Last Name (Please **print in BLOCK LETTERS)**	First Name(s) **as on student card**	Student Number	Practical Group Code

PHY131H1F - SUMMER
Term Test —version 1
Thursday, June 2, 2011
Duration: 110 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"x11", 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. It is just some extra paper for your rough work.
- 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. (This is worth one point!)
- 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 **11** multiple-choice questions, worth 2 points each, or altogether 22 points. The test also has a set of free-form questions worth 13 points, for which fully worked solutions are required. In addition, one point will be awarded for correctly and completely filling out the identifying information at the top of this page and on the answer sheet. The total possible number of points is 36.

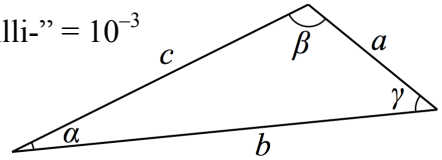
Multiple-choice questions:

- 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 this test:
$\pi = 3.14159$ 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}



The quadratic equation: If $ax^2 + bx + c = 0$, then $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

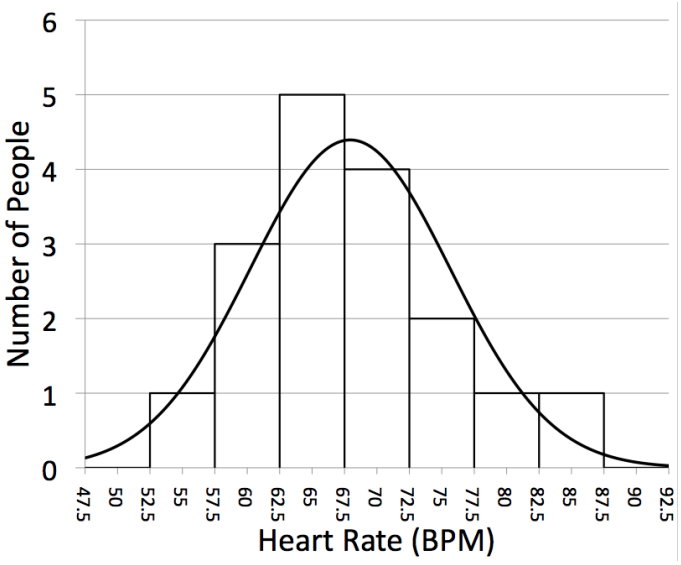
Law of Sines: $\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$ Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$

Some other trigonometry identities: $\tan\theta = \frac{\sin\theta}{\cos\theta}$ $\sin^2\theta + \cos^2\theta = 1$

Air resistance may be neglected in all questions.

MULTIPLE CHOICE (22 points total)

1. You measure the heart-rates of 17 of your co-workers and make a histogram with 5-BPM bins, as shown (BPM = "beats per minute"). You fit the histogram to a Gaussian function, as shown as a smoothly curved line. From this plot, what do you estimate is the standard deviation of the distribution?



   A. 0.4 BPM
   B. 4 BPM
   C. 8 BPM
   D. 16 BPM
   E. 68 BPM

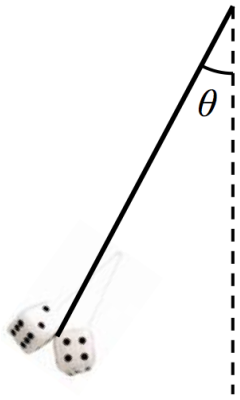
2. A rocket, initially at rest on the ground, accelerates straight upward from rest with constant acceleration, a. The acceleration period lasts for time t_1 until the fuel is exhausted. After that, the rocket is in free fall. What is the maximum height y_{max} reached by the rocket? Ignore air resistance and assume a constant acceleration due to gravity, $-g$, while in freefall.

   A. $\frac{1}{2}at_1^2$ B. $\frac{(at_1)^2}{2g}$ C. $\frac{1}{2}at_1^2\left(1+\frac{a}{g}\right)$

   D. $\frac{1}{2}at_1^2 - \frac{1}{2}gt_1^2$ E. $\frac{1}{2}at_1^2 - \frac{1}{2g}(at_1)^2$

3. A block of mass 0.85 kg lies on a horizontal table. The coefficient of static friction between the block and the table is $\mu_s = 0.60$. The coefficient of kinetic friction is $\mu_k = 0.25$. Suppose you push horizontally with precisely enough force to make the block start to move, and you continue to apply the same amount of force even after it starts moving. What is the magnitude of the acceleration, a, of the block after it begins to move?
   A. 2.5 m/s^2
   B. 3.4 m/s^2
   C. 5.9 m/s^2
   D. 6.1 m/s^2
   E. 9.8 m/s^2

4. Wilma, queen of the drag strip, is racing her Corvette Z06. She has a pair of fuzzy dice of mass m hanging from the rear view mirror. Assume Wilma is accelerating at a constant rate a. The dice reach a steady state where they are not hanging straight down, but making an angle θ with the vertical, as shown. What is θ ?

