A.P.C. PROBLEMS

regarding

ENERGY & LINEAR MOMENTUM

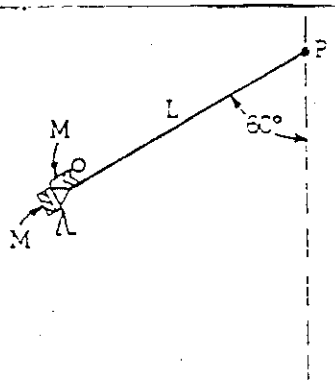

Figure I

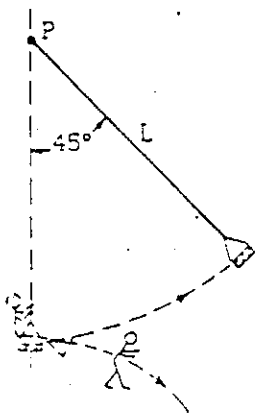

Figure II

Mech. 2. A swing seat of mass M is connected to a fixed point P by a massless cord of length L. A child also of mass M sits on the seat and begins to swing with zero velocity at a position at which the cord makes a 60° angle with the vertical as shown in Figure I. The swing continues down until the cord is exactly vertical at which time the child jumps off in a horizontal direction. The swing continues in the same direction until the cord makes a 45° angle with the vertical as shown in Figure II; at that point it begins to swing in the reverse direction. With what velocity relative to the ground did the child leave the swing? $\left(\cos 45^{\circ} = \sin 45^{\circ} = \frac{\sqrt{2}}{2},\ \sin 30^{\circ} = \cos 60^{\circ} = \frac{1}{2},\ \cos 30^{\circ} = \sin 60^{\circ} = \frac{\sqrt{3}}{2}\right)$

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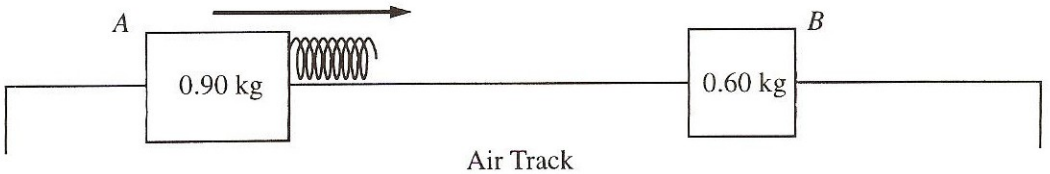
PHYSICS C

SECTION II, MECHANICS

Time—45 minutes

3 Questions

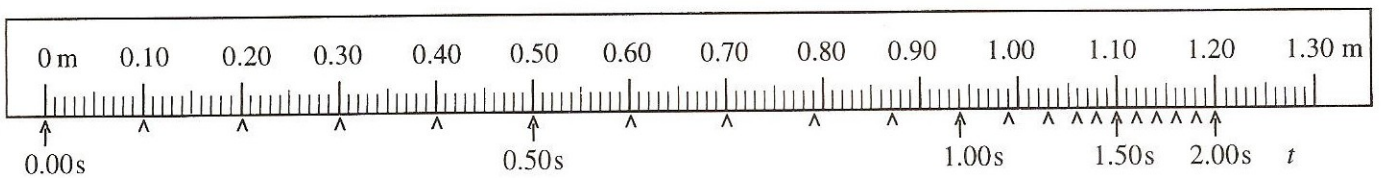
Directions: Answer all three questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part, NOT in the green insert.



Air Track

Mech. 1. Two gliders move freely on an air track with negligible friction, as shown above. Glider A has a mass of 0.90 kg and glider B has a mass of 0.60 kg. Initially, glider A moves toward glider B, which is at rest. A spring of negligible mass is attached to the right side of glider A. Strobe photography is used to record successive positions of glider A at 0.10 s intervals over a total time of 2.00 s, during which time it collides with glider B.

The following diagram represents the data for the motion of glider A. Positions of glider A at the end of each 0.10 s interval are indicated by the symbol ∧ against a metric ruler. The total elapsed time t after each 0.50 s is also indicated.



