CollegeBoard
Advanced Placement Program

AP® Physics B
2005 Scoring Commentary

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Question 1

Overview

This question centered on the graphical representation of one-dimensional motion. The object in motion was an elevator. Students were given a graph of the position of the elevator plotted against time. In part (a) students were asked to use the position versus time graph to plot the velocity versus time. In part (b) they then used the graph drawn in (a) to determine the average acceleration of the object. Students were also asked in part (b)(ii) to draw a free-body diagram representing the direction of the acceleration that they found in part (b)(i). In the final part of the question, students were directed to find the apparent weight of a 70-kilogram passenger at a particular time.

Sample: 1A
Score: 9

This response illustrates minimal writing that nevertheless earned almost the full 10 points of credit. The only point lost was for the magnitude of the negative part of the graph in (a).

Sample: 1B
Score: 7

Part (b)(i) uses a wrong approach and received no credit. All other parts are correct.

Sample: 1C
Score: 5

Part (a) of this response earned only 2 points since the magnitude of the negative section is wrong and the transitions are drawn vertical. Part (b)(i) received 1 point for using a correct expression for acceleration in the calculation, although the wrong average is used. Part (b)(ii) is correct but (c) earned only 1 point for the correct algebraic expression of Newton's second law.

Question 2

Overview

The first two parts of this mechanics question involved drawing a free-body diagram of an object suspended by a horizontal string and a string that makes an angle of 30^o with respect to the vertical, then using that diagram to determine the tension in the horizontal string. The final part of the problem involved the application of the principle of conservation of energy to find the speed of the mass after the horizontal string had been cut and the mass had descended to the nadir of its trajectory.

Sample: 2A
Score: 10

This response earned all 10 possible points. Part (a) shows how any components that are included in a diagram should be clearly labeled. Part (c) is well organized and includes clear indications of the points at which the calculations are being made.

Sample: 2B
Score: 7

This response earned full credit for the first two parts. Note the arrow indicating that the solution to part (b) is continued on the bottom of the second page. (The question appeared on facing pages in the exam booklet.) Part (c) has an incorrect approach and received only 1 point for having a zero initial speed.

Sample: 2C
Score: 5

Part (a) has one correct vector but lost the point for it because the force of gravity is not shown. Part (b) earned 1 point for attempting to use a component related to the pendulum string. Part (c) is completely correct and earned full credit.

Question 3

Overview

This question began by examining the student's knowledge of the electric fields and electric potentials generated by point charges. Parts (c) and (d) centered on electric forces generated by the same point charge distribution given in parts (a) and (b).

Sample: 3A
Score: 14

The 1 point lost in the response to this 15-point question was for not explicitly indicating the direction of the field in part (a).

Sample: 3B
Score: 10

This response does not have the correct final expression for the magnitude of the field in part (a) and earned only 3 points there. Part (b) also has an incorrect final expression and lost 1 point. The only point earned in (c) was for the expression for the distance between charges. Part (d) earned full credit.

Sample: 3C
Score: 5

Part (a) in this response earned only the point for the correct formula for the electric field. The diagram did not receive any credit since there is nothing to note that it is intended to show the net field, and it appears to refer to only the $+2q$ charge. Parts (b) and (d) earned nothing, while (c) received full credit.

Question 4

Overview

This lab question required constructing an experiment that would allow use of optical interference to determine the spacing between a pair of narrow slits. Students were given a list of equipment and asked to choose pertinent items. In part (b) students were directed to graph the intensity of light versus position, which ought to have been a tip that physical optics was involved in the question. The final two parts of the question asked students to describe the measurements, procedures, and equations that they would use to determine the slit separation.

Sample: 4A
Score: 15

This response earned the full 15 points of credit. It even describes using the paper given in the list of equipment to record data. Although the diagram of the experimental setup does not have the minima properly aligned with the slide position, the response as a whole shows sufficient understanding to allow some leeway in the exactness of drawings made under exam-timing constraints.

Sample: 4B
Score: 10

Part (a) earned full credit, but (b) earned only 2 points because no symbols for measurements are included in the figure. The student notes here that the distance from slide to screen is adjusted to determine the position of maximum brightness, and in part (c) the student appears to be graphing that relationship instead of the interference pattern, thus receiving no credit. Part (d) received full credit, and part (e) earned only 2 points since there is no indication of what *m* represents or what value to substitute for it.

