Midterm Exam # 1
Physics 8A, Fall 2013 (Section 1)

This examination has two parts.

Part I consists of 11 multiple choice questions worth 4 points each. You need not show your work here. No partial credit will be given for these questions. There is no penalty for wrong answers. PLEASE make a grid on the first page of your bluebook and put your answers to Part I onto that grid.

Part II consists of 3 problems. These problems each have multiple parts. You MUST show your work for these questions in your bluebook.

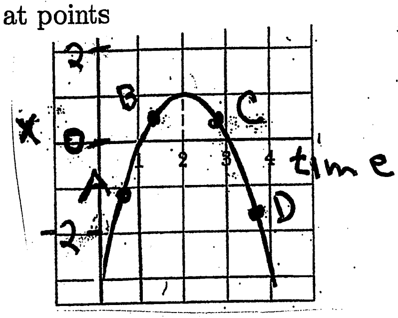
Calculators are NOT permitted; the arithmetic is designed to be easy. You may take ONE sheet of $8\frac{1}{2} \times 11$ inch paper with equations into this exam (for the first exam, please use only one side of the paper). Please refer to the fact sheet that has been distributed for information such as the sin and cos of angles.

Note: To make the math easier, you may approximate $g = 10\ \mathrm{m/s^2}$.

MAKE SURE THAT YOU HAVE WRITTEN YOUR NAME ON YOUR BLUEBOOK!

Part I: (44 points) Answer ALL the questions by writing the letter corresponding to the best answer next to the question. There is no penalty for wrong answers.

1. The graph below shows a ball's position along the x-axis as a function of time. The ball has negative velocity at points

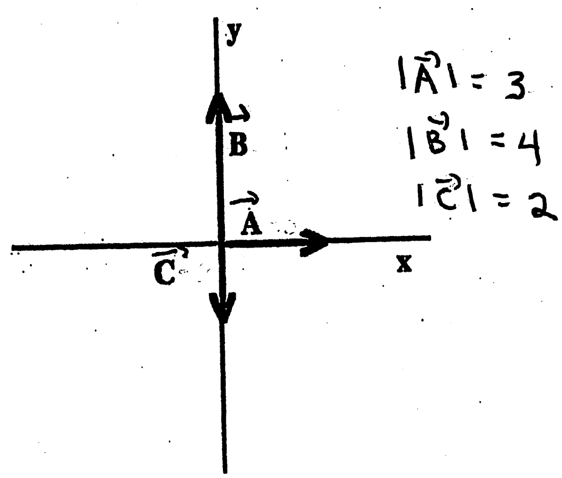


   (a) A and B
   (b) A and C
   (c) A and D
   (d) B and C
   (e) C and D

2. A ball is thrown straight upward from ground level with an initial speed of 20 m/s. For how many seconds is the ball in the air? Neglect air friction.

   (a) 0 s
   (b) 1 s
   (c) 2 s
   (d) 3 s
   (e) 4 s

3. Find the y-component of $\vec{D} = -2\vec{A} + \vec{B} - \vec{C}$



   (a) −2
   (b) 0
   (c) 2
   (d) 4
   (e) 6

4. A frog jumps at an angle of 60° to the horizontal at an initial speed of 3 m/s. How long will it take the frog to return to the ground?

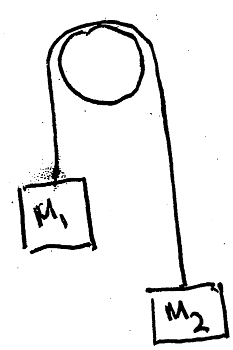
   (a) 0.15 s
   (b) 0.26 s
   (c) 0.30 s
   (d) 0.52 s
   (e) 0.60 s

5. A mass m is swung at constant speed v in a horizontal circle of radius R by a string which makes an angle θ with the horizontal. The vertical component of the tension in the string has a magnitude

