Family Name (Please print in BLOCK LETTERS)
$\begin{array}{lll}\begin{array}{l}\text { Given Name(s) } \\ \text { as on student card }\end{array} & \overline{\text { Student Number }} \quad \begin{array}{c}\text { Tutorial Group } \\ \text { Code (eg. R3C,etc) }\end{array}\end{array}$

PHY131H1S
Mid-Term Test —version 1
Tuesday, February 24, 2009
Duration: 80 minutes

## PLEASE read carefully the following instructions.

Aids allowed: A non-programmable calculator without text storage. A single, hand-written aid-sheet prepared by the student, no larger than 8.5 "x11", written on both sides.

- Turn off any communication device (phone, pager, PDA, iPod, etc.) you may have and place it far from where you are sitting.
- DO NOT separate the sheets of your question paper. Work lost or unattributable because of separated sheets will not receive any credit. You can, however, "carefully" tear off the blank pages at the end, as they do not have to be handed in.
- Before starting, please PRINT IN BLOCK LETTERS your name, student number, and tutorial group code at the top of this page and on the answer sheet.
- Check that the test-version numbers under the shaded circle at the top right of the answer sheet and in the title of your test paper match. If they do not, call an invigilator; if they do, do not write anything on or near the circles.


## Scanned Area of the Answer Sheet:

1. Use a dark-black, soft-lead pencil or a black pen.
2. Mark in your student number by shading the circles in the student number area.
3. 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.
4. If you wish to modify an answer, erase your pencil mark thoroughly, or use dry tape white-out sparingly.
5. 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 test consists of $\mathbf{8}$ multiple-choice questions, worth 2 points each, or altogether 16 points. The test also has a set of free-form questions worth 14 points, for which fully worked solutions are required. The total possible number of points is 30 .

## Multiple-choice questions:

- Please choose the best answer.
- Blank or incorrect answers are worth zero points.
- Multiple answers for the same question result in zero points for that question.

Free-form Questions: 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.

When the invigilators declare the test ended, stop any writing or filling of circles on the answer sheet immediately. Please put your answer sheet inside your test paper and have the paper ready for an invigilator to pick up.

## Possibly useful constants, equations:

Acceleration due to gravity near the surface of the Earth: $\mathrm{g}=9.80 \mathrm{~m} / \mathrm{s}^{2}$
$2 \pi$ radians $=360^{\circ}$
$\pi=3.14159$
Drag force due to the air: $D=\left(0.25 \mathrm{~kg} / \mathrm{m}^{3}\right) A v^{2}$, where $A$ is the cross-section area of the object, $v$ is the speed, and $\vec{D}$ and $\vec{v}$ are in opposite directions.

## MULTIPLE CHOICE (16 points total)

1. A woman stands at the edge of a cliff, holding one ball in each hand. At time $t_{0}$, she throws one ball straight up with speed $v_{0}$ and the other straight down, also with speed $v_{0}$. Which ball hits the ground with greater speed? [Neglect air resistance for this question.]
A. the ball thrown upward
B. the ball thrown downward
C. Neither; the balls hit the ground with the same speed.
2. Harlow gives a quick, initial push to a heavy textbook with his hands. The textbook then slides across the table to the right for a distance of 2 m , until it stops. Which of these forces are acting on the textbook as it slides?
3. Gravity, acting downward
4. The normal force, acting upward
5. The force of Harlow's hands, acting to the right
6. Friction, acting to the left
A. 1, 2 and 3
B. 3 only
C. 1, 2 and 4 but not 3
D. None of these
E. All of these
7. A sprinter runs a race in which he starts from rest, and crosses the finish line 100.0 m away. Assume that he runs with constant acceleration until reaching his top speed of $10.7 \mathrm{~m} / \mathrm{s}$, then maintains that speed through the finish line. If the sprinter reaches his top speed after 2.04 s , what will be his total time between starting and crossing the finish line?
A. 9.35 s
B. 18.7 s
C. 6.28 s
D. 10.4 s
E. 11.3 s
8. Sawyer is rescued from the ocean by grabbing onto the landing gear of a helicopter. The helicopter tows him upward at a constant velocity. Sawyer is so intent on gripping the landing gear that he lets go of his metal briefcase when he is 125 m above the water. If the briefcase hits the water 5.3 s later, what was the speed at which the helicopter was ascending? [Neglect air resistance for this question.]
A. $24 \mathrm{~m} / \mathrm{s}$
B. $12 \mathrm{~m} / \mathrm{s}$
C. $1.4 \mathrm{~m} / \mathrm{s}$
D. $140 \mathrm{~m} / \mathrm{s}$
E. $2.4 \mathrm{~m} / \mathrm{s}$
9. A steel beam of mass $M=440 \mathrm{~kg}$ is supported by two massless ropes, as shown in the figure. The angle between Rope 1 and vertical is $20.0^{\circ}$. The angle between Rope 2 and vertical is $30.0^{\circ}$. The angle between Rope 1 and Rope 2 is $50.0^{\circ}$. What is the tension in Rope 2?
A. $2.2 \times 10^{3} \mathrm{~N}$
B. $2.1 \times 10^{3} \mathrm{~N}$
C. $1.7 \times 10^{3} \mathrm{~N}$
D. $1.9 \times 10^{3} \mathrm{~N}$

