AP® Physics C: Mechanics
2005 Scoring Commentary

The College Board: Connecting Students to College Success

The College Board is a not-for-profit membership association whose mission is to connect students to college success and opportunity. Founded in 1900, the association is composed of more than 4,700 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three and a half million students and their parents, 23,000 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 excellence and equity, and that commitment is embodied in all of its programs, services, activities, and concerns.

Copyright © 2005 by College Board. All rights reserved. College Board, AP Central, APCD, Advanced Placement Program, AP, AP Vertical Teams, Pre-AP, SAT, and the acorn logo are registered trademarks of the College Entrance Examination Board. Admitted Class Evaluation Service, CollegeEd, Connect to college success, MyRoad, SAT Professional Development, SAT Readiness Program, and Setting the Cornerstones are trademarks owned by the College Entrance Examination Board. PSAT/NMSQT is a registered trademark of the College Entrance Examination Board and National Merit Scholarship Corporation. Other products and services may be trademarks of their respective owners. Permission to use copyrighted College Board materials may be requested online at: http://www.collegeboard.com/inquiry/cbpermit.html.

Visit the College Board on the Web: www.collegeboard.com.
AP Central is the official online home for the AP Program and Pre-AP: apcentral.collegeboard.com.

Question 1

Overview

This question probed students' understanding of Newtonian dynamics in one dimension. A ball that was thrown upward was subject to a drag force that depended on the velocity of the ball. In part (a) students were asked to state qualitatively if the acceleration changed as the ball traveled upward. In part (b) the students had to write the differential equation for the instantaneous velocity but were told not to solve it. Part (c) asked students to determine the terminal velocity of the ball. Parts (d) and (e) asked them to say whether the ball took longer to rise or fall and to graph the velocity of the ball as a function of time.

Sample: 1A
Score: 14

This response lost only 1 point, in part (b). The diagram on the left earned the point for having the two forces in the same direction, but in writing the equation they are given opposite signs so the final point for the correct equation was not earned.

Sample: 1B
Score: 10

This response earned full credit for the first three parts. Part (d) did not earn the justification point. Part (e) only earned the partial credit point for showing time interval consistent with the answer to (d). The last part of the graph is not clearly curved, so the point for being concave up was not awarded.

Sample: 1C
Score: 8

Parts (a) and (c) earned full credit. Part (b) earned only the point for $a = dv/dt$ since the signs of the forces imply that they are in opposite directions. Part (d) did not earn the justification point. Part (e) earned only the partial credit point for both parts of the curve being concave up.

Copyright © 2005 by College Board. All rights reserved.
Visit apcentral.collegeboard.com (for AP professionals) and www.collegeboard.com/apstudents (for students and parents).

Question 2

Overview

The question tested students' understanding of Newtonian gravitation and Kepler's Third Law. Students also had to recall that the centripetal acceleration of an object in a circular orbit is v^2/R, where v is the speed of the object and R the radius of its orbit. Parts (a) and (b) asked students to derive Kepler's Third Law of planetary motion from the Newtonian expression of the gravitational force between two objects. Part (c) asked what quantities needed to be graphed in order to yield a linear equation. Parts (d), (e), and (f) probed students' abilities to perform graphical analysis on the given data on the period and orbital radii of four of Saturn's moons, with the object of determining the mass of Saturn.

Sample: 2A
Score: 13

This response lost 1 point in part (d) for incorrect units on the last column of the table. It also lost 1 point in part (e) since the line drawn on the graph does not look like a best fit but rather appears to connect the dots.

Sample: 2B
Score: 9

No credit was earned in parts (a) and (b). In part (a) the correct equation does not contain Saturn's mass, and the equation that does is wrong. Full credit was earned for the next three parts, but (f) received only 1 point for calculating a slope.

Sample: 2C
Score: 3

The equation in (a) is incorrect, since it should contain R^2 instead of just R. Part (b) received full credit, since it correctly uses the expression from (a) and obtains a consistent answer. The rest of the response received nothing. In part (c) one cannot determine the gravitational potential energy since the masses of the moons are not given. Thus the table cannot be completed, although there are some erased numbers there that were apparently plotted.

Copyright © 2005 by College Board. All rights reserved.
Visit apcentral.collegeboard.com (for AP professionals) and www.collegeboard.com/apstudents (for students and parents).

Question 3

Overview

This question was an interesting combination of the principles of conservation of linear momentum, conservation of angular momentum, and conservation of energy. The problem revolved around a rod that was free to pivot in the horizontal plane about an axis located at one end of the rod. Part (a) was straightforward, asking students to write an expression for the angular momentum of the rod in terms of the mass, length, and angular velocity of the rod. In part (b) the rotating rod struck a ball of mass M_2. After the collision, the previously stationary ball sped off with a velocity v, and the rod remained stationary. Students needed to apply the conservation of angular momentum to find the velocity of the ball after the collision. In part (c) students were told that the collision was elastic, and they were asked to find the ratio of the mass of the rod to the mass of the ball. The final, most challenging, part of the question replaced the original ball with a ball of the same mass as that of the rod; students were directed to find the distance from the pivot at which the ball had to be placed if the rod were to come to rest after the elastic collision.

Sample: 3A
Score: 15

This clear and well-organized response follows the solution as outlined in the scoring guidelines.

Sample: 3B
Score: 9

Part (a) is correct, and (b) lost only the answer point because the factor of 1/3 got dropped in the simplification. The work in (c) is consistent with (b) and also lost only the answer point. Part (d) earned only the 2 points for conservation of angular momentum.

Sample: 3C
Score: 5

Part (a) is correct. Part (b) received 1 point for substituting the answer from (a). Part (c) lost only the point for the correct answer, and part (d) received no credit because the term for the kinetic energy of the ball uses M_2 instead of M_1.

Copyright © 2005 by College Board. All rights reserved.
Visit apcentral.collegeboard.com (for AP professionals) and www.collegeboard.com/apstudents (for students and parents).