LAST NAME as on student card	First Name(s) as on student card	Student Number	Practical Group Code (ie T3A)

PHY131H1F
Term Test —version A
Tuesday, October 6, 2015
Duration: 80 minutes

Aids allowed: A pocket calculator with no communication ability. A single hand-written aid-sheet prepared by the student, no larger than 8.5"x11", written on both sides. A hard-copy English translation dictionary. A ruler.

- **Completely turn off** any communication device you may have and leave it with your belongings at the front of the room.

- **DO NOT separate the sheets of your question paper.** You can, however, *carefully* tear off the blank page at the end, as it does not have to be handed in.

- Before starting, please **PRINT IN BLOCK LETTERS your name, student number, and practical group code** at the top of this page **and** on the answer sheet.

Locate your test version number in the header at the top of the page and fill in the circle with the corresponding version code on your answer sheet in the "Form Code" box. Mark in your student number by shading the circles at the top-right of the sheet, starting with a 0 if the first digit is a 9. It is not required to bubble in your surname on the lower half of the sheet.

Scanned Area of the Answer Sheet:

1. **Use a dark-black, soft-lead pencil or a black pen.**
2. Indicate your answer to a multiple-choice question by thoroughly filling the appropriate circle on the answer sheet and also by recording your answer on the test paper.
3. If you wish to modify an answer, erase your pencil mark thoroughly.
4. **Do not write anything else on the answer sheet.** Use the blank sheets at the end or the back of the question sheets for rough work.

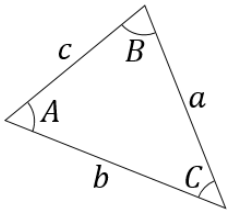
The first part of the test consists of **10** multiple-choice questions, worth 2 points each, or altogether 20 points. Each multiple-choice question has one best answer, and up to four answers that are not the best. You receive 2 points for choosing the best answer and nothing else. You receive 0 points if you either choose a non-best answer, multiple answers, or no answer at all.

The second part of the test is a set of free-form questions, worth a total of 12 points. To be awarded maximum credit, you must provide fully worked solutions to all parts of the free-form questions. In addition to showing your work, please put your answer(s) for each part in the boxes provided. You can use the back-side of the sheets and the blank pages at the end for your rough work which will not be graded or taken into account.

The total number of points available for the test is 32.

Possibly helpful information for this test:
π = 3.14159 is the ratio of the circumference to the diameter of a circle
g = 9.80 m/s^2 is the acceleration due to gravity near the Earth's surface.

Common Prefixes:
k = "kilo-" = 10^3 c = "centi-" = 10^{-2} m = "milli-" = 10^{-3} μ = "micro-" = 10^{-6}
n = "nano-" = 10^{-9}



Sine rule: $\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$

Cosine rule: $a^2 = b^2 + c^2 - 2bc\cos(A)$

Air resistance may be neglected in all questions, unless otherwise stated.

MULTIPLE CHOICE PART (20 points total)
Choose the best answer for each question. 2 points per question, no penalty for guessing.

Question 1
A Canadian $1 coin (called a "loonie") has a mass of 7 g, a diameter of 3 cm, and a thickness of 2 mm. Approximately how many loonies can you fit into an empty peanut butter jar? (Assume that the peanut butter jar originally held 1 kg of peanut butter, and that peanut butter has a density of 1000 kg/m^3. Please choose the closest answer.)

(A) 50 (B) 500 (C) 5000 (D) 50,000 (E) 500,000

Question 2
Two identical objects A and B fall from rest from different heights to the ground and feel no appreciable air resistance. If object B takes twice as long as object A to reach the ground, what is the ratio of the heights from which A and B fell?

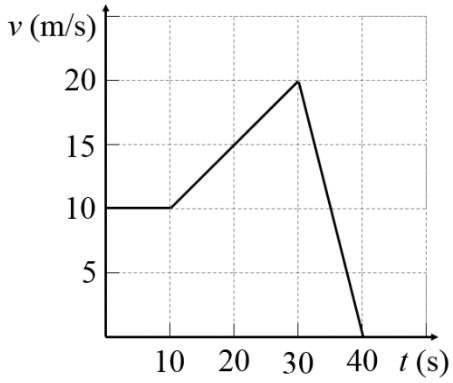
(A) $h_A/h_B = \sqrt{2}$ (B) $h_A/h_B = 2$ (C) $h_A/h_B = ½$ (D) $h_A/h_B = 1/\sqrt{2}$ (E) $h_A/h_B = 1/4$

Question 3
Your friend is sitting directly above you on a tree branch. You wish to throw an apple up to her. The upward distance the apple must travel between your hand and your friend's hand is 3.5 m. What is the minimum initial speed that you must throw the apple so that it reaches her?