E. $9.7 \times 10^{3} \mathrm{~N}$
10. A 65 kg skydiver can be modeled as a rectangular box with height 160 cm , front-to-back distance 25 cm , and side-to-side distance 35 cm . What is her terminal speed if she falls feet first?
A. $290 \mathrm{~km} / \mathrm{hr}$
B. $1.0 \times 10^{5} \mathrm{~km} / \mathrm{hr}$
C. $35 \mathrm{~km} / \mathrm{hr}$
D. $480 \mathrm{~km} / \mathrm{hr}$
E. $620 \mathrm{~km} / \mathrm{hr}$
11. Consider the figure below. In Case a, block A is accelerated across a frictionless table by a hanging mass whose weight is 10 N (its mass is 1.02 kg ). In Case b, block A is accelerated across a frictionless table by a steady 10 N tension in the string. The string is massless, and the pulley is massless and frictionless. The magnitude of the acceleration of Block A is
A. greater in Case a than in Case b.
B. less in Case a than in Case b.
C. the same in Case a as it is in Case b.

Case a


Case b

8. A child is sitting on the outer edge of a merry-go-round that is 18 m in diameter and spinning at a constant rate. If the merry-go-round makes 5.4 revolutions per minute, what is the speed of the child in $\mathrm{m} / \mathrm{s}$ ?
A. 49
B. $1.0 \times 10^{1}$
C. 5.1
D. 97
E. 17

## FREE-FORM IN THREE UNRELATED PARTS (14 points total)

Clearly show your reasoning and work as some part marks may be awarded. Write your final answers in the boxes provided.

## PART A (2 points)

Bob stands on a bathroom scale. There is an action force on Bob, which is gravity. Gravity pulls Bob down. Identify the reaction force, which, by Newton's Third Law, must be equal in magnitude but opposite in direction to the force of gravity on Bob.


## PART B (4 points)

A car of mass $M=1300 \mathrm{~kg}$ enters a level curve of radius $r=91.3 \mathrm{~m}$. The curve is not banked. The coefficient of static friction between the rubber of the car's tires and the concrete road is $\mu_{\mathrm{s}}=0.90$, and the coefficient of kinetic friction between the rubber of the car's tires and the concrete road is $\mu_{\mathrm{k}}$ $=0.77$. What is the maximum speed the car can travel around this curve without slipping? Express your final answer in $\mathrm{m} / \mathrm{s}$.


PART C (8 points)
In the figure the frictionless Track is at an angle $\theta$ with the horizontal. The Cart has a mass $M$, and is connected to a hanging mass $m=0.075 \pm$ 0.002 kg by a massless string over a massless, frictionless pulley.


For an angle $\theta=5.2 \pm 0.1^{\circ}$ the masses are in equilibrium, i.e. if they are at rest they remain at rest and if they are moving at some speed they continue moving at that speed. Calculate the value of the mass of the cart $M$. Express your final answer in kg. [You may use the small angle approximation which is that $\sin \theta \approx \tan \theta \approx \theta$ when $\theta$ is measured in radians.]

