AP® Physics B
2003 Sample Student Responses

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 whose mission is to prepare, inspire, and connect students to college and opportunity. Founded in 1900, the association is composed of more than 4,300 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 admissions, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT®, and the Advanced Placement Program® (AP®). 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.

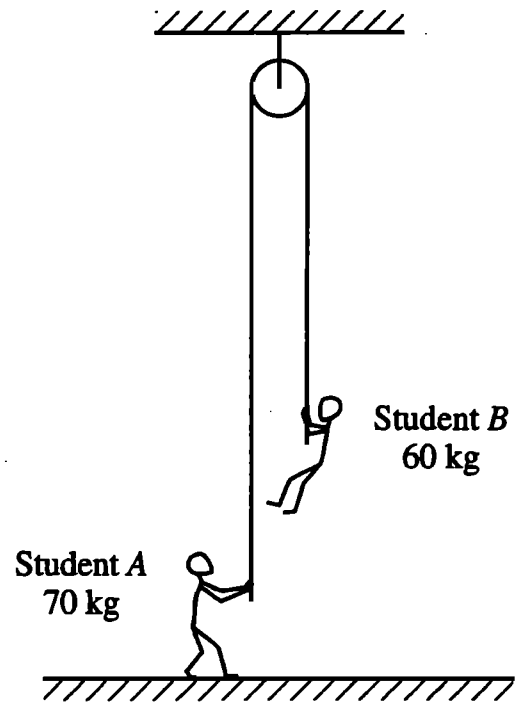
For further information, visit www.collegeboard.com

For the College Board's online home for AP professionals, visit AP Central at apcentral.collegeboard.com.

A1

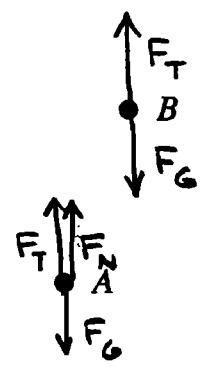
PHYSICS B
SECTION II
Time—90 minutes
7 Questions

Directions: Answer all seven questions, which are weighted according to the points indicated. The suggested time is about 15 minutes for answering each of questions 1-4, and about 10 minutes for answering each of questions 5-7. 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.



1. (15 points)
A rope of negligible mass passes over a pulley of negligible mass attached to the ceiling, as shown above. One end of the rope is held by Student *A* of mass 70 kg, who is at rest on the floor. The opposite end of the rope is held by Student *B* of mass 60 kg, who is suspended at rest above the floor.

   (a) On the dots below that represent the students, draw and label free-body diagrams showing the forces on Student *A* and on Student *B*.



GO ON TO THE NEXT PAGE.

(b) Calculate the magnitude of the force exerted by the floor on Student *A*.

$\Sigma F_A = Ma = 0$

$\Sigma F_A = F_T + F_N - F_G = 0$

$\Sigma F_B = Ma = 0$

$\Sigma F_B = F_T - F_G = 0$

$F_T = F_G$

$F_T = Mg$

$F_T = (60kg)(9.8 m/s^2)$

$F_T = 588 N$

$\Sigma F_A = F_T + F_N - F_G = 0$

$F_N = F_G - F_T$

$F_N = Mg - F_T$

$F_N = (70kg)(9.8 m/s^2) - 588N$

$F_N = 98 N$

Student *B* now climbs up the rope at a constant acceleration of 0.25 m/s^2 with respect to the floor.

(c) Calculate the tension in the rope while Student *B* is accelerating.

$\Sigma F_B = Ma$

$\Sigma F_B = F_T - F_G$

$F_T - F_G = Ma$

$F_T = Ma + Mg$

$F_T = (60kg)(.25 m/s^2) + (60kg)(9.8 m/s^2)$

$F_T = 603 N$

(d) As Student *B* is accelerating, is Student *A* pulled upward off the floor? Justify your answer.

$\Sigma F_A = F_T + F_N - F_G$

$\Sigma F_A = 603N + F_N - (70kg)(9.8 m/s^2)$

$F_T = 603 N$

$F_G = 686 N$

Student A is not being pulled upwards off the floor because the change in tension simply reduces the normal force (the force exerted by the floor). It does not overcome the force of gravity exerted on student A.

