PA CENTRAL REGIONAL SCIENCE OLYMPIAD 2006

PHYSICS LAB C DIVISION

MARCH 18, 2006

STATE COLLEGE HIGH SCHOOL

SCHOOL NAME_______________________________ **SCHOOL CODE**_____________

INSTRUCTIONS

1. Turn in all exam materials at the end of this event. *Missing exam materials will result in immediate disqualification of the team in question*. There is an exam packet and a blank answer sheet.

2. You may separate the exam pages. Re-staple them as you submit your materials to the supervisor. Keep the answer sheet separate.

3. *Only* the answers provided on the answer page will be considered. Do not write outside the designated spaces for each answer.

4. Include school name and school code in the appropriate locations on the answer sheet as well as on the title page. Indicate the names of the participants at the bottom of the answer sheet.

5. Point values for each question are in parentheses. Tiebreaker questions are indicated as such with a number indicating the first, second, third, etc. *Tiebreaker questions count toward the overall grade, and are only used as tiebreakers in the event of a tie.*

6. Pay close attention to the units given in the problem and the units asked for in the answer.

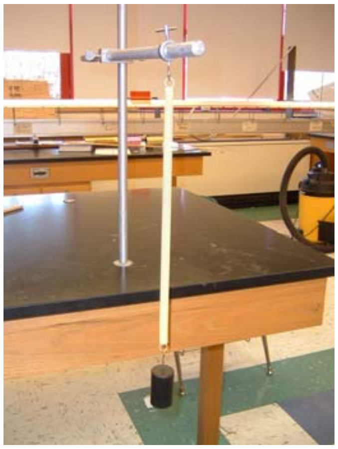
7. When the time is up, *the time is up*. Continuing to write after the time is up risks immediate disqualification.

8. There are NO resources for this event. NON-PROGRAMMABLE CALCULATORS ONLY.

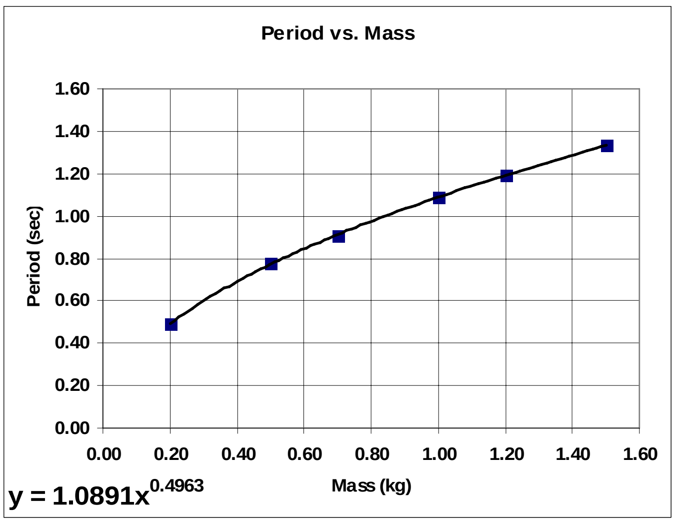
9. Your 2-point bonus question is this: Who is the guy on the cover page? Put your answer in the bonus box on the answer sheet.

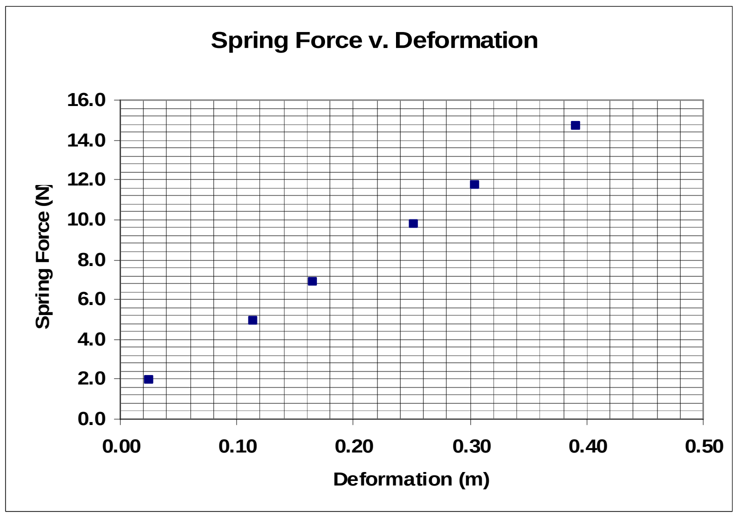
SECTION 1

The image below shows a spring with a mass hanging on it. The spring has an original, unstretched length of 28.0 cm. The spring is suspended from a hook-collar clamp as shown, and a series of masses are placed on the spring. For each trial, the spring's length was measured and recorded in the data table below. Then, the mass was pulled down an *additional* 5.0 cm from its rest position and released. The resulting oscillation's period was then measured and recorded in the table. The two graphs were created using the data. The period vs. mass graph contains the best-fit power function equation at the lower left. Use the data and graphs to answer the following questions.



