Principles of Calculus Modeling: An Interactive Approach by Donald Kreider, Dwight Lahr, and Susan Diesel
Exercises for Section 2.16

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1. (1 pt)
A point moves along the x axis so that its position x at time t is specified by the function $x(t) = t^3 - 8t + 8$. Determine the following:

A. the time intervals on which the point is moving to the right and to the left;
B. the time intervals on which the point is accelerating to the right and to the left;
C. the time intervals when the particle is speeding up and slowing down;
D. the acceleration at times when the velocity is zero;
E. the average velocity over the time interval [0,6].

Parts A, B, and C:
For each of parts A, B, and C, enter up to three intervals in the answer boxes below, starting with the smallest value of t, and continuing with increasing values of t.

For each interval in part A, indicate whether the point is moving to the right or to the left entering **R** or **L** in the appropriate answer box; for part B, indicated whether the point is accelerating to the right or to the left by entering **R** or **L** in the appropriate answer box; and for part C, indicate whether the particle is speeding up or slowing down by entering **U** or **D** in the appropriate answer box.

All parts:
Use only the answer boxes you need; leave the rest blank. When appropriate, type **-infinity** for $-\infty$ or **infinity** for ∞, without quotes.

Part A, Position
first interval:
__________ to __________ right/left: ___
second interval:
__________ to __________ right/left: ___
third interval:
__________ to __________ right/left: ___
fourth interval:
__________ to __________ right/left: ___

Part B, Acceleration
first interval:
__________ to __________ right/left: ___
second interval:
__________ to __________ right/left: ___
third interval:
__________ to __________ right/left: ___
fourth interval:
__________ to __________ right/left: ___

Part C, Speed
first interval:
__________ to __________ speeding up/slowing down: ___
second interval:
__________ to __________ speeding up/slowing down: ___
third interval:
__________ to __________ speeding up/slowing down: ___
fourth interval:
__________ to __________ speeding up/slowing down: ___

Part D
For times t when the velocity of the particle is 0, enter the acceleration. Enter up to three answers, beginning with the smallest value of t, and continuing with increasing t.

____
____
____

Part E
What is the average velocity over the time interval [0,6]?
____

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2. (1 pt)
A point moves along the x axis so that its position x at time t is specified by the function $x(t) = \frac{7t}{3t^2+2}$. Determine the following:

A. the time intervals on which the point is moving to the right and to the left;
B. the time intervals on which the point is accelerating to the right and to the left;
C. the time intervals when the particle is speeding up and slowing down;
D. the acceleration at times when the velocity is zero;
E. the average velocity over the time interval [0,8].

Parts A, B, and C:
For each of parts A, B, and C, enter up to three intervals in the answer boxes below, starting with the smallest value of t, and continuing with increasing values of t.

For each interval in part A, indicate whether the point is moving to the right or to the left entering **R** or **L** in the appropriate answer box; for part B, indicated whether the point is accelerating to the right or to the left by entering **R** or **L** in the appropriate answer box; and for part C, indicate whether the particle is speeding up or slowing down by entering **U** or **D** in the appropriate answer box.

All parts:
Use only the answer boxes you need; leave the rest blank. When appropriate, type **-infinity** for $-\infty$ or **infinity** for ∞, without quotes.

Part A, Position

first interval:

____ to ____ right/left: ____

second interval:

____ to ____ right/left: ____

third interval:

____ to ____ right/left: ____

fourth interval:

____ to ____ right/left: ____

Part B, Acceleration

first interval:

____ to ____ right/left: ____

second interval:

____ to ____ right/left: ____

third interval:

____ to ____ right/left: ____

fourth interval:

____ to ____ right/left: ____

Part C, Speed

first interval:

____ to ____ speeding up/slowing down: ____

second interval:

____ to ____ speeding up/slowing down: ____

third interval:

____ to ____ speeding up/slowing down: ____

fourth interval:

____ to ____ speeding up/slowing down: ____

fifth interval:

____ to ____ speeding up/slowing down: ____

sixth interval:

____ to ____ speeding up/slowing down: ____

Part D

For times t when the velocity of the particle is 0, enter the acceleration. Enter up to three answers, beginning with the smallest value of t, and continuing with increasing t.

