AP® CALCULUS AB/CALCULUS BC
2017 SCORING GUIDELINES

Question 1

1 : units in parts (a), (c), and (d)

(a) Volume $= \int_0^{10} A(h)\,dh$

$\approx (2-0)\cdot A(0) + (5-2)\cdot A(2) + (10-5)\cdot A(5)$

$= 2\cdot 50.3 + 3\cdot 14.4 + 5\cdot 6.5$

$= 176.3$ cubic feet

2 : { 1 : left Riemann sum; 1 : approximation }

(b) The approximation in part (a) is an overestimate because a left Riemann sum is used and A is decreasing.

1 : overestimate with reason

(c) $\int_0^{10} f(h)\,dh = 101.325338$

The volume is 101.325 cubic feet.

2 : { 1 : integral; 1 : answer }

(d) Using the model, $V(h) = \int_0^h f(x)\,dx$.

$$\left.\frac{dV}{dt}\right|_{h=5} = \left[\frac{dV}{dh}\cdot\frac{dh}{dt}\right]_{h=5}$$

$$= \left[f(h)\cdot\frac{dh}{dt}\right]_{h=5}$$

$$= f(5)\cdot 0.26 = 1.694419$$

When $h = 5$, the volume of water is changing at a rate of 1.694 cubic feet per minute.

3 : { 2 : $\frac{dV}{dt}$; 1 : answer }