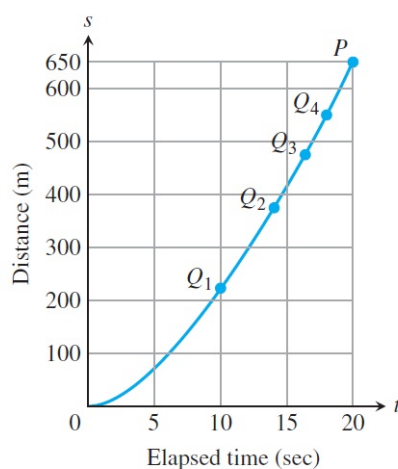


Rates of Change & Tangents to Curves

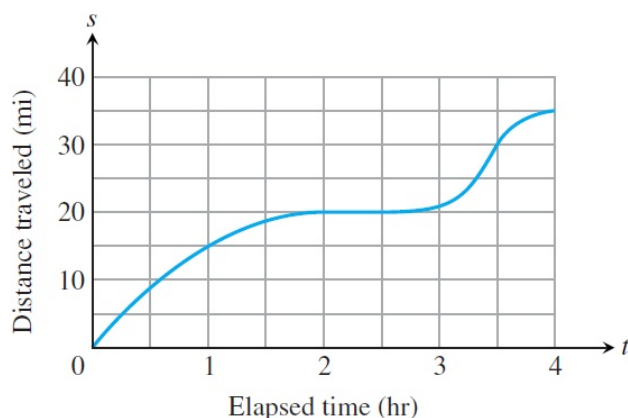
Instantaneous Rates of Change

1. **Speed of a car** The accompanying figure shows the time-to-distance graph for a sports car accelerating from a standstill.



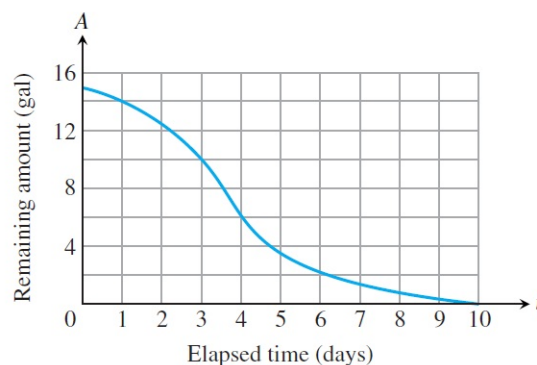
- 1.1 Estimate the slopes of secants PQ_1 , PQ_2 , PQ_3 , and PQ_4 . What are the appropriate units for these slopes?
- 1.2 Estimate the car's speed at time $t = 20$ sec.

2. The accompanying graph shows the total distance s traveled by a bicyclist after t hours.



- 2.1 Estimate the bicyclist's average speed over the time intervals $[0,1]$, $[1,2.5]$ and $[2.5,3.5]$.
- 2.2 Estimate the bicyclist's instantaneous speed at the times $t = 1/2$, $t = 2$ and $t = 3$.
- 2.3 Estimate the bicyclist's maximum speed and the specific time at which it occurs.

3. The accompanying graph shows the total amount of gasoline A in the gas tank of an automobile after being driven for t days.



- 3.1 Estimate the average rate of gasoline consumption over the time intervals $[0,3]$, $[0,5]$ and $[7,10]$.
- 3.2 Estimate the instantaneous rate of gasoline consumption at the times $t = 1$, $t = 4$ and $t = 8$.
- 3.3 Estimate the maximum rate of gasoline consumption and the specific time at which it occurs.

4. **Object dropped from a tower** An object is dropped from the top of a 100-m-high tower. Its height above ground after t sec is $100 - 4.9t^2$ m. how fast it is falling 2 sec after it is dropped?
5. **Speed of a rocket** At t sec after liftoff, the height of a rocket is $3t^2$ ft. How fast is the rocket climbing 10 sec after liftoff?
6. **Circle's changing area** What is the rate of change of the area of a circle ($A = \pi r^2$) with respect to the radius when the radius is $r = 3$?
7. **Ball's changing volume** What is the rate of change of the volume of a ball ($V = (4/3)\pi r^3$) with respect to the radius when the radius is $r = 2$?