



## AP<sup>®</sup> Calculus AB 2002 Sample Student Responses Form B

**The materials included in these files are intended for use by AP teachers for course and exam preparation in the classroom; permission for any other use must be sought from the Advanced Placement Program<sup>®</sup>. 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<sup>®</sup> (ETS<sup>®</sup>), 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.

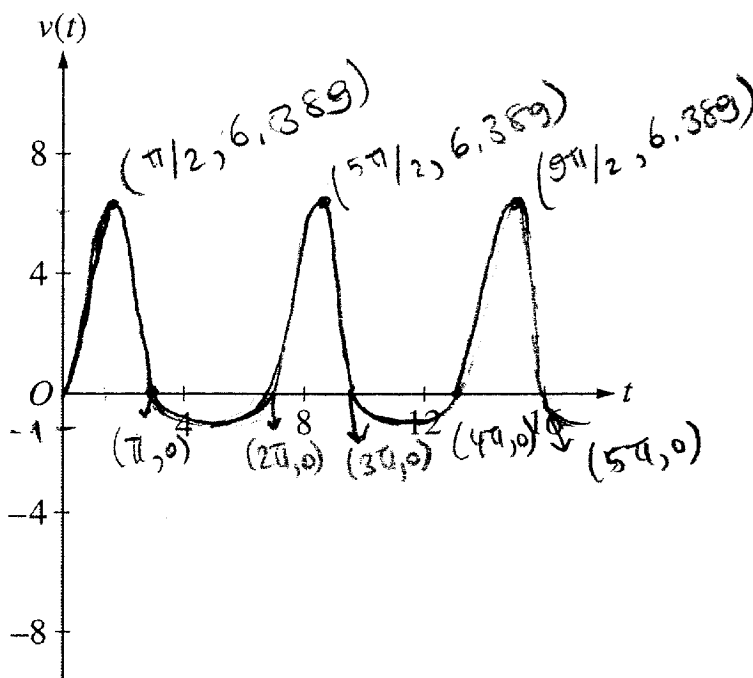
The College Board is a national nonprofit membership association dedicated to preparing, inspiring, and connecting students to college and opportunity. Founded in 1900, the association is composed of more than 4,200 schools, colleges, universities, and other educational organizations. Each year, the 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<sup>®</sup>, the PSAT/NMSQT<sup>®</sup>, and the Advanced Placement Program<sup>®</sup> (AP<sup>®</sup>). 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 © 2002 by College Entrance Examination Board. All rights reserved. College Board, Advanced Placement Program, AP, SAT, and the acorn logo are registered trademarks of the College Entrance Examination Board. APIEL is a trademark owned by the College Entrance Examination Board. PSAT/NMSQT is a registered trademark jointly owned by the College Entrance Examination Board and the National Merit Scholarship Corporation. Educational Testing Service and ETS are registered trademarks of Educational Testing Service.

Work for problem 3(a)

$$v(t) = e^{2.5\sin(t)} - 1$$

$$X(0) = 0$$



Work for problem 3(b)

If we consider  $y^+$  to be the  $x^+$  (right)  
then between

$$\pi < x < 2\pi, 3\pi < x < 4\pi \text{ and } 5\pi < x < 6\pi$$

the particle is going to left.

(when  $v(t)$  is (-))

Work for problem 3(c)

$$\text{distance}_{\text{total}} = \int_0^4 |v(t)| dt = \int_0^4 |e^{2\sin t} - 1| dt$$

$$= \underline{\underline{10.542}}$$

Work for problem 3(d)

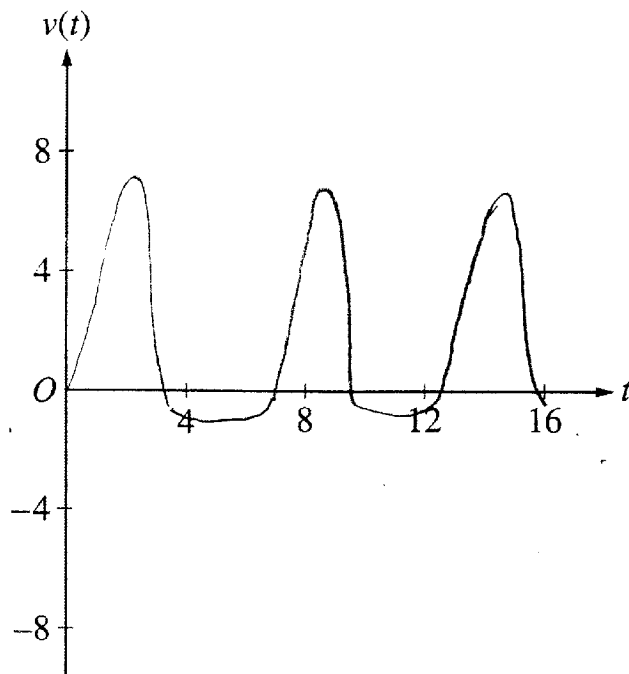
NO; since the area below the x-axis is not equal to the area above the x-axis, the particle will not return to the origin at any time:

$$\int_{\pi}^{2\pi} v(t) dt + \int_{3\pi}^{4\pi} v(t) dt + \int_{5\pi}^{6\pi} v(t) dt < \int_0^{\pi} v(t) dt + \int_{2\pi}^{3\pi} v(t) dt + \int_{4\pi}^{5\pi} v(t) dt$$

3 3 3 3 3 3 3 3 3 3

5

Work for problem 3(a)



Work for problem 3(b)

When  $v(t)$  is less than zero, the particle moves to the left.

$$e^{2\pi i n t} - 1 = 0$$

$$e^{2\pi i n t} = 1$$

$$2\pi i n t = \ln 1$$

$$2\pi i n t = 0$$

$$\pi i n t = 0$$

$$t = 0, \pi + n\pi$$

Velocity is  $< 0$  on  $(\pi, 2\pi)(3\pi, 4\pi)(5\pi, 16)$ , therefore the particle is moving left on these intervals

Work for problem 3(c)

Total distance travelled =  $\int_0^4 v(t) dt$ 

$$D = \int_0^4 (e^{2.5t} - 1) dt$$

by graphing calculator: ~~8~~

$$D = \underline{\underline{8.23}}$$

Work for problem 3(d)

When the particle is at the origin

$$0 = \int_0^t v(t) dt$$

by graphing calculator:

the area of intervals above x-axis is always greater than those below, so the particle never returns to the origin. The movement is not sustained for long enough to bring it back to the origin.