2017

AP CollegeBoard

AP Physics 1: Algebra-Based

Sample Student Responses and Scoring Commentary

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- ☑ Scoring Guideline
- ☑ Student Samples
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AP Central is the official online home for the AP Program: apcentral.collegeboard.org

AP® PHYSICS
2017 SCORING GUIDELINES

General Notes About 2017 AP Physics Scoring Guidelines

1. The solutions contain the most common method of solving the free-response questions and the allocation of points for this solution. Some also contain a common alternate solution. Other methods of solution also receive appropriate credit for correct work.

2. The requirements that have been established for the paragraph length response in Physics 1 and Physics 2 can be found on AP Central at https://secure-media.collegeboard.org/digitalServices/pdf/ap/paragraph-length-response.pdf.

3. Generally, double penalty for errors is avoided. For example, if an incorrect answer to part (a) is correctly substituted into an otherwise correct solution to part (b), full credit will usually be awarded. One exception to this may be cases when the numerical answer to a later part should be easily recognized as wrong, e.g., a speed faster than the speed of light in vacuum.

4. Implicit statements of concepts normally receive credit. For example, if use of the equation expressing a particular concept is worth one point, and a student's solution embeds the application of that equation to the problem in other work, the point is still awarded. However, when students are asked to derive an expression it is normally expected that they will begin by writing one or more fundamental equations, such as those given on the exam equation sheet. For a description of the use of such terms as "derive" and "calculate" on the exams, and what is expected for each, see "The Free-Response Sections—Student Presentation" in the *AP Physics; Physics C: Mechanics, Physics C: Electricity and Magnetism Course Description* or "Terms Defined" in the *AP Physics 1: Algebra-Based and AP Physics 2: Algebra-Based Course and Exam Description*.

5. The scoring guidelines typically show numerical results using the value $g = 9.8\ \text{m/s}^2$, but use of $10\ \text{m/s}^2$ is of course also acceptable. Solutions usually show numerical answers using both values when they are significantly different.

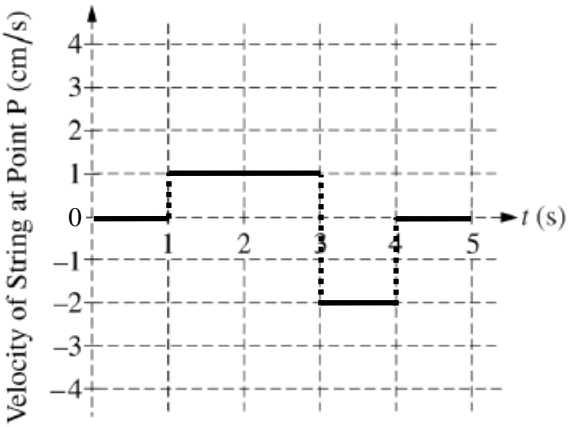
6. Strict rules regarding significant digits are usually not applied to numerical answers. However, in some cases answers containing too many digits may be penalized. In general, two to four significant digits are acceptable. Numerical answers that differ from the published answer due to differences in rounding throughout the question typically receive full credit. Exceptions to these guidelines usually occur when rounding makes a difference in obtaining a reasonable answer. For example, suppose a solution requires subtracting two numbers that should have five significant figures and that differ starting with the fourth digit (e.g., 20.295 and 20.278). Rounding to three digits will lose the accuracy required to determine the difference in the numbers, and some credit may be lost.

AP® PHYSICS 1
2017 SCORING GUIDELINES

Question 5

7 points total **Distribution of points**

(a) 3 points

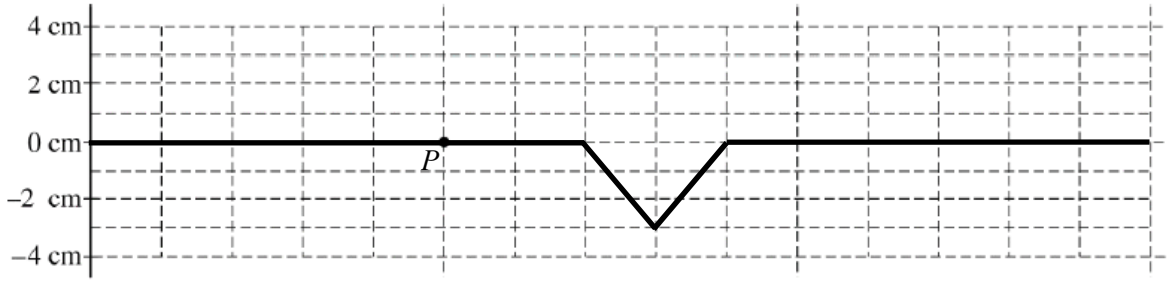


For indicating zero velocity for $0 < t < 1$ s and 4 s $< t < 5$ s — 1 point

For indicating two different non-zero constant velocities, one at the interval 1 s $< t < 3$ s and the other at the interval 3 s $< t < 4$ s — 1 point