Trial	Mass (g)	Length of spring (at rest) (cm)	Period of oscillation (seconds)
1	200	30.5	0.49
2	500	39.4	0.775
3	700	44.5	0.909
4	1000	53.2	1.087
5	1200	58.4	1.19
6	1500	67.1	1.337





(2) 1. What is the deformation of the spring (in meters) in trial 3?

(2) 2. What is the spring force (in Newtons) in trial 4?

(2) 3. How long would the spring be with a 2.00 kg mass hanging on it?

(2) 4. What would the period of oscillation be with a 2.00 kg mass on the spring?

(2) 5. With the spring-mass system at rest in trial 5, what is the elastic potential energy stored in the spring?

(2) 6. What is the amplitude of the oscillation in trial 1?

(2) 7. How much energy is contained *in the oscillation* of trial 3?

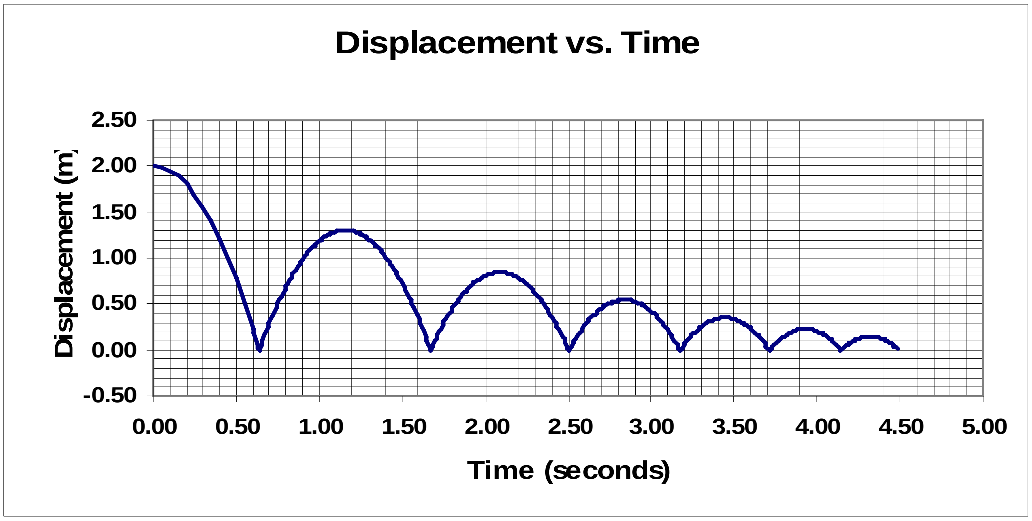
(2) 8. What is the instantaneous acceleration of the oscillating mass at its lowest point in trial 6?

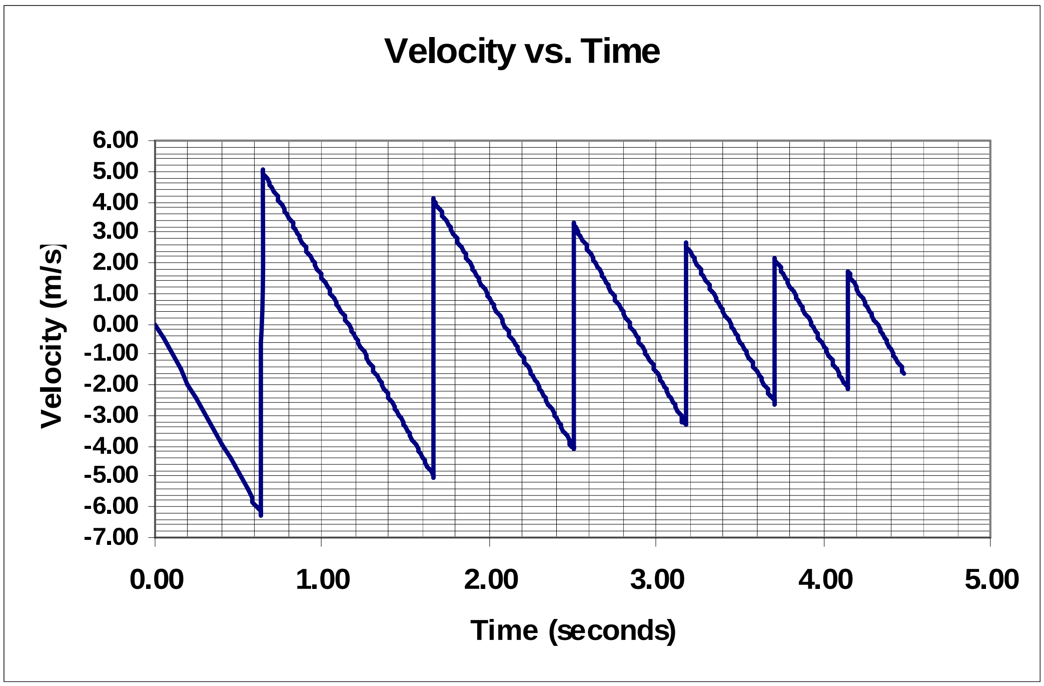
(2) 9. According to the spring force vs. deformation graph, what is the spring constant for this spring?

