AP® Calculus BC
2001 Sample Student Responses

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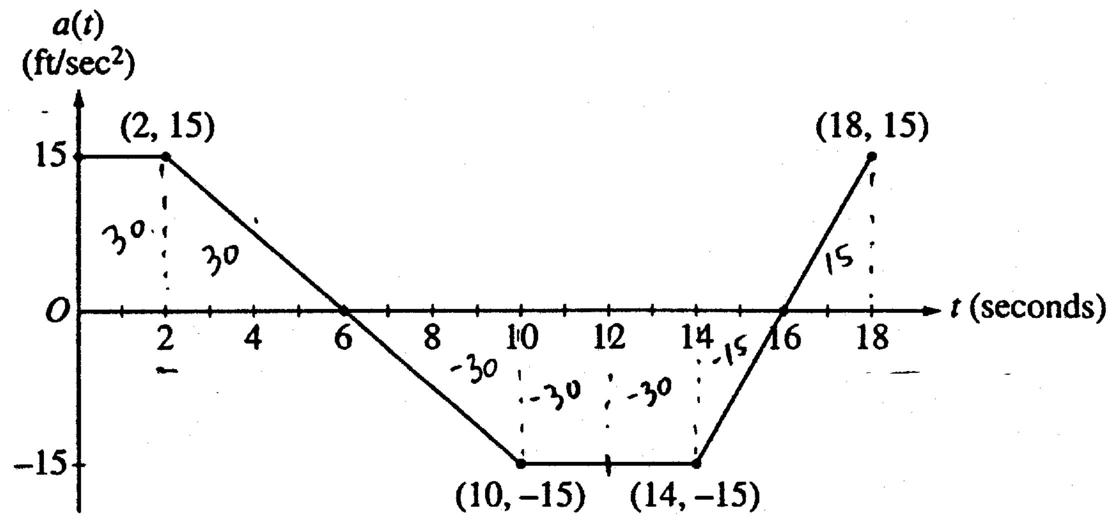
A.



Work for problem 3(a)

Yes, the velocity is increasing at $t=2s$ because according to the graph, the car is accelerating at that time. Acceleration is positive $(a_{t=2} = 15 \text{ ft/s}^2)$, thus the car must be getting faster.

Work for problem 3(b)

$v = \int_0^t a\,dt$

initial velocity

$\therefore$ velocity at time x = area under graph between $t=0$ and $t=x$ $+55$

$\therefore$ $v=55$ when area under graph is zero

$v=55$ ft/s at $t=12$

3 3 3 3 3 3 3 3 3 3

A_2

Work for problem 3(c)

$a(t)$ + 0 − 0 +

0 6 16 18

$v(t)$ inc dec inc

local max local max

$V_6 = \int_0^6 a(t)\,dt + 55$

$= 60 + 55$

$= 115$ ft/s

$V_{18} = \int_0^{18} a(t)\,dt + 55$

$= -30 + 55$

$= 25$ ft/s

∴ absolute max velocity = 115 ft/s at it occurs at $t = 6$s

Work for problem 3(d)

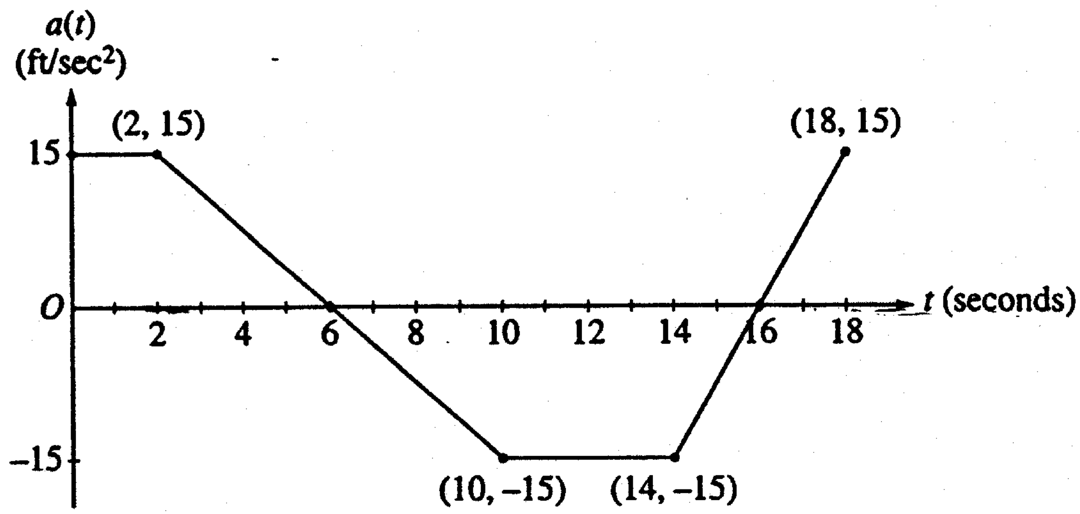
$V = \int_0^x a(t)\,dt + 55$

$-55 = \int_0^x a(t)\,dt$

for velocity to be zero, the area under the graph must be −55, which does not occur between $t = 0$s and $t = 18$s, as shown by the graph.

The lowest velocity on the interval $0 \le t \le 18$ is at $t = 16$, and it is 10 ft/s.

D1



Work for problem 3(a)

At $t=2$ seconds, the acceleration of the car is positive $15 \frac{ft}{sec^2}$ $\therefore$

yes, the velocity of the car is increasing

Work for problem 3(b)

$v(t) = \int_0^x a(t)\,dt + 55\frac{ft}{sec}$

$55\frac{ft}{sec} = \int_0^x a(t)\,dt + 55\frac{ft}{sec}$

$0 = \int_0^x a(t)\,dt$

from graph $\int_0^{12} a(t)\,dt = 0 \therefore v(12) = 55\frac{ft}{sec}$

$2(15)+\frac{1}{2}(4)(15)$

$-(2(15)+\frac{1}{2}(4)(15)) = 0$ $\boxed{t=12}$

D2

Work for problem 3(c)

$v'(t) = a(t)$

from graph

$v'(t)$ pos. $[0, 6)$

$v'(t) = 0$ $t = 6$

$v'(t)$ neg. $(6, 16)$ --

$v'(t) = 0$ $t = 16$

$v'(t)$ pos $(16, 18]$

A maximum occurs at $t = 6$ because the acceleration switches from positive to negative at that point and continues to be negative for an interval longer than it is positive.

$$v(t) = \int_0^x a(t)\,dt + 55\frac{ft}{sec}$$

$$v(6) = \int_0^6 a(t)\,dt + 55\frac{ft}{sec}$$

$$= 55\frac{ft}{sec} + 2sec\left(15\frac{ft}{sec^2}\right) + \frac{1}{2}(4\ sec)\left(15\frac{ft}{sec^2}\right) = \boxed{115\frac{ft}{sec}}$$

Work for problem 3(d)

$$v(t) = \int_0^x a(t)\,dt + 55\frac{ft}{sec}$$

$$0 = \int_0^x a(t)\,dt + 55\frac{ft}{sec}$$

$-55\frac{ft}{sec} \neq \int_0^x a(t)\,dt$ from graph, the $\int a(t)dt$ never equals $55\frac{ft}{sec}$

the velocity is never equal to zero