For indicating a maximum velocity of $+1$ cm/s and a minimum velocity of -2 cm/s — 1 point

(b) 4 points



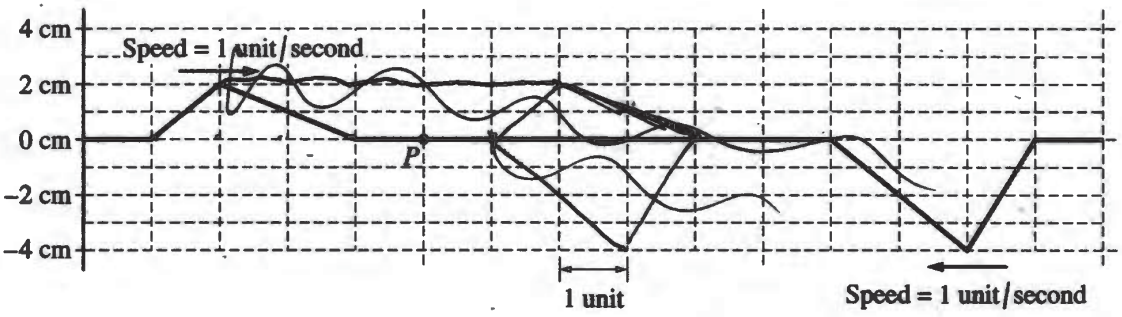
For drawing a single pulse and zero elsewhere — 1 point

For drawing a single pulse that is triangular (need not be isosceles or of two-unit extent) — 1 point

For drawing a single pulse with the correct maximum displacement from equilibrium of -3 cm — 1 point

For drawing a single pulse at the correct location that is two units wide between the 7th and 9th grid lines (i.e., 2 grid lines to the right of P to 4 grid lines to the right of P) and zero elsewhere — 1 point

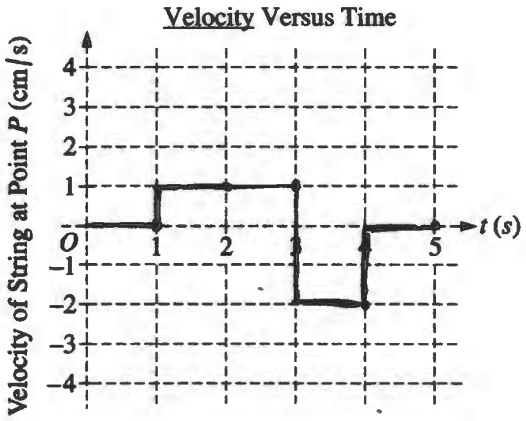
P1 Q5 A1



5. (7 points, suggested time 13 minutes)

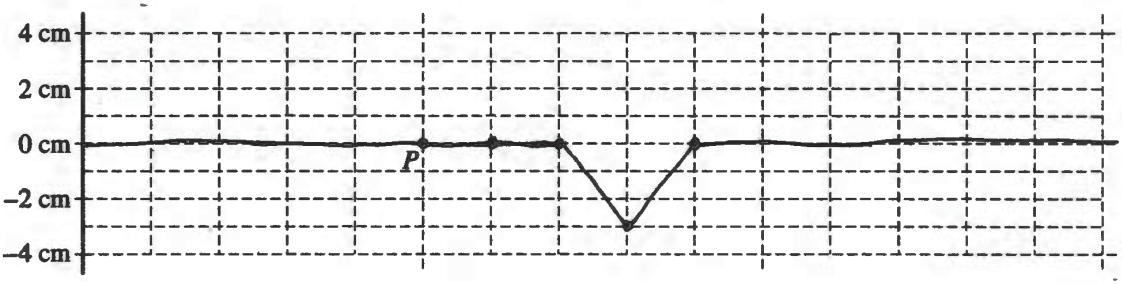
Two wave pulses are traveling in opposite directions on a string. The shape of the string at $t = 0$ is shown above. Each pulse is moving with a speed of one unit per second in the direction indicated.

(a) Between time $t = 0$ and $t = 5$ seconds, the entire left-hand pulse approaches and moves beyond point P on the string. On the coordinate axes below, plot the velocity of the piece of string located at point P as a function of time between $t = 0$ and $t = 5$ seconds.



