AP® Physics C: Mechanics
2001 Sample Student Responses

The materials included in these files are intended for non-commercial use by AP teachers for course and exam preparation; permission for any other use must be sought from the Advanced Placement Program. Teachers may reproduce them, in whole or in part, in limited quantities, for face-to-face teaching purposes but may not mass distribute the materials, electronically or otherwise. These materials and any copies made of them may not be resold, and the copyright notices must be retained as they appear here. This permission does not apply to any third-party copyrights contained herein.

These materials were produced by Educational Testing Service (ETS), which develops and administers the examinations of the Advanced Placement Program for the College Board. The College Board and Educational Testing Service (ETS) are dedicated to the principle of equal opportunity, and their programs, services, and employment policies are guided by that principle.

The College Board is a national nonprofit membership association dedicated to preparing, inspiring, and connecting students to college and opportunity. Founded in 1900, the association is composed of more than 3,900 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 22,000 high schools, and 3,500 colleges, through major programs and services in college admission, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT™, the Advanced Placement Program® (AP®), and Pacesetter®. The College Board is committed to the principles of equity and excellence, and that commitment is embodied in all of its programs, services, activities, and concerns.

Copyright © 2001 by College Entrance Examination Board. All rights reserved. College Board, Advanced Placement Program, AP, and the acorn logo are registered trademarks of the College Entrance Examination Board.

PHYSICS C

Section II, MECHANICS

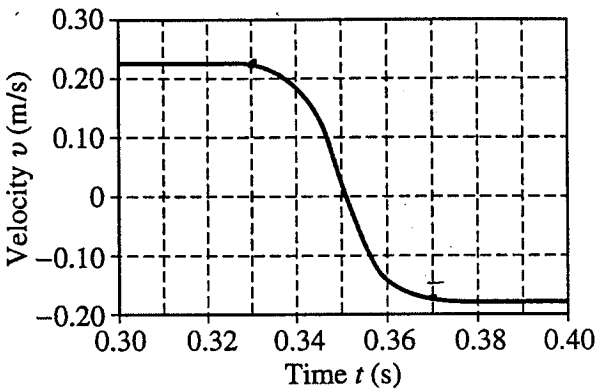
Time—45 minutes

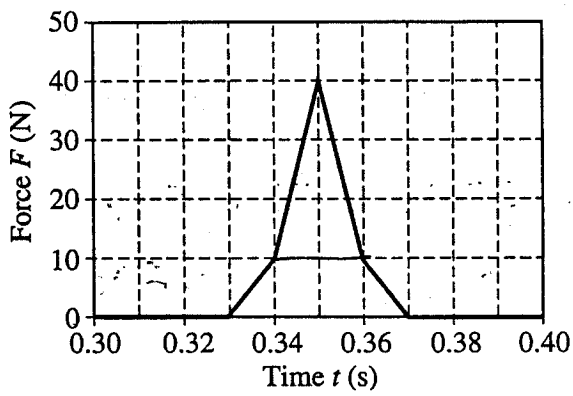
3 Questions

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.

Mech 1.

A motion sensor and a force sensor record the motion of a cart along a track, as shown above. The cart is given a push so that it moves toward the force sensor and then collides with it. The two sensors record the values shown in the following graphs.





(a) Determine the cart's average acceleration between $t = 0.33$ s and $t = 0.37$ s.

$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{-.17\frac{m}{s} - .22\frac{m}{s}}{.37s - .33s} = \frac{-.39\frac{m}{s}}{.4s} = \boxed{-9.75\ \frac{m}{s^2}}$

M M M M M M M M M M M M M

(b) Determine the magnitude of the change in the cart's momentum during the collision.

Impulse = $\int F\,dt$ = area under force graph = $\frac{30N \times .02s}{2} + 10N \times .03s$

$= .3\ kg\frac{m}{s} + .3\ kg\frac{m}{s}$

$= \boxed{.6\ kg\frac{m}{s}}$

(c) Determine the mass of the cart.

$p = mv$

$\Delta p = m\Delta v$

$-.6\ kg\frac{m}{s} = m(-.39\frac{m}{s})$

$m = \frac{\Delta p}{\Delta v} = \frac{-.6\ kg\frac{m}{s}}{-.39\frac{m}{s}} = \boxed{1.5\ kg}$

(d) Determine the energy lost in the collision between the force sensor and the cart.

