Two particles move along the x-axis. For $0 \leq t \leq 5$, the position of particle R at time t is given by $r(t) = 2\sin\left(\frac{\pi t}{3}\right)$. The velocity of particle P at time t is given by $v_p(t) = 3t^2 - 8t + 4$.

a) For $0 \leq t \leq 5$, find all times t during which particle P is moving to the right. Justify your answer.

b) For $0 \leq t \leq 5$, find all times t during which the two particles travel in opposite directions. Show the analysis that supports your conclusion.

c) At $t = 1$, determine if each particle is speeding up, slowing down or doing neither. Explain your reasoning.

d) Determine all time intervals when the speed of particle P is decreasing.

e) If the distance between the particles is zero at $t = 3$, determine an expression for $p(t)$, the position of particle P at time t.

f) Determine the distance between the particles at t = 2.

g) Write, but do not evaluate, an expression for the average distance between the two particles on the interval $1 \leq t \leq 4$.

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h) Write, but do not evaluate, an integral expression for the total distance traveled by particle P on the interval $0 \leq t \leq 5$.

i) Interpret the meaning of each of the following in the context of the problem

1. $\int_0^5 r'(t)dt$

2. $\frac{\int_0^5 r'(t)dt}{5-0}$

3. $r(0) + \int_0^5 r'(t)dt$

j) Determine when the particle R is farthest to the right on the interval $0 \leq t \leq 5$. What is the position of the particle at that time? Justify your answer.

k) When is the velocity of particle R increasing the fastest? Justify your answer.

l) Without using integrals, write an equation that can be solved to determine all values of t when the instantaneous velocity of particle P is the same as its average velocity on the interval $0 \leq t \leq 5$. Do not solve the equation.