The rate of change, in kilometers per hour, of the altitude of a hot air balloon is given by $r(t) = t^3 - 4t^2 + 6$ for time $0 \le t \le 4$, where t is measured in hours. Assume the balloon is initially at ground level.

1. For what values of t, $0 \le t \le 4$, is the altitude of the balloon decreasing?

2. Find the value of $r'(2)$ and explain the meaning of the answer in the context of the problem. Indicate units of measure.

3. What is the altitude of the balloon when it is closest to the ground during the time interval $2 \le t \le 4$?

4. Find the value of $\int_0^4 r(t)\,dt$ and explain the meaning of the answer in the context of the problem. Indicate units of measure.

5. Find the value of $\int_0^4 |r(t)|\,dt$ and explain the meaning of the answer in the context of the problem. Indicate units of measure.

6. What is the maximum altitude of the balloon during the time interval $0 \le t \le 4$?

The table below gives values for the velocity and acceleration of a particle moving along the x-axis for selected values of time t. Both velocity and acceleration are differentiable functions of time t. The velocity is decreasing for all values of t, $0 \le t \le 10$. Use the data in the table to answer the questions that follow.

Time, t	0	2	6	10
Velocity, $v(t)$	5	3	-1	-8
Acceleration, $a(t)$	0	-1	-3	-5

1. Is there a time t when the particle is at rest? Explain your answer.

2. At what time indicated in the table is the speed of the particle decreasing? Explain your answer.

3. Use a left Riemann sum to approximate $\int_0^{10} v(t)\,dt$. Show the computations you use to arrive at your answer. Explain the meaning of the definite integral in the context of the problem.

4. Is the approximation found in part (3) greater than or less than the actual value of the definite integral shown below? Explain your reasoning.

$$\int_0^{10} v(t)\,dt$$

5. Approximate the value of $\int_0^{10} |v(t)|\,dt$ using a trapezoidal approximation with the three sub-intervals indicated by the values in the table. Show the computations you use to arrive at your answer. Explain the meaning of the definite integral in the context of the problem.

6. Determine the value of $\int_0^{10} a(t)\,dt$. Explain the meaning of the definite integral in the context of the problem.

4. The rate at which water is being pumped into a tank is given by the continuous, increasing function $R(t)$. A table of selected values of $R(t)$, for the time interval $0 \le t \le 20$ minutes, is shown below.

t (min)	0	4	9	17	20
$R(t)$ (gal/min)	25	28	33	42	46

a. Use a right Riemann sum with four subintervals to approximate the value of:

$$\int_0^{20} R(t)dt.$$

Is your approximation greater or less than the true value? Give a reason for your answer.

b. A model for the rate at which water is being pumped into the tank is given by the function:

$$W(t) = 25e^{0.03t},$$

where t is measured in minutes and $W(t)$ is measured in gallons per minute. Use the model to find the average rate at which water is being pumped into the tank from $t = 0$ to $t = 20$ minutes.

c. The tank contained 100 gallons of water at time $t = 0$. Use the model given in part (b) to find the amount of water in the tank at $t = 20$ minutes.

3. A bowl of soup is placed on the kitchen counter to cool. Let $T(x)$ represent the temperature of the soup at time x, where T is a differentiable function of x. The temperature of the soup at selected times is given in the table below.

x (min)	0	4	7	12
$T(x)$ (°F)	108	101	99	95

a. Use data from the table to find:

$$\int_0^{12} T'(x)\,dx$$

Explain the meaning of this definite integral in terms of the temperature of the soup.

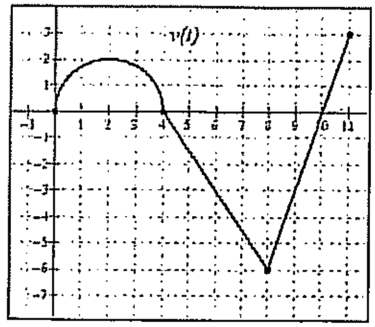
b. Use data from the table to find the average rate of change of $T(x)$ over the time interval $x = 4$ to $x = 7$.

c. Explain the meaning of:

$$\frac{1}{12}\int_0^{12} T(x)\,dx$$

in terms of the temperature of the soup, and approximate the value of this integral expression by using a trapezoidal sum with three subintervals.

The graph to the right shows the velocity, $v(t)$, of a particle moving along the x-axis for $0 \le t \le 11$. It consists of a semicircle and two line segments. Use the graph and your knowledge of motion to answer the following questions.



1. At what time t, $0 \le t \le 11$, is the speed of the particle the greatest?

2. At which of the times, $t = 2$, $t = 6$ or $t = 9$, is the acceleration of the particle the greatest? Explain your answer.

3. Over what time intervals is the particle moving to the left? Explain your answer.

4. Over what time intervals is the speed of the particle decreasing? Explain your answer.

5. Find the total distance traveled by the particle over the time interval $0 \le t \le 11$.

6. Find the value of $\int_0^{11} v(t)\,dt$ and explain the meaning of this integral in the context of the problem.

7. If the initial position of the particle is $x(0) = 2$, find the position of the particle at time $t = 11$.