

① (8,8) ⑥ $2 < x < 4, 6 < x < 8$
 ② (2,1) ⑦ $0 < x < 2, 4 < x < 6, 8 < x < 10$
 ③ (4,5), (8,8)
 ④ (2,1), (6,2)
 ⑤ 2, 4, 6, 8

⑧ $f(x) = 4x^3 - x^4$
 $f'(x) = 12x^2 - 4x^3$ $f''(x) = 24x - 12x^2$
 $12x^2 - 4x^3 = 0$ a) $(-\infty, 0) \cup (0, 3)$
 $4x^2(3-x) = 0$ b) $(3, \infty)$
 $x=0 \quad x=3$
 $f''(x) = 24x - 12x^2$
 $0 = 24x - 12x^2$
 $0 = 12x(2-x)$
 $x=0 \quad x=2$

$f''(x)$ sign chart: $+$ $-$ $+$ $-$
 0 2

c) (0,2)
 d) $(-\infty, 0) \cup (2, \infty)$
 e) (0,0), (2,16)
 $f(0)=0 \quad f(2)=16$

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12a) $f(x) = 2x^3 - 9x^2 + 12x - 5 \quad [0,2]$
 $f'(x) = 6x^2 - 18x + 12$
 $= 6(x^2 - 3x + 2)$
 $= 6(x-2)(x-1)$

abs min \rightarrow $x=2$ | $x=1$
 $f(0) = -5$
 $f(1) = 0 \leftarrow \text{abs Max}$
 $f(2) = -1$

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13a) $y = x^4 - 10x^2 + 9$
 $y' = 4x^3 - 20x$ $f''(x) = 12x^2 - 20$
 $0 = 4x(x^2 - 5)$ $\uparrow (-\sqrt{5}, 0) \cup (\sqrt{5}, \infty)$
 $x=0 \quad | \quad x^2 = 5$ $\downarrow (-\infty, -\sqrt{5}) \cup (0, \sqrt{5})$
 $x = \pm\sqrt{5}$

b) $y = \frac{-x}{x^2+4}$
 $y' = \frac{(x^2+4)(-1) - (-x)(2x)}{(x^2+4)^2}$
 $= \frac{-x^2-4+2x^2}{(x^2+4)^2} \rightarrow \frac{x^2-4}{(x^2+4)^2}$
 $x^2-4=0 \quad x=\pm 2$ $(x^2+4)^2=0 \quad x^2+4=0 \quad x^2=-4 \quad x=\pm 2i$

$f''(x)$ sign chart: $+$ $-$ $+$
 -2 2

$\uparrow (-\infty, -2) \cup (2, \infty)$
 $\downarrow (-2, 2)$

Dec 16-10:07 AM