____

____

____

Part E

What is the average velocity over the time interval [0,8]?

____

3. (1 pt)
A ball is thrown upward from ground level with an initial speed of 16.6 meters per second so that its height in meters after t seconds is given by $y = 16.6t - 4.9t^2$. What is the acceleration of the ball at any time t?

____ m/sec^2

How high does the ball go?

____ m

How fast is it moving when it strikes the ground?

____ m/sec

4. (1 pt)
Projectiles on Mars
In this problem and the next, assume that the acceleration (on earth) due to gravity is $9.8m/sec^2$.

A projectile fired upward from the surface of the earth falls back to the ground after 29.2 seconds. How long would it take to fall back to the surface if it is fired upward on Mars with the same initial velocity?

Use the fact that the force of gravity on Mars is $g_{Mars} = 3.72m/sec^2$.

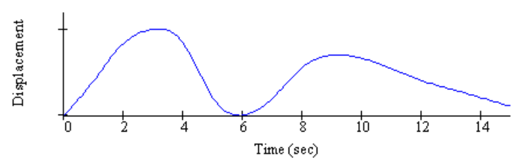
____ seconds

5. (1 pt)
In this problem, assume that the acceleration (on earth) due to gravity is $9.8m/sec^2$.

A rock falls from the top of a cliff. Its speed as it hits the ground at the base of the cliff is 31 meters per second. How high is the cliff?

____ meters

6. (1 pt)
The graph below shows the position $y = s(t)$ of an object moving back and forth on a coordinate line. Click the image to see a larger view.



At approximately what times is the object's velocity equal to zero? Enter values from left to right. Leave blank any unused boxes.

____ ____ ____ ____

At approximately what times is the object's acceleration equal to zero? Enter values from left to right. Leave blank any unused boxes.

____ ____ ____ ____

7. (1 pt)
A rocket lifts off the surface of the earth with a constant acceleration of 20 meters per second per second. How far will the rocket have traveled 70 seconds later?

____ meters

At this rate of acceleration, when does the rocket reach escape velocity (11.3 km per second)?

____ seconds

8. (1 pt)
The motion of a simple pendulum is approximated by the equation

$$\theta(t) = \theta_{max} \cos\left(\sqrt{\frac{g}{L}}t\right)$$

where g = 9.8 meters per second per second is the force of earth's gravity, L is the length of the rod, and the initial position of the pendulum is at θ_{max}, the maximum angle with the vertical formed by the pendulum during its swing.

Suppose $\theta_{max} = 0.08$ radians and L = 0.9 meters. What is the angular velocity of the pendulum when it is at its maximum angle?

________ radians per second

What is the acceleration?

________ radians per second per second

What is the angle with the vertical when the velocity is greatest?

________ radians

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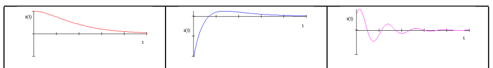
9. (1 pt)

Damped Oscillation

Three ways to damp vibration are shown in the following graphs.



A	B	C

Match the equation of the curve with the graph.

___ $x(t) = e^{-t}\sin(5t + \pi/4)$

___ $x(t) = (1+t)e^{-t}$

___ $x(t) = e^{-t} - 2e^{-2t}$

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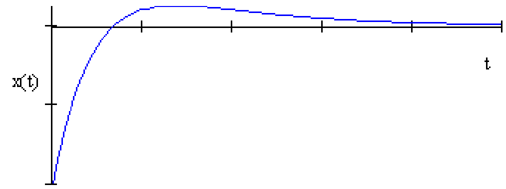
10. (1 pt)

Overcritical Damping

With this type of damping, the oscillating mass is allowed to pass the equilibrium position once after being released, then slowly settles back to equilibrium without changing direction. A swinging door is an example of an object that might be damped in this way.



Suppose the equation of motion for an object is $x(t) = e^{-4t} - 5e^{-5t}$. Find the time when the acceleration of the object is at its maximum.

________ seconds

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