$\Delta K = K_f - K_i$

$= \frac{1}{2}m(v_f^2 - v_0^2)$

$\Delta K = \frac{1}{2}(1.5\ kg)\left[(-.17\frac{m}{s})^2 - (.22\frac{m}{s})^2\right]$

$\Delta K = \boxed{-.015\ J}$

GO ON TO THE NEXT PAGE.

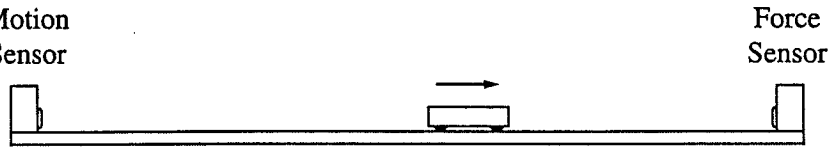
PHYSICS C

Section II, MECHANICS

Time—45 minutes

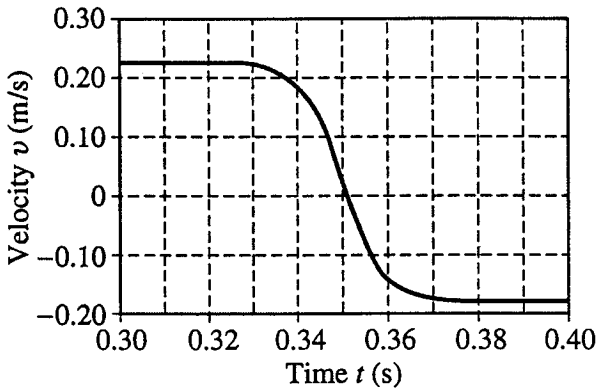
3 Questions

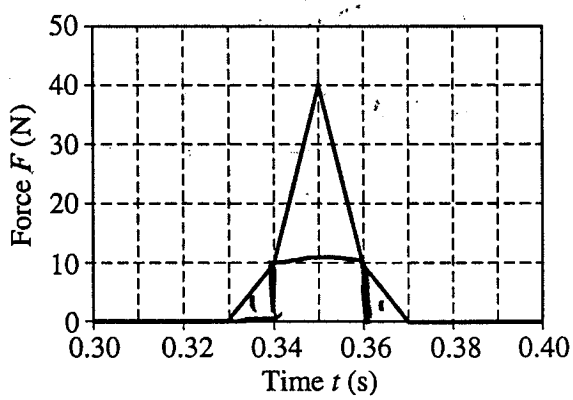
Directions: Answer all three questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part, NOT in the green insert.



Mech 1.

A motion sensor and a force sensor record the motion of a cart along a track, as shown above. The cart is given a push so that it moves toward the force sensor and then collides with it. The two sensors record the values shown in the following graphs.





(a) Determine the cart's average acceleration between $t = 0.33$ s and $t = 0.37$ s.

$a_{ave} = \frac{v_f - v_i}{t}$

$a_{ave} = \frac{-.18 m/s - .22 m/s}{.37 s - .33 s}$

$a_{ave} = -10.0 m/s^2$

(b) Determine the magnitude of the change in the cart's momentum during the collision.

Momentum = Mass · velocity

ΔMomentum = Mass · Δ vel

$F\Delta t = m\Delta v$

$F\Delta t = \int F(t)\,dt$

$F\Delta t = (.01)10 + (.02)10 + \frac{1}{2}(.02)30$

$F\Delta t = .6$ $\quad$ $\boxed{\Delta \text{Momentum} = .6 \text{ kg}\cdot\text{m/s}}$

(c) Determine the mass of the cart.

$F\Delta t = |m\Delta v|$

$.6 = m|(-.18 - .22)|$

$.6 = m(.4)$

$\boxed{m = 1.5 \text{ kg}}$

(d) Determine the energy lost in the collision between the force sensor and the cart.

Energy lost = $K_i - K_f$

$E = \frac{1}{2}mv^2 \quad \frac{1}{2}mv^2$

$E = \left[\frac{1}{2}(1.5)(-.18)^2\right] + \frac{1}{2}(1.5)(.22)^2$ (KE, F_i)

$E = .0243 + .0363$

$\boxed{E_{lost} = .012 \text{ Joules}}$

GO ON TO THE NEXT PAGE.