Principles of Calculus Modeling: An Interactive Approach by Donald Kreider, Dwight Lahr, and Susan Diesel
Exercises for Section 2.2

1. (1 pt)
Suppose that an object moves along the x-axis in such a way that its position at time t (seconds) is $x = t^3$ feet to the right of the origin. What is the average velocity of the object over the time interval $[t, t + 2h]$?

average velocity over $[t, t + 2h] =$ —————— ft/s

Now find the average velocity of the object over each of the following time intervals:

average velocity over $[1, 2] =$ —————— ft/s
average velocity over $[1, 1.1] =$ —————— ft/s
average velocity over $[1, 1.01] =$ —————— ft/s
average velocity over $[1, 1.001] =$ —————— ft/s
average velocity over $[1, 1.0001] =$ —————— ft/s

2. (1 pt)
Suppose that an object moves along the x-axis in such a way that its position at time t (seconds) is $x = t^3$ feet to the right of the origin. Find the average velocity of the object over each of the following time intervals:

average velocity over $[3, 4] =$ —————— ft/s
average velocity over $[3, 3.01] =$ —————— ft/s
average velocity over $[3, 3.0001] =$ —————— ft/s
These results should allow you to guess the instantaneous velocity of the object at $t = 3$ second(s). You can confirm this guess by calculating the limit of the average velocity over $[3, 3 + h]$ as h goes to zero. To calculate the limit, first expand the numerator of the average velocity of the object over the time interval $[3, 3 + h]$ and simplify the result. Enter just the numerator of the expression you get here:

——————

What is the instantaneous velocity at $t = 3$ second(s)?
velocity at 3 second(s) = —————— ft/s

3. (1 pt)
A weight that is suspended by a spring bobs up and down so that its height above the floor at time t seconds is y feet, where $y = 3 + \frac{1}{\pi}\sin \pi t$. Sketch the graph of y as a function of t, and use this sketch to determine the following:

The height of the weight at $t = 3$ second(s) = —————— ft

At $t = 3$ second(s), the weight is moving ——

A. downward
B. upward

4. (1 pt)
A weight that is suspended by a spring bobs up and down so that its height above the floor at time t seconds is y feet, where $y = 2 + \frac{1}{\pi}\sin \pi t$. Calculate the average velocity of the weight over each of the following time intervals:

average velocity over $[2, 3] =$ —————— ft/s
average velocity over $[2, 2.1] =$ —————— ft/s
average velocity over $[2, 2.01] =$ —————— ft/s
average velocity over $[2, 2.001] =$ —————— ft/s
Use these results to estimate the instantaneous velocity of the weight at $t = 2$ second(s).

—————— ft/s
The sign of your answer indicates that at $t = 2$ second(s)
——

A. the weight is stationary
B. the weight is moving downward
C. the weight is slowing down
D. the weight is speeding up
E. the weight is moving upward

5. (1 pt)
A napping cat is awakened by a mouse scooting past her at a velocity of 0.6 feet per second. The cat rouses itself after 2.7 seconds and accelerates after the mouse at a rate of 6 feet per second per second.

How many seconds does it take for the cat to overtake the mouse?
—————— seconds
How far has the cat traveled in that time?
—————— feet

6. (1 pt)
Find the instantaneous velocity of the object whose position at time t is $x(t) = t^3 + 2t^2 - 6$ at the times given below.
t = 0: ——————
t = 0.6: ——————
t = 2: ——————

7. (1 pt)
Find the instantaneous velocity of the object whose position at time t is $x(t) = \sqrt{2t^2 + 7} - 6$ at the times given below.
t = 0: ——————
t = 0.2: ——————
t = 5: ——————

8. (1 pt)
Find the instantaneous velocity of the object whose position at time t is $x(t) = 10\sin(6t) - 5\cos(t)$ at the times given below.
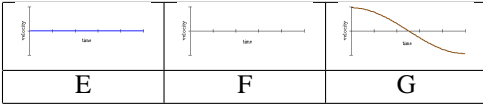t = 0: ——————
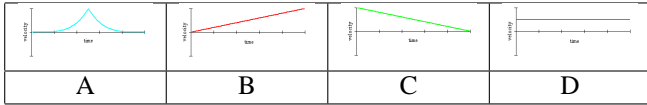t = 0.8: ——————
t = 5: ——————

9. (1 pt)

An object moves along a positive distance axis. Select the velocity graph that best answers each question below.

A	B	C	D

E	F	G

Which graph shows:

___ An object changing direction?

___ An object that is speeding up?

___ An object standing still?

___ An object moving away from the origin at a constant velocity?

___ An object moving away from the origin at varying velocity?

---

10. (1 pt)

A car is moving at 8 feet per second; 15 seconds later, it is moving at 14 feet per second. What is the acceleration of the car over this period of time?

_____ feet per second per second

---

11. (1 pt)

A heavy package falls off a helicopter when the helicopter is flying at 500 meters above ground level. How many seconds does it take for the package to hit the ground?

_____ seconds

What is the instantaneous velocity of the package when it hits the ground?

_____ meters per second

---

12. (1 pt)

A boy sitting on the balcony of high-rise apartment drops the ice cream cone he was eating. The ice cream cone hits the ground with a velocity of 68 m/s. How many meters above the ground was the boy?

_____ meters

---

13. (1 pt)

Achilles, fleetest of foot of all mortals, is challenged to a race by the Tortoise. The Tortoise is granted a 700 meter head start, and the runs at 3 meters per second. Achilles starts at the same time, and accelerates at a constant rate of 1.5 meter per second per second. How long will it be until Achilles catches the Tortoise?

_____ seconds

How far will Achilles will have to run before he catches the Tortoise?

_____ meters

---

14. (1 pt)

Two balls are rolled down two planes of different slopes. The first accelerates at 1.1 meters per second and the second ball accelerates at 2.1 meters per second. The second ball starts rolling 13 seconds after the first ball.

In how many seconds will the second ball have rolled as far as the first?

_____ seconds