Family Name (Please print in BLOCK LETTERS)

| Given Name(s) <br> as on student card | Student Number | Tutorial Group <br> Code |
| :--- | :--- | :--- | as on student card Code

## PHY131H1S

Test 2 -version 1
Tuesday, March 16, 2010
Duration: 80 minutes

## PLEASE read carefully the following instructions.

Aids allowed: A pocket calculator with no communication ability. A single aid-sheet prepared by the student, no larger than 8.5 " x 11 ", written on both sides.

- Turn off any communication device you may have and place it far from where you are sitting.
- 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 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 12 points, for which fully worked solutions are required. The total possible number of points is 28 .

## 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 helpful information for the test:

acceleration due to gravity near the Earth's surface is: $\vec{g}=9.8 \mathrm{~m} / \mathrm{s}^{2}$, down.
Coefficients of static and kinetic friction of rubber on concrete, $\mu_{\mathrm{s}}=1.00, \mu_{\mathrm{k}}=0.80$.
Air resistance may be neglected in all questions.

## MULTIPLE CHOICE (16 points total)

1. A string is attached to the rear-view mirror of a car. A ball is hanging on the other end of the string. The car is driving along a circular path, at a constant speed. Which of the following lists gives all of the forces directly acting on the ball?
A. tension
B. tension and gravity
C. tension and centripetal force
D. tension, gravity and centripetal force
E. tension, gravity, centripetal force and friction
2. Block 1 , of mass $m_{1}=1.0 \mathrm{~kg}$, is connected over an ideal (massless and frictionless) pulley to block 2 , of mass $m_{2}=0.25 \mathrm{~kg}$, as shown. Assume that the blocks accelerate as shown with an acceleration of magnitude $a$, and that the coefficient of kinetic friction between block 2 and the plane is $\mu=0.20$. The velocity of each block at this moment is in the same direction as its acceleration. The angle of the incline is $\theta=30.0^{\circ}$. What is the magnitude of the acceleration, $a$ ?
A. $4.9 \mathrm{~m} / \mathrm{s}^{2}$
B. $6.5 \mathrm{~m} / \mathrm{s}^{2}$
C. $6.9 \mathrm{~m} / \mathrm{s}^{2}$
D. $8.2 \mathrm{~m} / \mathrm{s}^{2}$
E. $9.7 \mathrm{~m} / \mathrm{s}^{2}$
3. A concrete highway with a curve of radius 70.0 m is banked at a $15^{\circ}$ angle. A car of total mass 1400 kg drives around this curve at a constant speed of $21 \mathrm{~m} / \mathrm{s}$. It has rubber wheels, and they do not slip. What is the magnitude of the force of static friction on the car?
A. 3600 N
B. 3800 N
C. 5000 N
D. 8800 N
E. $13,000 \mathrm{~N}$
4. 


C. $F_{1}>F_{2}=F_{3}$
D. $F_{1}<F_{2}=F_{3}$
E. $F_{1}=F_{2}=F_{3}$ collision takes the same amount of time. Rank the magnitudes of the forces exerted on the block by each ball.
A. $F_{1}<F_{2}<F_{3}$
B. $F_{1}>F_{2}>F_{3}$

$$
\text { E. } F_{1}=F_{2}=F_{3}
$$

4. Three identical balls slide on a table and hit a block that is fixed to the table. In the figures we are looking down from above. In each case the ball is going at the same speed before it hits the block. Each



5. On a frictionless horizontal air table, puck A (with mass $m_{\mathrm{A}}=0.25 \mathrm{~kg}$ ) is moving directly toward puck B (with mass $m_{\mathrm{B}}=0.40 \mathrm{~kg}$ ), which is initially at rest. Initially, puck A is to the left of puck B. After the collision, puck A has velocity $0.13 \mathrm{~m} / \mathrm{s}$, to the left, and puck B has velocity $0.65 \mathrm{~m} / \mathrm{s}$ to the right. How much energy is lost from the system during the collision?
A. 0 J
B. 0.017 J
C. 0.087 J
D. 0.082 J
E. 0.91 J
6. Two forces, of magnitudes $F_{1}$ and $F_{2}$, act in opposite directions on a block, which sits atop a frictionless surface, as shown in the figure. Initially, the centre of the block is at position $x_{\mathrm{i}}$. At some later time, the block has moved to the right, and its centre is at a new position, $x_{\mathrm{f}}$. What is the change in the kinetic energy, $\Delta K$, of the block as it moves from $x_{\mathrm{i}}$ to $x_{\mathrm{f}}$ ?
A. zero
B. $\left(F_{1}-F_{2}\right)\left(x_{\mathrm{f}}-x_{\mathrm{i}}\right)$
C. $\left(F_{2}-F_{1}\right)\left(x_{\mathrm{f}}-x_{\mathrm{i}}\right)$
D. $\left(F_{1}+F_{2}\right)\left(x_{\mathrm{f}}-x_{\mathrm{i}}\right)$
E. impossible to determine without knowing the mass of the block

7. Here is a complete python code:

$$
\begin{aligned}
& \mathrm{t}=0 \\
& \mathrm{dt}=1 \\
& \text { while } \mathrm{t}<3: \\
& \quad \text { print } \mathrm{t} \\
& \quad \mathrm{t}=\mathrm{t}+\mathrm{dt} \\
& \hline
\end{aligned}
$$

What is the output of this code?
A. 0

B. | 1 |
| :--- |
| 2 |

C. | 0 |
| :--- |
| 1 |
| 2 |

D. | 1 |
| :--- |
| 2 |
| 3 |

E. | 0 |
| :---: |
| 1 |
| 2 |
| 3 |

8. A ping pong ball is a spherical shell, for which the moment of inertia is given by $(2 / 3) M R^{2}$. A particular ping pong ball is rolling without slipping along the floor at a speed of $1.0 \mathrm{~m} / \mathrm{s}$. Its mass is $M=0.0027 \mathrm{~kg}$ and its radius is $R=0.020 \mathrm{~m}$. What is the total kinetic energy (rotational plus linear) of the ball as it rolls, in milli-Joules [mJ]?
A. 0
B. 0.90
C. 1.4
D. 2.3
E. 2.7

FREE-FORM IN TWO UNRELATED PARTS (12 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 (6 points)
It's a snowy day and you're pulling a friend along a level road on a sled. The sled and your friend together have a total mass of 55 kg . As you walk, you are pulling up and forward on the sled with a rope that is angled at $35^{\circ}$ above the horizontal. If you pull with a force of 95 N , you can cause the sled to accelerate along the flat road at $0.71 \mathrm{~m} / \mathrm{s}^{2}$, in the same direction as the velocity. What is the coefficient of kinetic friction between the sled and the road?
[Please write your final answer in the box provided, and express your answer to 2 significant figures.]

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PART B (6 points)
A 0.057 kg tennis ball is dropped from rest, a height of 1.3 m above the surface of a bathroom scale. It bounces off the scale and returns to a final height of 1.1 m above the surface of the scale before stopping again. The scale measures the upward normal force on the tennis ball in Newtons, as shown in the plot. What is $\Delta t$, the duration of the collision of the tennis ball with the scale?
[Please write your final answer in the box provided, and express your answer to 2 significant figures.]


ROUGH WORK (not marked)

