

1. If $f(x) = x^3 + 3x^2 - 9x + 4$ for $-4 \leq x \leq 5$

$x^3 + 2x^2 - 3$

$f'(x) = 3x^2 + 6x - 9 = 0$

$(x+3)(x-1) = 0$

relatin

$f''(x) = 6x + 6$

$x = -1$

inflection

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2. If $f(x)$ is continuous on $[0, 3]$ and satisfies the following conditions find each below

a) extreme values → $\max(0, 2) \leq \min \text{ none}$

b) inflection points → 2nd change in signs → none

c) sketch the possible graph

1st derivative

X	0	(0,0)	1	(1, 2)	2	3
F	✓	0	2	0	-2	
F'	3	0	↓↓↓	-3	1+D	
F''	0	-1	↓↓↓	0		

2nd derivative

X	0 < x < 1	1 < x < 2	2 < x < 3
F''	+	+	-
F'''	-	-	-

Graphs:

- Graph 1: A curve starting at (0,0), increasing to (1,2), decreasing to (2,0), and then decreasing again.
- Graph 2: A curve starting at (0,0), increasing to (1,2), decreasing to (2,0), and then increasing again to (3, -2).
- Graph 3: A curve starting at (0,0), increasing to (1,2), decreasing to (2,0), and then decreasing again to (3, -2).

Derivative Test:

$f'(x) = 3x^2 - 3$

$f''(x) = 6x$

$f'''(x) = 6$

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2. Assuming $f'(x)$ exists for all values of x sketch a basic shape of the graph f with the following properties:

1st der

- $< 0, x < 1$
- $< 0, x = -1$
- $> 0, 0 < x < 2$
- $< 0, x = 2$
- $< 0, x > 2$

$F'(x)$

$f(x)$

dec

$x=1$
rel min

$x=2$ rel max

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3. Position function of a particle is given by $s(t) = \frac{1}{3}t^3 - 3t^2 + 8t + 1, t \geq 0$. Describe the motion of the particle and make a sketch.

$(t-4)(t-2)=0$

right $\rightarrow v(t) +$
 left $\leftarrow v(t) -$

Speed inc: $v(t)$ and $a(t)$ same sign
 Speed dec: " diff sign

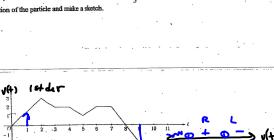
Motion:
 right: $(0, 2) \cup (4, \infty)$
 left: $(2, 4)$
 Speed inc: $(2, 3) (4, \infty)$
 Speed dec: $(0, 2) (3, 4)$

$v(t) = t^2 - 6t + 8$
 $a(t) = 2t - 6 = 0$

$s(t)$

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3. A position function of a particle is given by $s(t) = \frac{1}{3}t^3 - 3t^2 + 4t + 1, t \geq 0$. Describe the motion of the particle and make a sketch.



At time $t = 0$, the particle is moving along the straight line $y = 4x + 1$, i.e., the tangent line to the graph at $(0,1)$.

Use the graph above to answer each question.

4. According to the graph, at what time does the particle change direction? \rightarrow ~~at $t=2$~~

According to the graph, at which instant is it the farthest from the ground?

$t = 1$ ~~at speed $|s'(t)| = 10$~~ \rightarrow ~~at $t=10$~~

5. The figure shows a graph of $f'(x)$ on the interval $[-3, 5]$. The graph consists of two line segments and a curve. The graph has a cusp at $x = -1$ and a vertical tangent at $x = 3$.

a) The figure shows three intervals I_1, I_2, I_3 on the interval $[-3, 5]$. The intersection of the set of values of x for which $f(x)$ is increasing and the union of the sets of values of x for which $f(x)$ is decreasing is such that $I_1 \cup I_2 \cup I_3$. \rightarrow ~~$I_1 \cap I_2 \cap I_3$~~

b) For what values of x does $f(x)$ have a relative min? why?

c) For what values of x does $f(x)$ have a relative max? why?

d) At which points of $f(x)$ does the graph of $f(x)$ cross the x -axis?

e) For which values of x is the graph of $f(x)$ concave up? the graph of $f(x)$ is concave down?

f) For which values of x is the graph of $f(x)$ increasing? the graph of $f(x)$ is decreasing?

g) For which values of x is the graph of $f(x)$ relatively flat? the graph of $f(x)$ is relatively steep?

h) For which values of x is the graph of $f(x)$ relatively high? the graph of $f(x)$ is relatively low?

i) For which values of x is the graph of $f(x)$ relatively sharp? the graph of $f(x)$ is relatively smooth?

j) For which values of x is the graph of $f(x)$ relatively flat? the graph of $f(x)$ is relatively steep?

k) For which values of x is the graph of $f(x)$ relatively high? the graph of $f(x)$ is relatively low?

l) For which values of x is the graph of $f(x)$ relatively sharp? the graph of $f(x)$ is relatively smooth?

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4. The figure above shows the graph of f' , the derivative of f , not the graph of f . The domain of f is the set of all real numbers x such that $-3 < x < 5$.

- a) For what values of x does f have a relative max? why?
- b) For what values of x does f have a relative min? why?
- c) On what intervals is the graph of f concave upward? Use f' to justify

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