(e) With what minimum acceleration must Student *B* climb up the rope to lift Student *A* upward off the floor?

$F_T > F_G$

$F_T > 686N$

$Ma = F_T - F_G$

$a = \frac{F_T - F_G}{M}$

$a = \frac{686N - (60kg)(9.8 m/s^2)}{60 kg}$

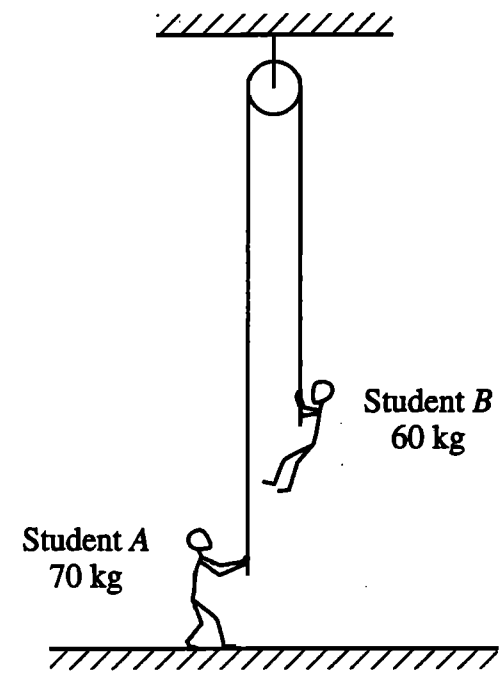
$a = 1.63 m/s^2$

GO ON TO THE NEXT PAGE.

B1

PHYSICS B
SECTION II
Time—90 minutes
7 Questions

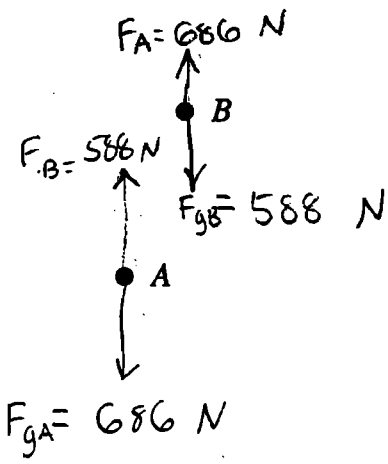
Directions: Answer all seven questions, which are weighted according to the points indicated. The suggested time is about 15 minutes for answering each of questions 1-4, and about 10 minutes for answering each of questions 5-7. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part, NOT in the green insert.



1. (15 points)
A rope of negligible mass passes over a pulley of negligible mass attached to the ceiling, as shown above. One end of the rope is held by Student *A* of mass 70 kg, who is at rest on the floor. The opposite end of the rope is held by Student *B* of mass 60 kg, who is suspended at rest above the floor.

   (a) On the dots below that represent the students, draw and label free-body diagrams showing the forces on Student *A* and on Student *B*.

$F_{gA} = 70^{kg} \times 9.8\ \frac{m}{s^2} = 686\ N$
$F_{gB} = 60\ kg \times 9.8\ m/s^2 = 588\ N$



GO ON TO THE NEXT PAGE.

B2

(b) Calculate the magnitude of the force exerted by the floor on Student *A*.

$F_{gA} - F_B$

$70\ kg \times 9.8\ \frac{m}{s^2} - 60\ kg \times 9.8\ \frac{m}{s^2} = 98\ N$.

Student *B* now climbs up the rope at a constant acceleration of 0.25 m/s^2 with respect to the floor.

(c) Calculate the tension in the rope while Student *B* is accelerating.

$60\ kg \times \left(9.8\ \frac{m}{s^2} + 0.25\ \frac{m}{s^2}\right) = 603\ N$

(d) As Student *B* is accelerating, is Student *A* pulled upward off the floor? Justify your answer.

No. The tension in the rope (603 N) is less than the weight of student A (686 N).

(e) With what minimum acceleration must Student *B* climb up the rope to lift Student *A* upward off the floor?

$70\ kg \times 9.8\ \frac{m}{s^2} = 60\ kg \times \left(9.8\ \frac{m}{s^2} + a\right)$

$686\ N = 588\ N + 60a$

$98\ N = 60a$

$1.6333\ m/s^2 = a$

GO ON TO THE NEXT PAGE.