

No calculators will be allowed and no partial credit will be given.

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1. Find all the critical points of  $f(x) = 3x^2 + 4x + 6$ , if any. Express your answer(s) in simplified form.
2. Find all the critical points of  $f(x) = \frac{1}{3}x^3 - \frac{7}{2}x^2 + 10x + \sin(\ln(2))$ , if any. Express your answer(s) in simplified form.
3. Find all the positive critical points of  $f(x) = 9x^2 + \frac{19}{x}$ , if any. Express your answer(s) in simplified form.
4. Find all the critical points of  $f(x) = (x - 7)^2(2x + 6)$ , if any. Express your answer(s) in simplified form.
5. Find all the critical points of  $f(x) = \frac{x - 2}{x^2 + 32}$ , if any. Express your answer(s) in simplified form.
6. Find all critical points of  $f(x) = (4x - 3)e^{9x}$ , if any. Express your answer(s) in simplified form.
7. Suppose the twice differentiable function has derivatives with signs as in the chart below. State the interval(s) on which  $f$  is increasing.

	$x < 3$	$3 < x < 6$	$6 < x < 10$	$10 < x$
$f'(x)$	+	-	-	+
$f''(x)$	-	-	+	+

8. Suppose the twice differentiable function has derivatives with signs as in the chart below. State the interval(s) on which  $f$  is concave up.

	$x < 1$	$1 < x < 5$	$5 < x < 9$	$9 < x$
$f'(x)$	+	+	+	-
$f''(x)$	+	-	-	-

1.  $-\frac{2}{3}$

2. 5, 2

3.  $\left(\frac{19}{18}\right)^{\frac{1}{3}}$

4. 7,  $1/3$

5. -4, 8

6.  $\frac{23}{36}$

7.  $(-\infty, 3)$   $(10, \infty)$

8.  $(-\infty, 1)$