(2) 10. (Tiebreaker 1) According to the period vs. mass graph, what is the spring constant for this spring?

SECTION 2

The graphs below show displacement and velocity vs. time graphs for a ball of mass 25.0 grams dropped from an initial height at time t = 0. The acceleration due to gravity is g = 9.80 m/s^2. Each bounce takes 0.0400 seconds.





(2) 1. What is the initial height from which the ball is dropped?

(2) 2. Where is the ball 2.00 seconds after it is dropped?

(2) 3. How fast and in what direction is the ball moving 2.00 seconds after it is dropped?

(2) 4. How much kinetic energy does the ball have at t = 0.50 seconds?

(2) 5. How much gravitational potential energy does the ball have at t = 1.00 seconds?

(2) 6. What are the magnitude and direction of the impulse on the ball the first time it bounces?

(2) 7. What are the magnitude and direction of the net force on the ball at t = 1.00 seconds?

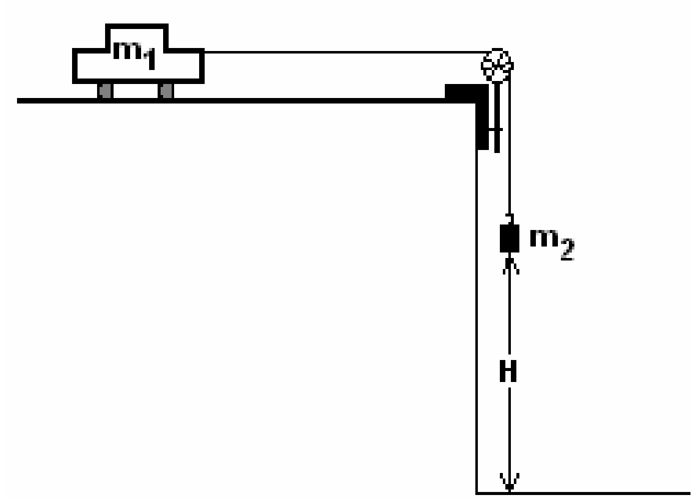
(2) 8. What are the magnitude and direction of the average force exerted by the floor on the ball during the second bounce?

(2) 9. How much kinetic energy is lost in the 1st bounce?

(2) 10. (Tiebreaker 2) What is the ball's coefficient of restitution on this surface?

SECTION 3

The image below shows a schematic diagram of a standard experimental apparatus used to test Newton's 2nd Law. It consists of a small cart connected by a string over a low-friction pulley to a mass hanger. The system is released from rest with the hanging mass at a height H above the floor and allowed to accelerate until the hanging mass hits the floor. The time it takes for the hanging mass to hit the floor is measured and recorded. Some data is provided.



Trial	Cart mass	Hanging mass	Height	Coefficient of friction	Time of descent
	kg	kg	m		s
1	0.350	0.050	0.850	0.0875	1.892
2	0.350	0.070	0.800	0.0875	1.320
3	0.350	0.090	0.750	0.0875	1.065
4	0.350	0.110	0.750	0.0875	0.942
5	0.350	0.130	0.750	0.0875	0.860
6	0.350	0.150	0.650	0.0875	0.745
7	0.350	0.170	0.650	0.0875	0.704
8	0.350	0.190	0.650	0.0875	

(2) 1. What is the net force on the cart in trial 2?

(2) 2. What is the friction force on the cart in trial 3?

(2) 3. What is the tension in the string in trial 6?

(2) 4. What is the work done by friction in trial 5?