(b) At $t = 5$ s, the pulses completely overlap. On the grid provided below, sketch the shape of the entire string at $t = 5$ s.

Note: Do any scratch (practice) work on the grids on the following page. You will only be graded for the sketch made on the grid on this page.



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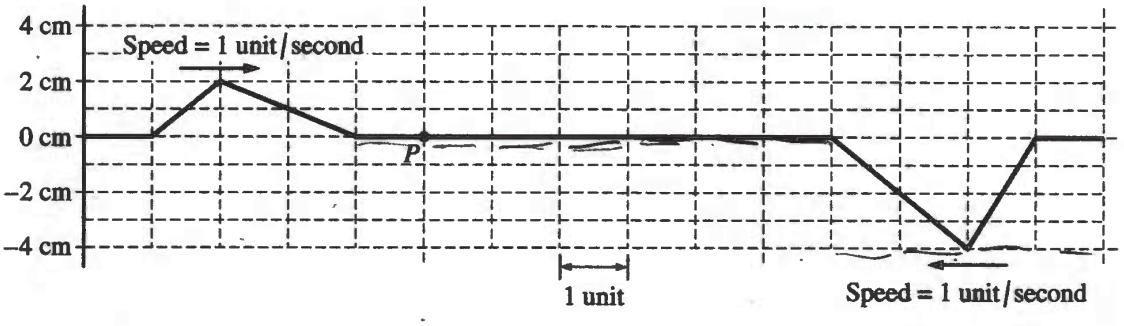
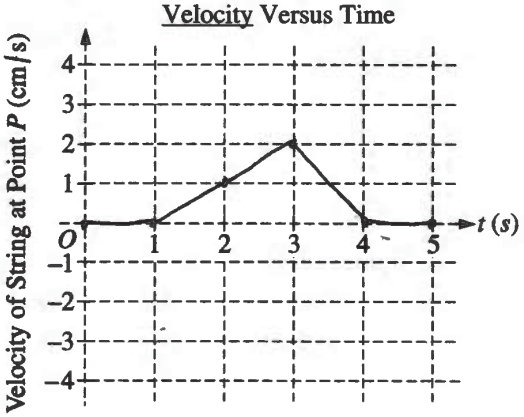
P1 Q5 B1



5. (7 points, suggested time 13 minutes)

Two wave pulses are traveling in opposite directions on a string. The shape of the string at $t = 0$ is shown above. Each pulse is moving with a speed of one unit per second in the direction indicated.

(a) Between time $t = 0$ and $t = 5$ seconds, the entire left-hand pulse approaches and moves beyond point P on the string. On the coordinate axes below, plot the velocity of the piece of string located at point P as a function of time between $t = 0$ and $t = 5$ seconds.



(b) At $t = 5$ s, the pulses completely overlap. On the grid provided below, sketch the shape of the entire string at $t = 5$ s.

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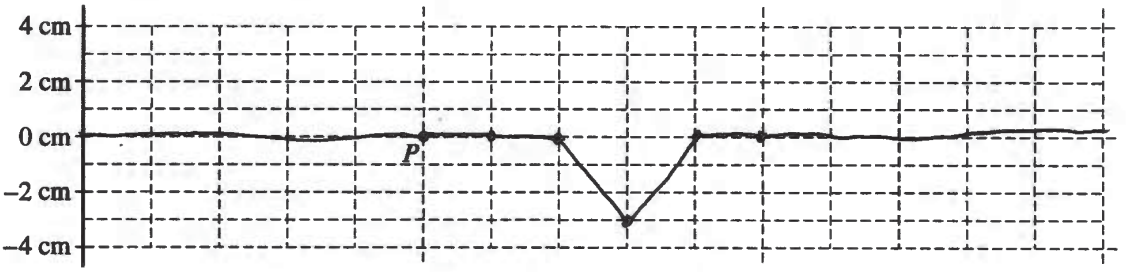

