.

BEFORE SCRATCHING ANY OPTIONS, BE SURE TO DOUBLE-CHECK YOUR LOGIC AND CALCULATIONS.

YOU MAY FIND IT ADVANTAGEOUS TO DO AS MANY OF THE PARTS OF A QUESTION AS YOU CAN BEFORE SCRATCHING ANY OPTIONS.

WHEN YOU HAVE AN ANSWER THAT IS ONE OF THE OPTIONS AND ARE CONFIDENT THAT YOUR METHOD IS CORRECT, SCRATCH THAT OPTION ON THE SCRATCH CARD. IF YOU REVEAL A STAR ON THE SCRATCH CARD THEN YOUR ANSWER IS CORRECT (FULL MARKS, 2/2).

IF YOU DO NOT REVEAL A STAR WITH YOUR FIRST SCRATCH, TRY TO FIND THE ERROR IN YOUR SOLUTION. IF YOU REVEAL A STAR WITH YOUR SECOND SCRATCH, YOU RECEIVE 1.2 MARKS OUT OF 2.

REVEALING THE STAR WITH YOUR THIRD, FOURTH, OR FIFTH SCRATCHES DOES NOT EARN YOU ANY MARKS, BUT IT DOES GIVE YOU THE CORRECT ANSWER.

YOU MAY ANSWER ALL FOUR PART B QUESTION GROUPINGS (1-4, 5-8, 9-12, AND 13-16) AND YOU WILL RECEIVE THE MARKS FOR YOUR BEST 3 GROUPINGS.

USE THE PROVIDED EXAM BOOKLET FOR YOUR ROUGH WORK.

Grouping B1-B4

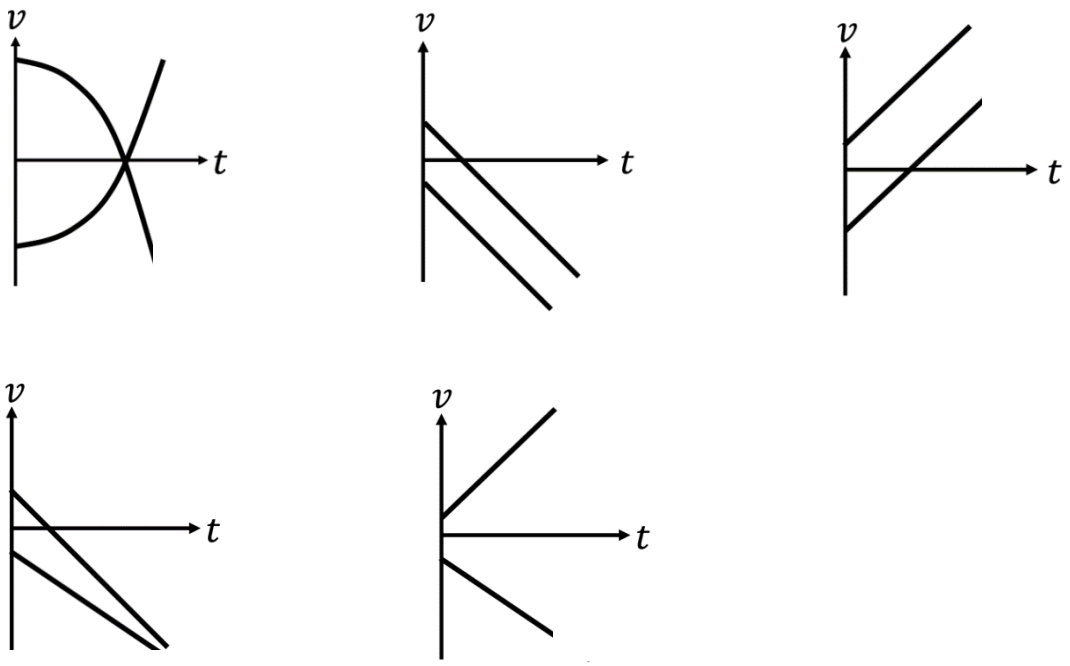
A person throws ball A straight up from the base of a tower with a speed of 30.0 m/s. At the same instant, a friend who is standing on the tower at a height of 275 m directly above the person on the ground throws ball B directly downward with a speed of 25.0 m/s. Assume up to be the positive direction and ignore any effects due to air resistance.

B1. At the instant when the two balls strike each other in the air, which one of the following expressions is correct for the relationship between their displacements?

(A) $\Delta y_A - \Delta y_B = 275$ m (B) $\Delta y_A + \Delta y_B = 275$ m (C) $\Delta y_B - \Delta y_A = 275$ m

(D) $-\Delta y_A - \Delta y_B = 275$ m (E) $\Delta y_A - \Delta y_B = 0$

B2. Which figure best represents v vs. t plots for the two balls during the time interval before they strike each other?