   (a) mv^2/R
   (b) mg
   (c) $mg - mv^2/R$
   (d) $mg + mv^2/R$
   (e) $(mv^2/R)\tan\theta$

6. A rope passing over a frictionless pulley has masses M_1 and M_2 hanging from its ends. M_2 is falling with an acceleration $a = -g/2\hat{j}$. The value of M_1/M_2 is:

   (a) 1/6
   (b) 1/3
   (c) 1/2
   (d) 1
   (e) 2



7. A piano weighing 200 N is at rest. The coefficient of static friction is $\mu_s = 0.2$. If a man now pushes the piano with a force of 300 N,

(a) the piano starts to slide
(b) the frictional force is zero
(c) the frictional force is 300 N
(d) the frictional force is 400 N
(e) the frictional force is 800 N

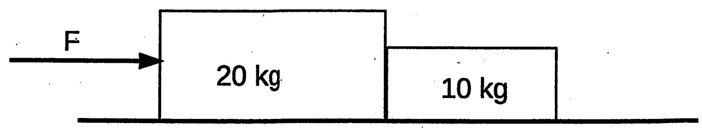
8. A ski tow pulls a 60 kg skier up a slope that makes an angle of 30° with the horizontal direction for a distance of 50 m. The skier starts at rest and finishes at rest. How much work does the ski tow do to overcome the gravitational force?

(a) 1,500 J
(b) 2,600 J
(c) 15,000 J
(d) 26,000 J
(e) 30,000 J

9. A 1200 kg car is accelerated from 10 m/s to 30 m/s. How much work does this require?

(a) 240,000 J
(b) 480,000 J
(c) 600,000 J
(d) 960,000 J
(e) 1,200,000 J

10. Two boxes, one made of wood and one made of steel sit on a table with their sides touching as shown below. The wooden box mas a mass of 20 kg and a coefficient of kinetic friction with the table of $\mu_K = 0.2$. The steel box mas a mass of 10 kg and a coefficient of kinetic friction with the table of $\mu_K = 0.1$. If a force $F = 80$ N is applied to the wooden box as show, the magnitufde of the acceleration of the wooden box is



(a) 1 m/s^2
(b) 4/3 m/s^2
(c) 8/3 m/s^2
(d) 13/3 m/s^2
(e) 10 m/s^2

11. A charged particle moves in an electric field such that its position is

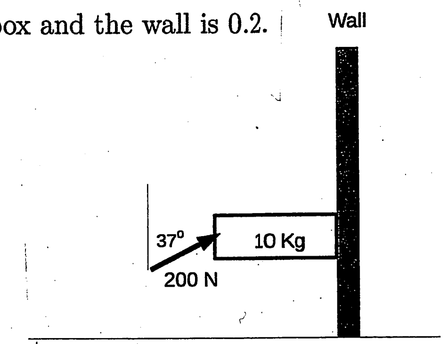
$$\vec{r}(t) = (0.5\text{ m} + 2\text{ m/s}t + 2.5\text{ m/s}^2t^2)\hat{\imath} + (2\text{m/s}t - 6\text{m/s}^2t^2)\hat{\jmath}$$

After 1 second, the magnitude of the particle's acceleration is

(a) 6.5 m/s^2
(b) 7 m/s^2
(c) 8.5 m/s^2
(d) 13 m/s^2
(e) 17 m/s^2

Part II You must show the reasoning for your answers in your blue book. Do this as clearly as possible so that you may be given partial credit if your approach is correct but your numerical answer is wrong. (Note: A neat easy-to-read answer is much more likely to gain you partial credit than one we can't decipher!) If you end up with an answer with square root that does not simplify to an integer, you may leave your result in that form. For example, writing $x = 5 + \sqrt{307}$ m would receive full credit if that is the correct result.