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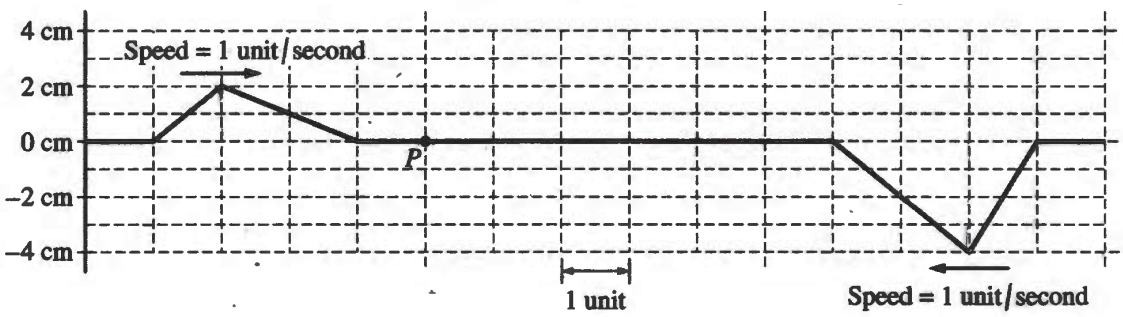
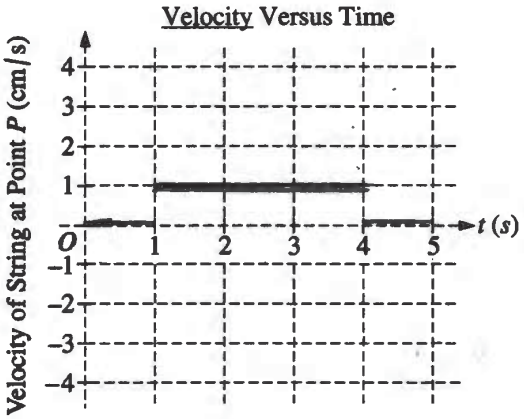


5. (7 points, suggested time 13 minutes)

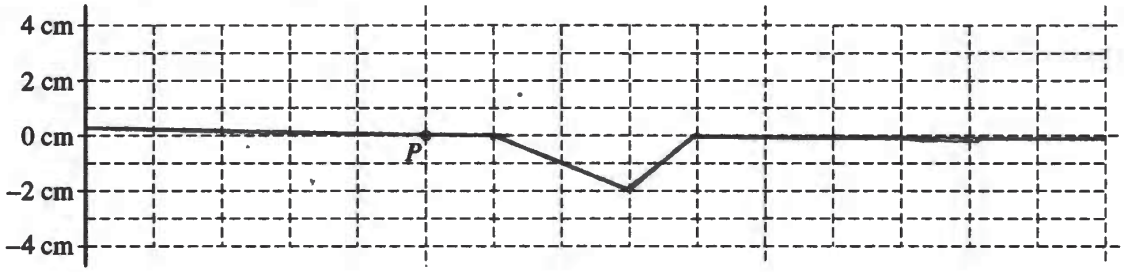
Two wave pulses are traveling in opposite directions on a string. The shape of the string at $t = 0$ is shown above. Each pulse is moving with a speed of one unit per second in the direction indicated.

(a) Between time $t = 0$ and $t = 5$ seconds, the entire left-hand pulse approaches and moves beyond point P on the string. On the coordinate axes below, plot the velocity of the piece of string located at point P as a function of time between $t = 0$ and $t = 5$ seconds.



(b) At $t = 5$ s, the pulses completely overlap. On the grid provided below, sketch the shape of the entire string at $t = 5$ s.

Note: Do any scratch (practice) work on the grids on the following page. You will only be graded for the sketch made on the grid on this page.



AP® PHYSICS 1
2017 SCORING COMMENTARY

Question 5

Overview

This question assessed learning objectives 3.A.1.1, 6.A.1.2, 6.D.1.1, and 6.D.2.1.
The responses to this question were expected to demonstrate the following:

- The ability to translate a position versus time graph to a velocity versus time graph.
- Understanding the difference between the speed of a pulse versus the speed of a point in the medium (string).
- The ability to apply the principle of superposition.
- Understanding the difference between constructive and destructive interference when two wave pulses overlap.

Sample: P1 Q5 A
Score: 7

In part (a) full credit was earned for a correct graph of velocity as a function of time. In part (b) full credit was earned for a single pulse with the correct orientation, location, and displacement from equilibrium.

Sample: P1 Q5 B
Score: 5

In part (a) 1 point was earned for having a zero velocity in the intervals $0 < t < 1$ s and $4 \text{ s} < t < 5$ s. In part (b) full credit was earned for a single pulse with the correct orientation, location, and displacement from equilibrium.

Sample: P1 Q5 C
Score: 3

In part (a) 1 point was earned for having a zero velocity in the intervals $0 < t < 1$ s and $4 \text{ s} < t < 5$ s. In part (b) 1 point was earned for a having a single pulse and zero elsewhere on the string. A second point in part (b) was earned for having the single pulse be triangular.