(a) Determine the average speed of glider A for the following time intervals.

i. 0.10 s to 0.30 s

ii. 0.90 s to 1.10 s

iii. 1.70 s to 1.90 s

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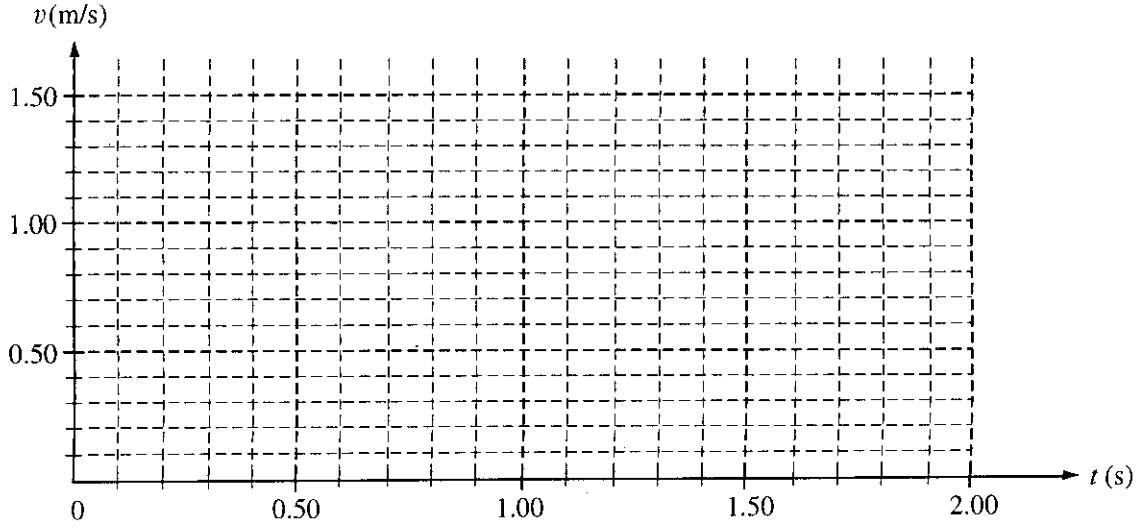
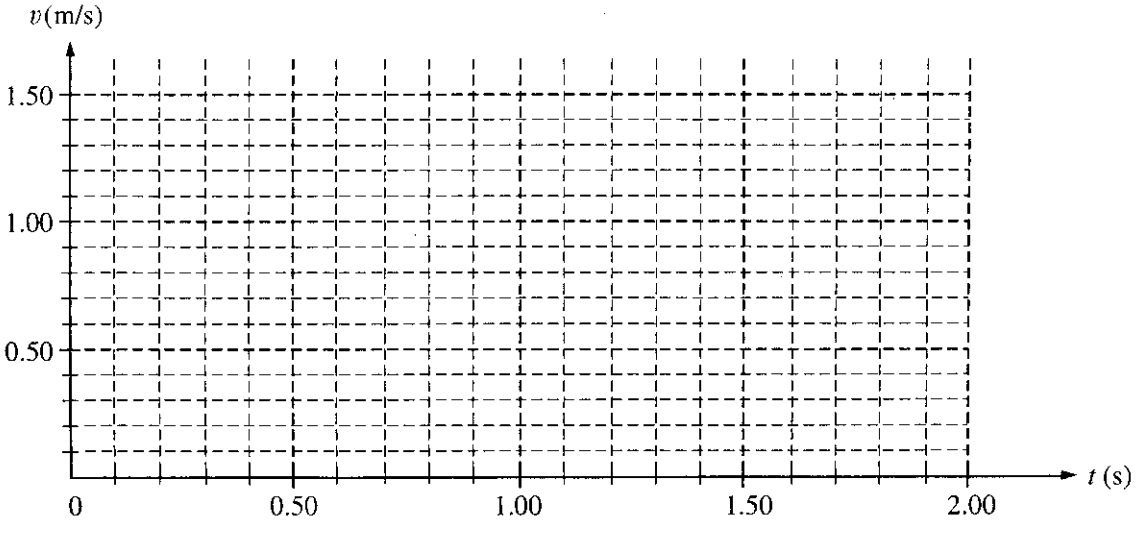
(b) On the axes below, sketch a graph, consistent with the data above, of the speed of glider A as a function of time t for the 2.00 s interval.