(A) 5.9 m/s (B) 8.3 m/s (C) 11 m/s (D) 34 m/s (E) 69 m/s

Question 4

The velocity vs time graph shown represents the motion of a car along a straight line. What was the displacement of the car between $t = 0$ s and $t = 40$ s?



(A) 350 m (B) 400 m (C) 500 m
(D) 550 m (E) 800 m

Question 5

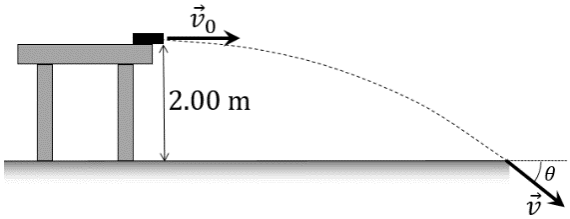
A rabbit trying to escape a fox runs north for 8.0 m, then runs in a direction 45° west of north for 1.0 m, then drops 1.0 m down a hole into its burrow. What is the magnitude of the net displacement of the rabbit away from her starting point?

(A) 7.1 m (B) 7.7 m (C) 8.1 m (D) 8.8 m (E) 10 m

Question 6

A hockey puck slides off the edge of a table with an initial velocity of $\vec{v}_0 = 28.0$ m/s, directly toward the right, as shown. The height of the tabletop above the flat floor is 2.00 m. What is the angle θ below the horizontal of the velocity of the puck just before it hits the ground?

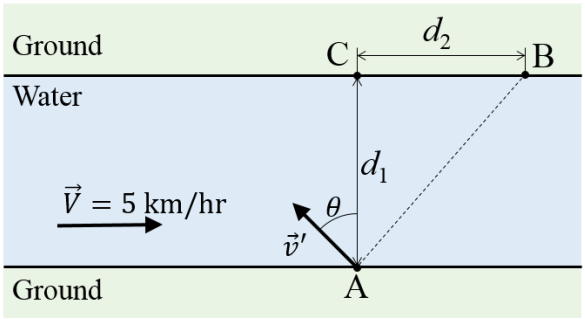
(A) 12.6° (B) 25.2° (C) 31.8°
(D) 72.6° (E) 77.2°



Question 7

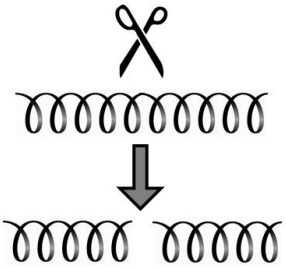
A swimmer wants to cross a river, from point A to point B, as shown in the figure. The distance d_1 (from A to C) is 150 m, the distance d_2 (from C to B) is 120 m, and the speed V of the current in the river is 5 km/hr. Suppose that the swimmer's velocity relative to the water makes an angle of $\theta = 45°$ relative with the line from A to C, as indicated in the figure. To swim directly from A to B, what speed v', relative to the water, should the swimmer have?

(A) 2.8 km/hr (B) 3.9 km/hr
(C) 4.0 km/hr (D) 6.3 km/hr
(E) 7.1 km/hr



Question 8

A metal spring has a spring constant of k. If you cut the spring in half, as shown, what is the spring constant of each new spring?

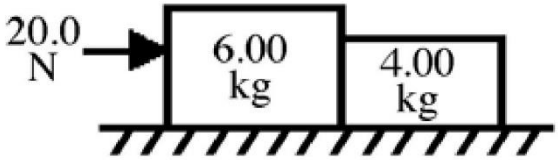


(A) k (B) $2k$ (C) $k/2$ (D) $0.1k$ (E) zero

Question 9

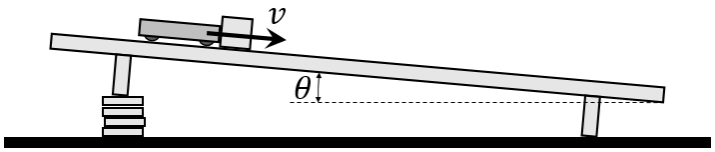
A 6.00-kg block is in contact with a 4.00-kg block on a horizontal frictionless surface as shown in the figure. The 6.00-kg block is being pushed by a horizontal 20.0-N force as shown. What is the magnitude of the force that the 4.00-kg block exerts on the 6.00-kg block?

