

## Motion Classwork

1.

For  $t \geq 0$ , a particle moves along the  $x$ -axis. The velocity of the particle at time  $t$  is given by

$$v(t) = 1 + 2\sin\left(\frac{t^2}{2}\right). \text{ The particle is at position } x = 2 \text{ at time } t = 4.$$

- At time  $t = 4$ , is the particle speeding up or slowing down?
- Find all times  $t$  in the interval  $0 < t < 3$  when the particle changes direction. Justify your answer.
- Find the position of the particle at time  $t = 0$ .
- Find the total distance the particle travels from time  $t = 0$  to time  $t = 3$ .

2.

An object moves along the  $x$ -axis with initial position  $x(0) = 2$ . The velocity of the object at time  $t \geq 0$  is given by  $v(t) = \sin\left(\frac{\pi}{3}t\right)$ .

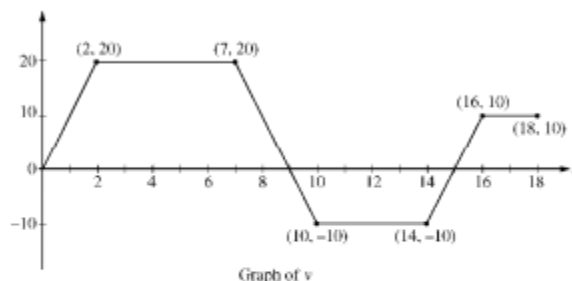
- What is the acceleration of the object at time  $t = 4$ ?
- Consider the following two statements.  
Statement I: For  $3 < t < 4.5$ , the velocity of the object is decreasing.  
Statement II: For  $3 < t < 4.5$ , the speed of the object is increasing.

Are either or both of these statements correct? For each statement provide a reason why it is correct or not correct.

- What is the total distance traveled by the object over the time interval  $0 \leq t \leq 4$ ?
- What is the position of the object at time  $t = 4$ ?

3.

A squirrel starts at building  $A$  at time  $t = 0$  and travels along a straight wire connected to building  $B$ . For  $0 \leq t \leq 18$ , the squirrel's velocity is modeled by the piecewise-linear function defined by the graph above.



- At what times in the interval  $0 < t < 18$ , if any, does the squirrel change direction? Give a reason for your answer.
- At what time in the interval  $0 \leq t \leq 18$  is the squirrel farthest from building  $A$ ? How far from building  $A$  is the squirrel at this time?
- Find the total distance the squirrel travels during the time interval  $0 \leq t \leq 18$ .
- Write expressions for the squirrel's acceleration  $a(t)$ , velocity  $v(t)$ , and distance  $x(t)$  from building  $A$  that are valid for the time interval  $7 < t < 10$ .

4.

$t$ (seconds)	0	10	20	30	40	50	60	70	80
$v(t)$ (feet per second)	5	14	22	29	35	40	44	47	49

Rocket  $A$  has positive velocity  $v(t)$  after being launched upward from an initial height of 0 feet at time  $t = 0$  seconds. The velocity of the rocket is recorded for selected values of  $t$  over the interval  $0 \leq t \leq 80$  seconds, as shown in the table above.

(a) Find the average acceleration of rocket  $A$  over the time interval  $0 \leq t \leq 80$  seconds. Indicate units of measure.

(b) Using correct units, explain the meaning of  $\int_{10}^{70} v(t) dt$  in terms of the rocket's flight. Use a midpoint

Riemann sum with 3 subintervals of equal length to approximate  $\int_{10}^{70} v(t) dt$ .

(c) Rocket  $B$  is launched upward with an acceleration of  $a(t) = \frac{3}{\sqrt{t+1}}$  feet per second per second. At time  $t = 0$  seconds, the initial height of the rocket is 0 feet, and the initial velocity is 2 feet per second. Which of the two rockets is traveling faster at time  $t = 80$  seconds? Explain your answer.