1. (15 points) Harry is trying to push a heavy (10 kg) box over a wall that is 2 m high. He starts with the box at rest and with the bottom of the box 0.5 m from the ground and pushes the box with a constant force of 200 N at an angle of 37° from the vertical as shown. The coefficient of friction between the box and the wall is 0.2.



   (a) Draw a free body diagram (also called a force diagram) for the box.

   (b) Find the magnitude and the direction of the acceleration the box feels.

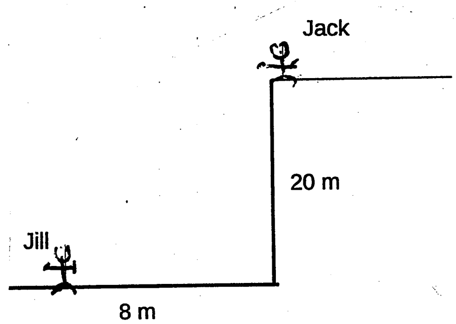
   (c) What is the speed of the box when it reaches the top of the wall?

   (d) How much work has Harry done on the box to push it over the wall?

2. (15 points) Jill is standing on the beach 8 m from the base of a cliff. Jack is standing at the top of the cliff, 20 m above the beach. Jill has a toy airplane that she wants to send to Jack. She releases the toy, which has a motor that exerts a constant force

$$\vec{F} = F_x\hat{\imath} + F_y\hat{\jmath}$$

from rest at time $t = 0$.



(a) What is the acceleration that the toy airplane feels after Jill releases it? Express your answer in terms of F_x, F_y, g and m (the mass of the airplane).

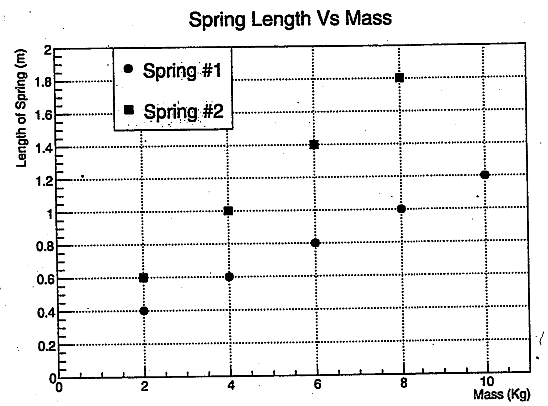
(b) If the airplane has a mass of 1 kg and $F_x = 1$ N, how long will it take for the airplane to reach the cliff?

(c) What is value F_y is needed for the airplane to reach Jack?

(d) What is the velocity of the airplane when it reaches Jack? You can either express your answer in components or as a magnitude and direction.

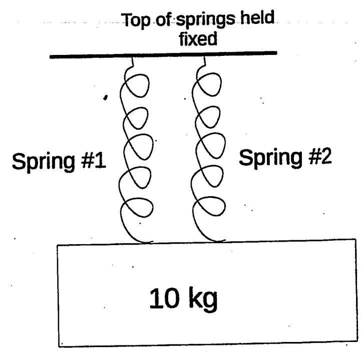
3. (16 points) Terry has hired Mary, a work-study student, to help design new experiments for Physics 8A. He goes to lunch and leaves the student in the lab to play with the equipment. Mary finds two springs of the same length and a collection of weights.

   (a) Mary hangs spring # 1 vertically. She measures the length of the spring when she puts different weights on the end. Then she repeats the exercise for spring # 2 and plots the results, as shown below. Find the spring constant k for each of the springs.



   (b) What is the equilibrium length of the springs (the length when no weight is hung from the spring)?

(c) Mary now hangs both springs vertically and connects a mass of 10 kg to the two springs as shown below. Calculate the length of the spring.



(d) Now Mary puts spring # 1 on a frictionless horizontal table and attaches one end to a peg, so that the spring is free to rotate on the peg. She puts a 2 kg mass on the other end of the spring and starts it moving in a circle with a constant speed of 1 m/s. What is the length of the spring for this configuration?