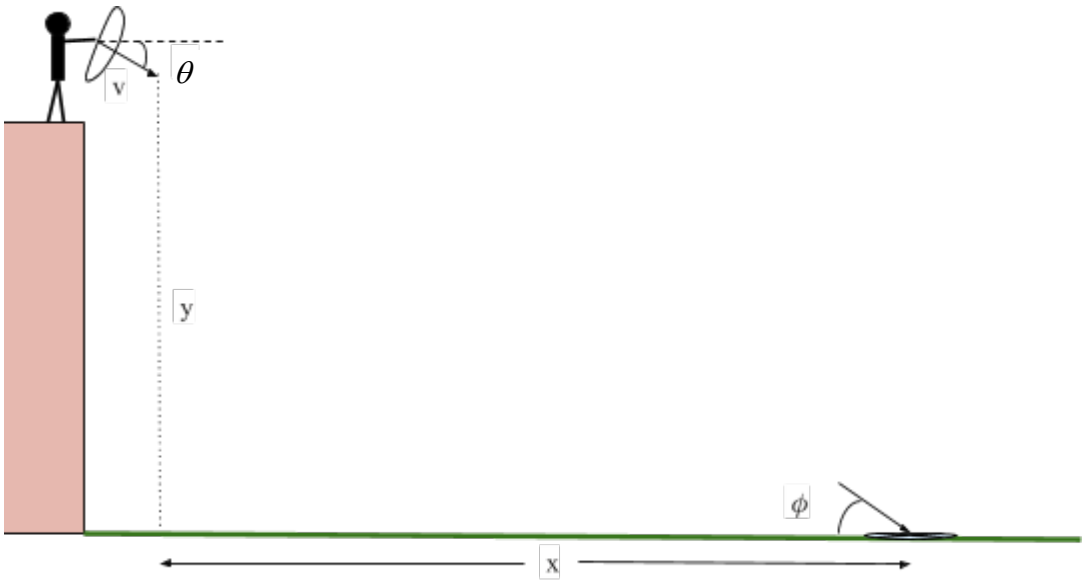


B3. Calculate the time it takes the balls to strike each other (assume the balls have negligible size).

B4. How high above the ground do the two balls strike each other?

Grouping B5-B8

An archer on top of a cliff fires an arrow at a target painted on the ground. The arrow has a velocity of 75.0 m/s and is released at an angle of $\theta = 35.0°$ below the horizontal. Assume air resistance is negligible. The arrow hits the target 1.05 s after it is released.



B5. Calculate the horizontal distance from the arrow's release point to the target.

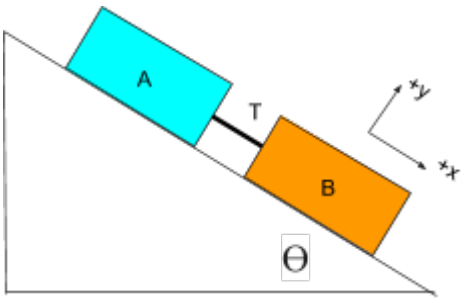
B6. Calculate the height above the ground of the arrow's release point.

B7. Calculate the time for the arrow to reach a point 20.0 m below its release point.

B8. Calculate the velocity of the arrow when it hits the target.

Grouping B9-B12

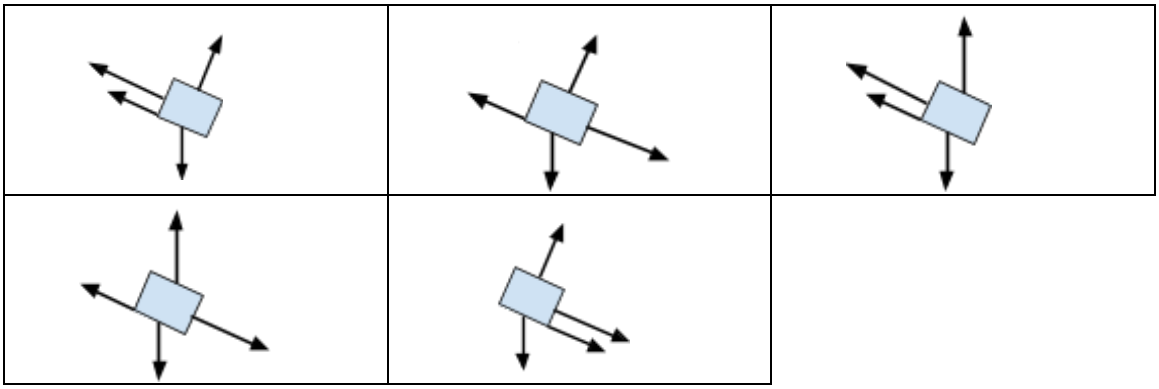
Two blocks, each of mass m = 2.00 kg, are made of different materials. The blocks are tied together, placed on an inclined plane of angle $\Theta = 22.0°$, and released from rest. Assume the string connecting the blocks has negligible mass. The coefficient of kinetic friction between block A and the incline is 0.246 and the coefficient of kinetic friction between block B and the incline is 0.123.



B9. Given the choice of axes shown in the diagram, which one of the following is the correct expression for the magnitude of the normal force, n_A, on block A?

(A) $n_A = mg \sin\Theta$ (B) $n_A = mg \cos\Theta$ (C) $n_A = mg$
(D) $n_A = mg + T\cos\Theta$ (E) $n_A = mg - T\sin\Theta$

B10. Which one of the following free-body diagrams best represents the forces acting on block A?



B11. Calculate the magnitude of the tension in the string.

B12. Calculate the magnitude of the acceleration of the blocks down the incline.

Grouping B13-B16

A 75.0 kg skier starts from rest and slides down a 41.5 m long slope, which is inclined at 25.0° to the horizontal. The slope is not frictionless, and the final velocity of the skier is 12.5 m/s. You can neglect air resistance.

B13. Calculate the work done on the skier by gravity as she skis from the top to the bottom of the slope.

B14. Calculate the work done on the skier by friction as she skis from the top to the bottom of the slope.

B15. Calculate the coefficient of kinetic friction between the skier and the slope.

B16. Once the skier reaches the bottom of the slope, she encounters an uphill slope inclined at 15.0° to the horizontal. Assuming that the coefficient of kinetic friction stays the same, find the vertical height the skier reaches before coming to rest.

END OF EXAMINATION