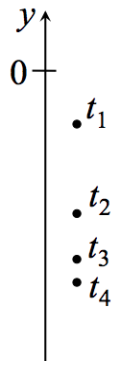


   A. $\cos^{-1}\left(\frac{a}{g}\right)$ B. $\cos^{-1}\left(\sqrt{\frac{a}{g}}\right)$ C. $\sin^{-1}\left(\frac{a}{g}\right)$

   D. $\sin^{-1}\left(\sqrt{\frac{a}{g}}\right)$ E. $\tan^{-1}\left(\frac{a}{g}\right)$

5. You drop a glass barometer from the top of McLennan Physical Labs. A short time later, before the barometer hits the ground, you drop a bottle of scotch. Assume air resistance is negligible. As they fall, the distance between the barometer and bottle
   A. decreases
   B. increases
   C. stays the same.

6. Shown is the motion diagram for a particle. Four equally spaced time intervals are shown, t_1, t_2, t_3 and t_4, which are representative of the smooth motion of this particle. The y-axis is also shown, including $y = 0$. Assume that y increases upwards. What are the signs of the y-components of the position, velocity and acceleration for the particle in the time between times t_1 and t_4?



   A. position: + velocity: + acceleration: +
   B. position: + velocity: – acceleration: +
   C. position: – velocity: + acceleration: –
   D. position: – velocity: – acceleration: +
   E. position: – velocity: – acceleration: –

7. The Earth has a radius of 6.37×10^6 m, and, of course, rotates at a rate of one revolution every 24 hours. The centripetal acceleration, in m/s^2, of a person standing at the equator is closest to:

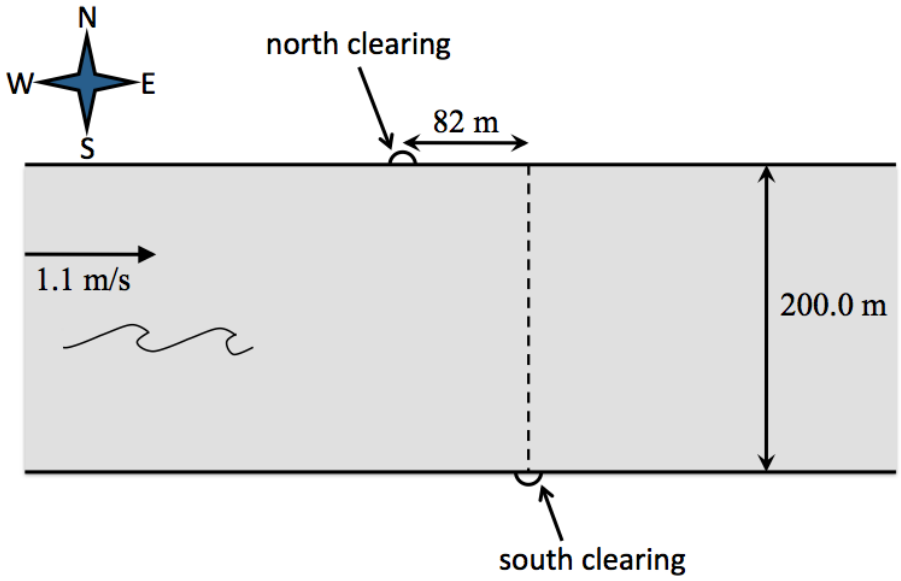
   A. 8.6×10^{-4}
   B. 5.4×10^{-3}
   C. 0.034
   D. 460
   E. 4.4×10^5

8. A box of canned goods slides down a ramp from street level into the basement of a grocery store with acceleration 2.7 m/s^2 directed down the ramp. The ramp makes an angle of 35° with the horizontal. What is the coefficient of kinetic friction between the box and the ramp?