Sample: 4C
Score: 6

Part (a) earned full credit, but (b) earned only 1 point for noting the distances to measure since the laser is not shown and the equipment is not labeled. The graph in (c) is rotated $90°$ from the correct response and received no credit. Part (d) earned only 3 points since it is not clear that the distance from slits to screen is actually measured. Both equations in (e) are wrong, and no credit was earned there.

Question 5

Overview

This question in fluid statics centered on a rectangular raft floating in fresh (as opposed to salt) water. Students were given the surface area, density, and volume of the raft and asked to find the freeboard of the raft, or how high the top of the raft was above the surface of the water. In part (b) students were asked to find the buoyant force acting on the raft and to state the direction of this buoyant force. In the final part of the question, students were instructed to find how many 75-kilogram people could stand on the raft before it sank below the surface of the water.

Sample: 5A
Score: 10

This response earned all 10 possible points. In part (a) the solution is written to indicate first that the buoyant force equals the weight of displaced water, and then that it also equals the weight of the raft, which is calculated along the right side of the page. These two quantities are then equated. In part (b) the phrase "against the raft" is too ambiguous to receive credit, but the drawing at the right makes the direction clear.

Sample: 5B
Score: 7

In part (a), which received full credit, the student first calculates the total height H of the raft. Without showing any derivation, the student then writes a correct expression for h that is equivalent to the one given in the scoring guidelines, which satisfies the requirements for the first 2 points noted there. Part (b) earned only 1 point for the correct direction of the buoyant force. The water density is used with the total raft volume instead of the part under the water when determining the buoyant force. Then the student appears to be trying to determine the net force. In part (c) the limiting condition is that the entire raft is in the water, so it is now correct to use its entire volume in determining the buoyant force, and full credit was earned.

Sample: 5C
Score: 3

This response earned no credit for parts (a) and (c). Part (b) lost only 1 point for not indicating the direction of the buoyant force.

Question 6

Overview

This question on thermodynamics concerned the ideal gas law. Students were given the description of a cylinder with a movable piston. Gas within the cylinder was heated, and the gas expanded against constant atmospheric pressure. Students were given a data table listing the height H of the piston and the temperature T of the gas and asked to find a relationship between those quantities that would allow them to find the number of moles of gas contained within the cylinder. In part (b) students were asked to plot the data given in the H-T table in such a manner as to be able to find the number of moles of the gas. In the final part of the question, students were asked to use the graph to find the number of moles after being given the cross-sectional area of the piston.

Sample: 6A
Score: 10

This response earned all 10 points. While the labeling in part (b) of the points used in the calculation in part (c) is helpful, the addition of the dots at these points requires a careful examination by the reader to not confuse them with the data points.

Sample: 6B
Score: 7

This response earned full credit for the first two parts. The only point earned for part (c) is the one for an answer consistent with the substitutions made. While the value of H/T is reasonable, there is no indication of how it was obtained, so the points for using more than one data point and correctly calculating a slope were not awarded. The substitution point was also lost because the pressure is not converted but left in atmospheres.

Sample: 6C
Score: 4

Part (a) earned only 1 point since an incorrect substitution for volume was made. Part (b) lost only 1 point for having the vertical axis starting at zero, which bunches up the data in one corner of the grid. No credit was received for part (c).

Question 7

Overview

In this modern physics question, students were given a set of energy levels that occur in an atom (actually singly ionized helium). The levels were the ground state and first three excited states. In part (a) students were given the energies in eV of the first two excited states and the ground state. They were asked to find the energy in eV of the third excited state if the $n = 4$ to $n = 2$ transition yielded a photon with a wavelength of 121.9 nm. In part (b) they were asked to find the momentum of that photon. In parts (c) and (d) the problem switched focus to the photoelectric effect. The 121.9 nm photon struck a silver surface whose work function was 4.7 eV, and students were asked to find the kinetic energy of the emitted photoelectrons and the stopping potential for those electrons.

Sample: 7A
Score: 10

This response received all 10 possible points. In part (a) there is no intermediate step calculating the photon frequency but a direct use of the equation relating energy to wavelength that is equivalent to the two steps shown in the solution in the scoring guidelines.

Sample: 7B
Score: 8

This response uses the alternative solution in part (a) and earned full credit for the first three parts but nothing for part (d). Note that in part (c) the quantities are unnecessarily converted to joules and then back to eV.

Sample: 7C
Score: 6

The work in part (a) stops after determining the photon energy and only earned 2 points. Parts (b) and (c) earned full credit, but (d) earned nothing.