(2) 5. What is the kinetic energy of the system when the hanging mass hits the floor in trial 7?

(2) 6. What is the velocity of the cart when the hanging mass hits the floor in trial 1?

(2) 7. What is the momentum of the hanging mass as it hits the floor in trial 4?

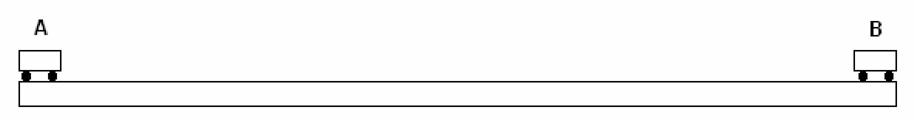
(2) 8. What will be the time of descent in trial 8?

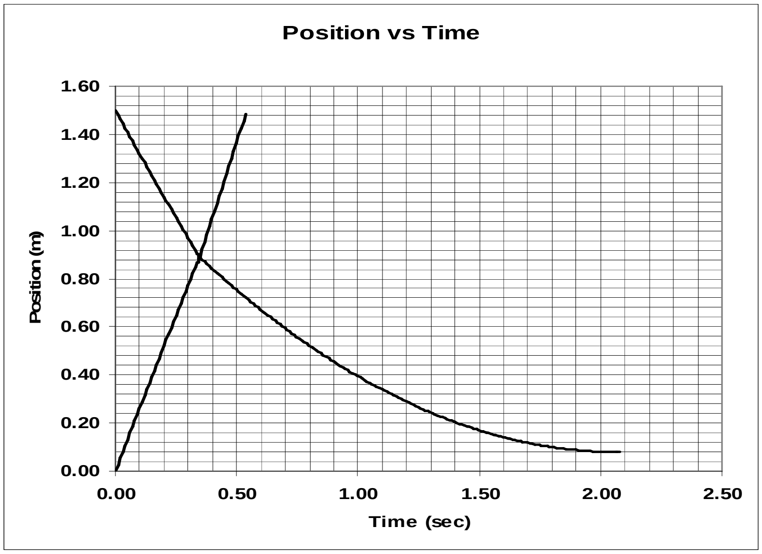
(2) 9. What is the weight of the hanging mass in trial 7?

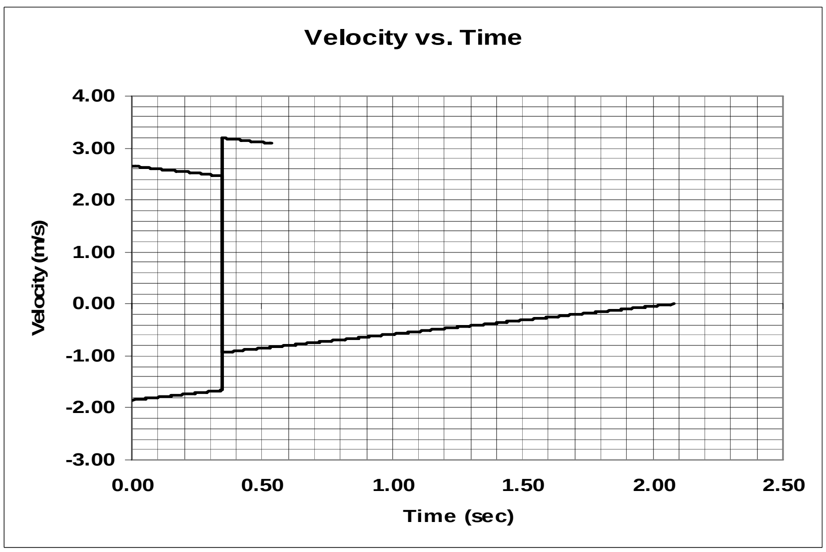
(2) 10. What is the acceleration of the cart in trial 4?

SECTION 4

The graphs below show displacement and velocity vs. time graphs for a 1-dimensional, perfectly elastic collision between two objects. The objects are given initial velocities towards each other at t = 0 seconds. Their positions at t = 0 are at either end of a long track where the left end of the track is d = 0.







(2) 1. How long is the track?

(2) 2. What is the initial velocity of object B?

(2) 3. Where does the collision take place?

(2) 4. When does the collision take place?

(2) 5. What is the velocity of object A at t = 1.00 seconds?

(2) 6. What is the acceleration of object A after the collision?

(2) 7. What is the coefficient of friction on the track?

(2) 8. How much kinetic energy is lost in the collision?

(2) 9. What is the total distance traveled by object A?

(2) 10. (Tiebreaker 4) What is the ratio of the masses (m_A/m_B)?