

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

**Question 5**

(a)  $x'_P(t) = \frac{2t - 2}{t^2 - 2t + 10} = \frac{2(t - 1)}{t^2 - 2t + 10}$

$t^2 - 2t + 10 > 0$  for all  $t$ .

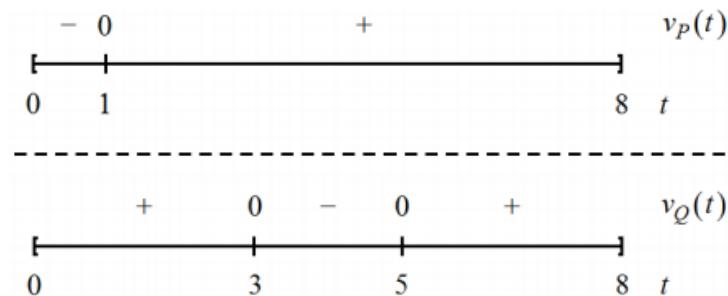
$x'_P(t) = 0 \Rightarrow t = 1$

$x'_P(t) < 0$  for  $0 \leq t < 1$ .

Therefore, the particle is moving to the left for  $0 \leq t < 1$ .

(b)  $v_Q(t) = (t - 5)(t - 3)$

$v_Q(t) = 0 \Rightarrow t = 3, t = 5$



Both particles move in the same direction for  $1 < t < 3$  and  $5 < t \leq 8$  since  $v_P(t) = x'_P(t)$  and  $v_Q(t)$  have the same sign on these intervals.

(c)  $a_Q(t) = v'_Q(t) = 2t - 8$

$a_Q(2) = 2 \cdot 2 - 8 = -4$

$a_Q(2) < 0$  and  $v_Q(2) = 3 > 0$

At time  $t = 2$ , the speed of the particle is decreasing because velocity and acceleration have opposite signs.

(d) Particle  $Q$  first changes direction at time  $t = 3$ .

$$\begin{aligned}x_Q(3) &= x_Q(0) + \int_0^3 v_Q(t) dt = 5 + \int_0^3 (t^2 - 8t + 15) dt \\&= 5 + \left[ \frac{1}{3}t^3 - 4t^2 + 15t \right]_{t=0}^{t=3} = 5 + (9 - 36 + 45) = 23\end{aligned}$$

2 :  $\begin{cases} 1 : x'_P(t) \\ 1 : \text{interval} \end{cases}$

2 :  $\begin{cases} 1 : \text{intervals} \\ 1 : \text{analysis using } v_P(t) \text{ and } v_Q(t) \end{cases}$

Note: 1/2 if only one interval with analysis

Note: 0/2 if no analysis

2 :  $\begin{cases} 1 : a_Q(2) \\ 1 : \text{speed decreasing with reason} \end{cases}$

3 :  $\begin{cases} 1 : \text{antiderivative} \\ 1 : \text{uses initial condition} \\ 1 : \text{answer} \end{cases}$