(c) i. Use the data to calculate the speed of glider B immediately after it separates from the spring.

ii. On the axes below, sketch a graph of the speed of glider B as a function of time t.



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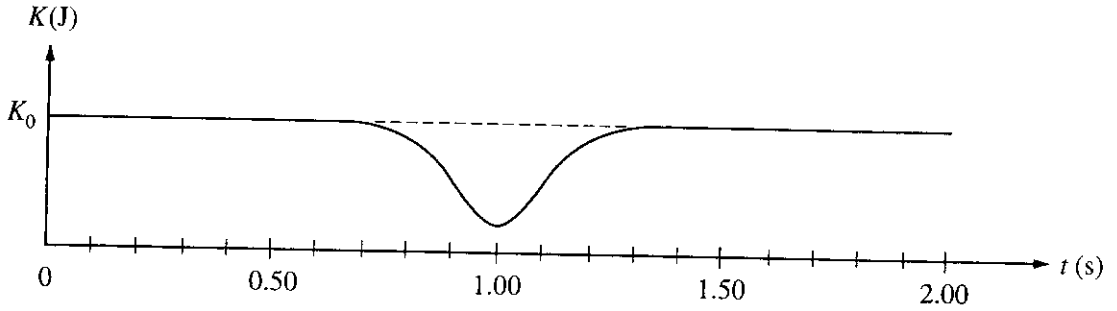
A graph of the total kinetic energy K for the two-glider system over the 2.00 s interval has the following shape. K_0 is the total kinetic energy of the system at time $t = 0$.



(d) i. Is the collision elastic? Justify your answer.

ii. Briefly explain why there is a minimum in the kinetic energy curve at $t = 1.00$ s.

PHYSICS C

SECTION II, MECHANICS

Time—45 minutes

3 Questions

ANSWER ALL OF THE QUESTIONS. EACH OF THE THREE QUESTIONS HAS EQUAL WEIGHT, BUT THE PARTS WITHIN A QUESTION MAY NOT HAVE EQUAL WEIGHT. SHOW YOUR WORK. CREDIT FOR YOUR ANSWERS DEPENDS ON THE QUALITY OF YOUR EXPLANATIONS.

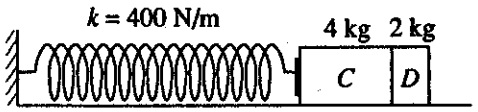


Figure I

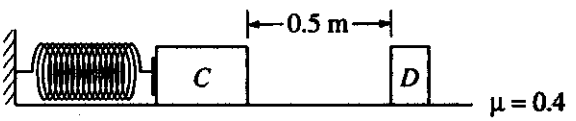


Figure II

Mech. 1. A massless spring with force constant $k = 400$ newtons per meter is fastened at its left end to a vertical wall, as shown in Figure I. Initially, block C (mass $m_C = 4.0$ kilograms) and block D (mass $m_D = 2.0$ kilograms) rest on a horizontal surface with block C in contact with the spring (but not compressing it) and with block D in contact with block C. Block C is then moved to the left, compressing the spring a distance of 0.50 meter, and held in place while block D remains at rest as shown in Figure II. (Use $g = 10$ m/s^2.)

(a) Determine the elastic energy stored in the compressed spring.

Block C is then released and accelerates to the right, toward block D. The surface is rough and the coefficient of friction between each block and the surface is $\mu = 0.4$. The two blocks collide instantaneously, stick together, and move to the right. Remember that the spring is not attached to block C. Determine each of the following.

(b) The speed v_C of block C just before it collides with block D

(c) The speed v_f of blocks C and D just after they collide

(d) The horizontal distance the blocks move before coming to rest

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