1. (From the 2006 AP Calculus AB exam.) 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 $0 \le t \le 80$ seconds, as shown in the table below.

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

(a) Find the average acceleration of rocket A over the time interval $0 \le t \le 80$ 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.

(c) Use Simpson's rule with the six subintervals indicated by the table to approximate $\int_{10}^{70} v(t)\,dt$.

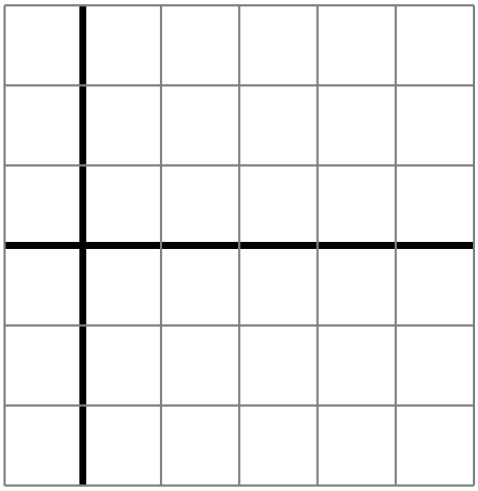
(d) Rocket B is launched upward with an acceleration of $a(t) = \dfrac{3}{\sqrt{t+1}}$ feet per second per second. At time $t = 0$ seconds, the initial height of the rocket is 0 feet, and the initial velocity is 2 feet per second. Which of the two rockets is traveling faster at time $t = 80$ seconds?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

2. (From the 2005 AP Calculus AB exam.) Let f be a function that is continuous on the interval $[0, 4)$. The function f is twice differentiable except at $x = 2$. The function f and its derivatives have the properties indicated in the table below. (DNE stands for "does not exist".)

x	0	$0 < x < 1$	1	$1 < x < 2$	2	$2 < x < 3$	3	$3 < x < 4$
$f(x)$	-1	Negative	0	Positive	2	Positive	0	Negative
$f'(x)$	4	Positive	0	Positive	DNE	Negative	-3	Negative
$f''(x)$	-2	Negative	0	Positive	DNE	Negative	0	Positive

(a) For $0 < x < 4$, find all values of x at which f has a relative extremum. Determine whether f has a relative maximum or a relative minimum at each of these values. Justify your answer.

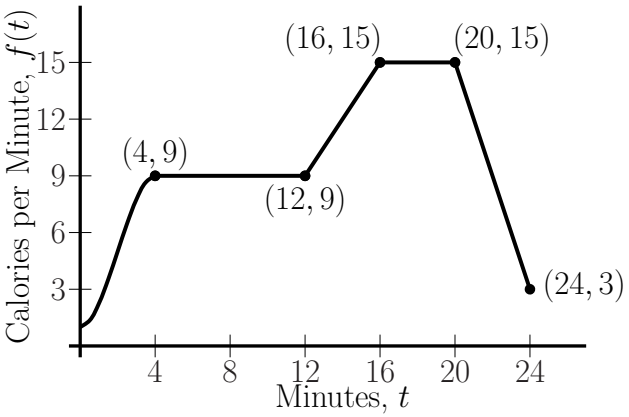
(b) On the axes provided, sketch the graph of a function that has all the characteristics of f.



(c) Let g be the function defined by $g(x) = \int_1^x f(t)\,dt$ on the open interval $(0, 4)$. For $0 < x < 4$, find all values of x at which g has a relative extremum. Determine whether g has a relative maximum or a relative minimum at each of these values. Justify your answer.

(d) For the function g defined in part (c), find all values of x, for $0 < x < 4$, at which the graph of g has a point of inflection. Justify your answer.

3. (From the 2006 AP Calculus AB exam.) The rate, in calories per minute, at which a person using an exercise machine burns calories is modeled by the function f. In the figure below, $f(t) = -\frac{1}{4}t^3 + \frac{3}{2}t^2 + 1$ for $0 \le t \le 4$ and f is piecewise linear for $4 \le t \le 24$. (Note that this problem continues on the next page.)



(a) Find each of the following limits or state that it does not exist.

(i) $\lim_{x\to 2} f(x)$ (vi) $\lim_{x\to 24^-} f(x)$ (xi) $\lim_{x\to 4} f'(x)$ (xvi) $\lim_{x\to 18} f'(x)$

(ii) $\lim_{x\to 4} f(x)$ (vii) $\lim_{x\to 0^+} f'(x)$ (xii) $\lim_{x\to 12^-} f'(x)$ (xvii) $\lim_{x\to 22} f'(x)$

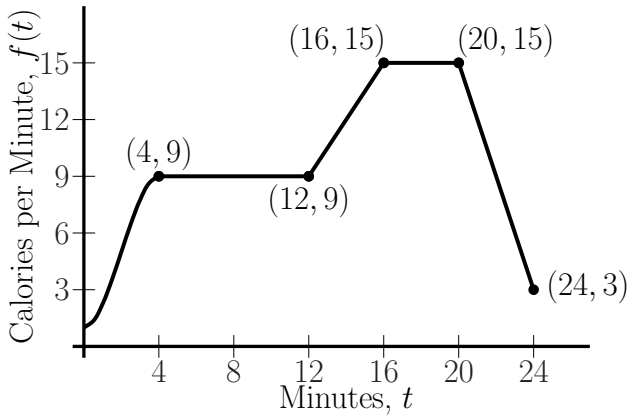
(iii) $\lim_{x\to 8} f(x)$ (viii) $\lim_{x\to 2} f'(x)$ (xiii) $\lim_{x\to 12^+} f'(x)$ (xviii) $\lim_{x\to 24^-} f'(x)$

(iv) $\lim_{x\to 12} f(x)$ (ix) $\lim_{x\to 4^-} f'(x)$ (xiv) $\lim_{x\to 12} f'(x)$ (xix) $\lim_{x\to 24} f'(x)$

(v) $\lim_{x\to 22} f(x)$ (x) $\lim_{x\to 4^+} f'(x)$ (xv) $\lim_{x\to 14} f'(x)$

(b) Find any x-values in the open interval $(0, 24)$ where f is not continuous.

(c) Find any x-values in the open interval $(0, 24)$ where f' is not continuous.



(d) For the time interval $0 \leq t \leq 24$, at what time t is f increasing at its greatest rate? Show the reasoning that supports your answer.

(e) Find the total number of calories burned over the time interval $6 \leq t \leq 18$ minutes.

(f) The setting on the machine is now changed so that the person burns $f(t)+c$ calories per minute. For this setting, find c so that an average of 15 calories per minute is burned during the time interval $6 \leq t \leq 18$.