   A. 0.25
   B. 0.28
   C. 0.30
   D. 0.36
   E. 0.57

9. A 200.0 m wide river has a uniform flow speed of 1.1 m/s toward the east. An explorer wishes to leave a small clearing on the south bank and cross the river in a powerboat that moves at a constant speed of 4.0 m/s with respect to the water. There is a clearing on the north bank 82 m west of a point directly opposite the clearing on the south bank. The skillful driver points the boat in the direction necessary to travel in a straight line and land in the clearing on the north bank. How long does the boat take to cross the river and land in the north clearing?

   A. 5.0×10^1 s
   B. 52 s
   C. 54 s
   D. 56 s
   E. 63 s



10. Consider three vectors which satisfy the equation: $\vec{C} = \vec{A} - \vec{B}$. The magnitudes of these vectors are the letters without the arrows on top: C, A and B. If $A > B$, which of the following must *always* be true?

    A. $C = A - B$

    B. $C < A - B$

    C. $C = \sqrt{A^2 + B^2}$

    D. $C = \sqrt{A^2 - B^2}$

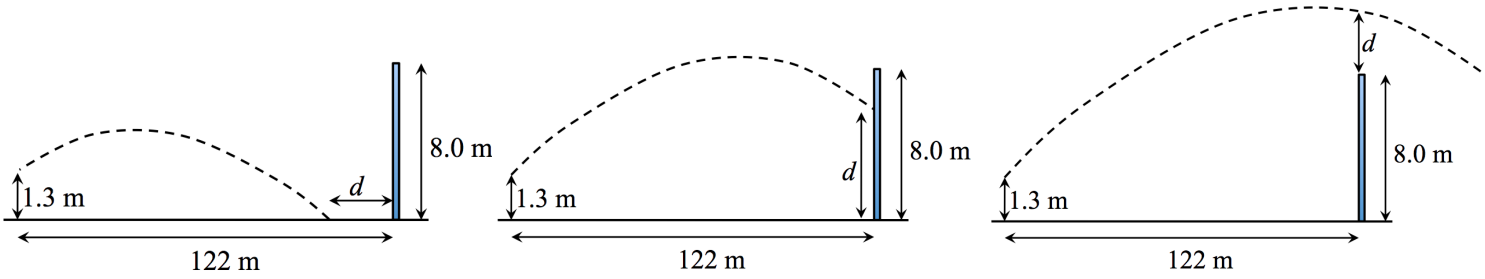
    E. $C \geq A - B$ and $C \leq A + B$

11. A constant net force is applied to an object, causing it to accelerate with acceleration of magnitude a. What will the magnitude of the acceleration be if the force is doubled and the object's mass is halved?

    A. $a/4$
    B. $a/2$
    C. a
    D. $2a$
    E. $4a$

FREE-FORM IN TWO UNRELATED PARTS (13 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)
A baseball is hit from an initial height of 1.3 m above the ground. Its initial velocity is 36 m/s, at an angle of 41° above the horizontal. The outfield wall is 8.0 m high, a horizontal distance of 122 m away. The ball is not caught, and the field is horizontal and flat. There are three possible trajectories, shown below (not to scale): **A** the ball hits the ground before it gets to the wall, **B** the ball hits the wall, or **C** the ball goes over the wall for a "home run". Circle the letter corresponding to the correct trajectory.



What is the distance, *d*, in the correct diagram? (For **A** this is the distance from where the ball hits the ground to the wall, for **B** this is the height of the ball when it hits the wall, or for **C** this is the distance of the ball above the wall as it passes over the wall.) [Please write your final answer in the box provided, in units of m.]

d =

PART B (7 points)
In Practicals Mechanics Module 1 Activities 11 and 12, which you did in the second Practicals Session, you used a spring-loaded cart-launcher to launch a cart along a straight, inclined aluminum track. After several trials with the same launcher setting, you determine that the cart travels 1.83 ± 0.06 m along the track before stopping. It does this in a time of 4.2 ± 0.2 seconds. Assume the cart is frictionless, and that it has a constant acceleration as it slows down, due to the fact that it is going up the incline.
B1. From these measurements, what do you predict is the initial launch speed of the cart? [Please write your final answer in the box provided, with units and error.]

v_i = ±

B2. From these measurements, and any other information you may have, what do you predict was the vertical distance traveled by the cart before stopping? [Please write your final answer in the box provided, in cm with error also in cm.]

y_{max} = ±

ROUGH WORK (not marked)