(A) 6.00 N (B) 20.0 N
(C) 8.00 N (D) 4.00 N
(E) 10.0 N



Question 10

A cart with frictionless wheels is rolling down a straight metal track which is inclined at an angle of $\theta = 5°$ to the horizontal. As it rolls, it is pushing a sliding wooden block. Because of friction from the wooden block, the cart rolls at a constant speed. If you were to raise the left leg of the track more to increase θ, and repeat the experiment, what would be the motion of the cart pushing the same block?



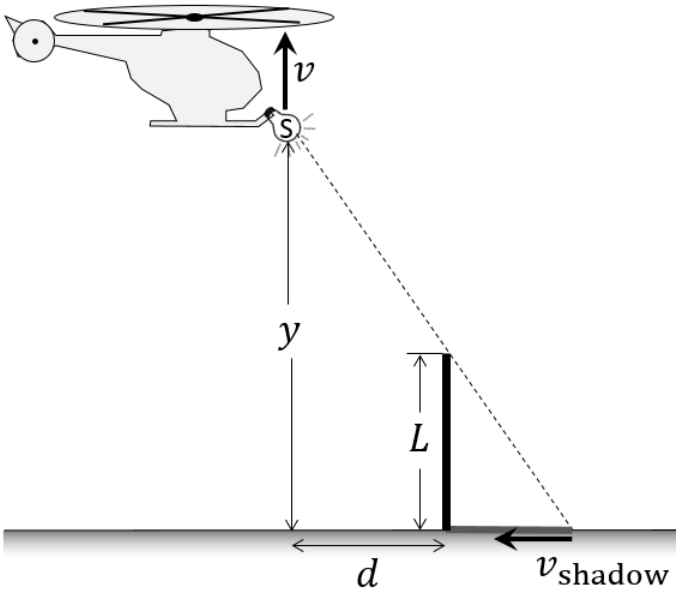
(A) The cart would have negative acceleration down the incline, so that it would be slowing down.
(B) The cart would have positive acceleration down the incline, so that it would be speeding up.
(C) The cart would roll with the same constant speed down the incline as before.
(D) The cart would roll with a constant speed, which is greater than before.
(E) The cart would roll with a constant speed, which is less than before.

FREE-FORM PART (12 points total)

For full marks, you must clearly show all of your work and reasoning in the space provided. State any assumptions you make, and show all the steps of your calculations. Write your final answers in the boxes provided.

Problem A (6 points)

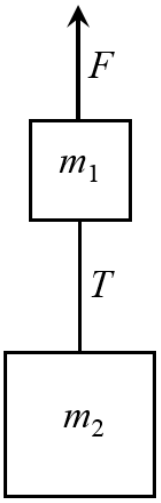
A helicopter flies upward at a speed, *v*, and holds a very bright light source, S, at an increasing height *y* above the flat ground. The light source is always above a point on the ground which is a distance *d* away from the bottom of a vertical post of height *L*. At time $t = 0$, the light source is at $y = L$. As the helicopter continues to fly upward at constant velocity, the shadow of the vertical post gets shorter, as shown. Find an expression for the speed of the tip of the shadow, v_{shadow}. Express your final result in terms of some or all of the following variables only: *v*, *t*, *d* and *L*. Your final answer should *not* include the variable *y*.



$v_{shadow} =$

Problem B (6 points)

Two masses, m_1 and m_2, are joined by a string. An upward pulling force of magnitude F is applied directly to m_1. As a result, both blocks accelerate upward with acceleration magnitude a. While accelerating, the tension in the string has a magnitude of T.



1. **[1 point]** In the box below, sketch a free-body diagram for m_1, and label the forces. Please label the gravitational force on m_1 as "m_1g", where g is the acceleration due to gravity.

2. **[1 point]** In the box below, sketch a free-body diagram for m_2, and label the forces. Please label the gravitational force on m_2 as "m_2g", where g is the acceleration due to gravity.

3. [**4 points**] If F = 36 N, a = 2.2 m/s^2, and T = 24 N, what are the values of the masses m_1 and m_2, in kg?

m_1 =

m_2 =

ROUGH WORK (not marked)