

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

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1. Find all the critical points of  $f(x) = 3x^2 + 8x + 3$ , if any. Express your answer(s) in simplified form.
2. Find all the critical points of  $f(x) = \frac{1}{3}x^3 + 5x^2 + 25x + \sin(\ln(2))$ , if any. Express your answer(s) in simplified form.
3. Find all the positive critical points of  $f(x) = 9x^2 + \frac{13}{x}$ , if any. Express your answer(s) in simplified form.
4. Find all the critical points of  $f(x) = (x - 7)^2(3x + 1)$ , if any. Express your answer(s) in simplified form.
5. Find all the critical points of  $f(x) = \frac{x + 1}{x^2 + 15}$ , if any. Express your answer(s) in simplified form.
6. Find all critical points of  $f(x) = (4x - 7)e^{6x}$ , 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.

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

1.  $-\frac{4}{3}$
2.  $-5, -5$
3.  $\left(\frac{13}{18}\right)^{\frac{1}{3}}$
4.  $7, 19/9$
5.  $-5, 3$
6.  $\frac{19}{12}$
7.  $(-\infty, 10)$
8.  $(3, 10)$