

**AP<sup>®</sup> CALCULUS AB/CALCULUS BC  
2017 SCORING GUIDELINES**

**Question 1**

(a) 
$$\begin{aligned} \text{Volume} &= \int_0^{10} A(h) \, dh \\ &\approx (2 - 0) \cdot A(0) + (5 - 2) \cdot A(2) + (10 - 5) \cdot A(5) \\ &= 2 \cdot 50.3 + 3 \cdot 14.4 + 5 \cdot 6.5 \\ &= 176.3 \text{ cubic feet} \end{aligned}$$

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

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

The volume is 101.325 cubic feet.

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

$$\begin{aligned} \left. \frac{dV}{dt} \right|_{h=5} &= \left[ \frac{dV}{dh} \cdot \frac{dh}{dt} \right]_{h=5} \\ &= \left[ f(h) \cdot \frac{dh}{dt} \right]_{h=5} \\ &= f(5) \cdot 0.26 = 1.694419 \end{aligned}$$

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

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

2 :  $\begin{cases} 1 : \text{left Riemann sum} \\ 1 : \text{approximation} \end{cases}$

1 : overestimate with reason

2 :  $\begin{cases} 1 : \text{integral} \\ 1 : \text{answer} \end{cases}$

3 :  $\begin{cases} 2 : \frac{dV}{dt} \\ 1 : \text{answer} \end{cases}$