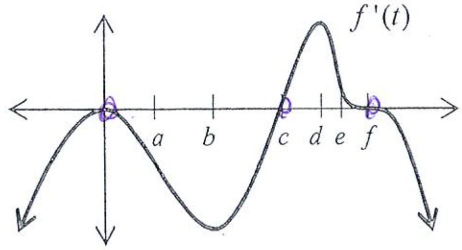
Name:______________________

No calculator is allowed for these problems.

Use the figure on the right to answer #1 to #8.



1. What are the critical values of $f(t)$?
   (A) b, d
   (B) $0, b, d$
   (C) $0, b, d, f$
   (D) $0, c, f$
   (E) $0, c$

2. When is $f(t)$ increasing?
   (A) $(-\infty, 0)$ and (b, d)
   (B) $(0, b)$ and $(d, +\infty)$
   (C) $(-\infty, c)$ and $(f, +\infty)$
   (D) (c, f)
   (E) (a, c) and (e, f)
   (F) $(-\infty, a)$, (c, e), and $(f, +\infty)$

3. When is $f(t)$ decreasing?
   (A) $(-\infty, 0)$ and (b, d)
   (B) $(0, b)$ and $(d, +\infty)$
   (C) $(-\infty, c)$ and $(f, +\infty)$
   (D) (c, f)
   (E) (a, c) and (e, f)
   (F) $(-\infty, a)$, (c, e), and $(f, +\infty)$

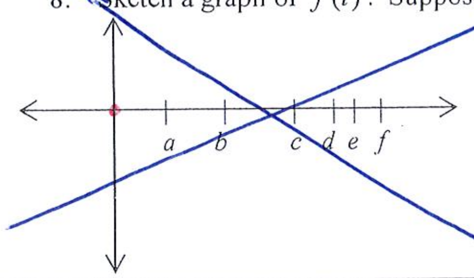
4. For each value of t below, classify $f(t)$ as a relative maximum, minimum, or neither.
   0 neither a neither b neither c minimum
   d neither e neither f maximum

5. What are the ~~possible~~ possible points of inflection of $f(t)$?
   (A) $0, a, c$
   (B) a, c
   (C) $0, b, d$ ← actual I.P.
   (D) b, d
   (E) 0
   (F) $0, b, d, f$ ← possible I.P.

6. When is $f(t)$ concaving up?
   (A) $(-\infty, 0)$ and (b, d)
   (B) $(0, b)$ and $(d, +\infty)$
   (C) $(-\infty, c)$ and $(f, +\infty)$
   (D) (c, f)
   (E) (a, c) and (e, f)
   (F) $(-\infty, a)$, (c, e), and $(f, +\infty)$

7. When is $f(t)$ concaving down?
   (A) $(-\infty, 0)$ and (b, d)
   (B) $(0, b)$ and $(d, +\infty)$
   (C) $(-\infty, c)$ and $(f, +\infty)$
   (D) (c, f)
   (E) (a, c) and (e, f)
   (F) $(-\infty, a)$, (c, e), and $(f, +\infty)$

8. Sketch a graph of $f(t)$. Suppose $f(0) = 0$.



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9. On what interval is $f(x) = x^3 + x$ concave up?
   (A) $(-\infty, +\infty)$
   (B) $(0, +\infty)$
   (C) $(-\infty, 0)$
   (D) $(0, 1)$
   (E) $(-1, 0)$

$f'(x) = 3x^2 + 1$

$f''(x) = 6x = 0$

$x = 0$

f'': $-\infty$ — $-$ — 0 — $+$ — ∞

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why is this absolute?

10. The absolute maximum of $f(x) = \dfrac{x}{x^2+1}$ is
   (A) 0
   (B) .25
   (C) .5 ← y-value
   (D) .75
   (E) 1 ← x-value

$f' = \dfrac{(x^2+1)(1) - (x)(2x)}{(x^2+1)^2} = 0$

numerator simplified → $x^2 + 1 - 2x^2 = 0$

$-x^2 = -1$

$x^2 = 1$

$x = -1, 1$

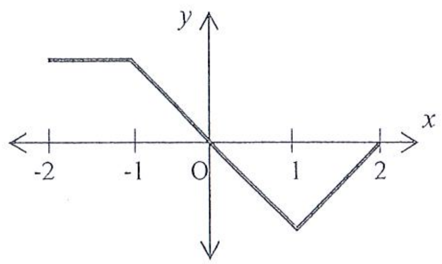
f': $-\infty$ — $-$ — -1 — $+$ — 1 — $-$ — ∞

11. On what interval(s) is the graph of $f(x) = \dfrac{x}{x^2+1}$ concave down?

(A) $(0, \sqrt{3})$
(B) $(-\sqrt{3}, 0)$
(C) $(-\sqrt{3}, 0) \cup (0, +\infty)$
(D) $(-\infty, -\sqrt{3}) \cup (0, \sqrt{3})$
(E) $(\sqrt{3}, +\infty)$

$f' = \dfrac{-x^2+1}{(x^2+1)^2}$

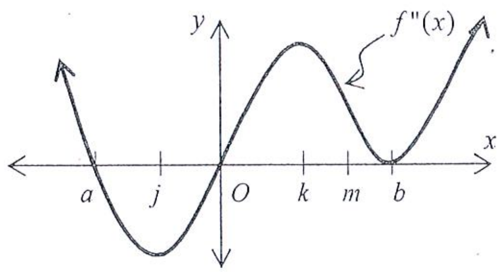
$f'' = \dfrac{(x^2+1)^2(-2x) - (-x^2+1)(2(x^2+1)\cdot 2x)}{(x^2+1)^4}$



Graph of f'

12. The graph of f', the derivative of the function f, is shown above. Which of the following statements is true about f?

(A) f is decreasing for $-1 \le x \le 1$
(B) f is increasing for $-2 \le x \le 0$
(C) f is increasing for $-1 \le x \le 2$
~~(D)~~ f has a local minimum at $x = 0$
(E) f is not differentiable at $x = -1$ and $x = 1$



$x = 0, a, b$

$f'' =$ $-\infty$ + a − 0 + b + ∞

13. The second derivative of the function f is given by $f''(x) = x(x-a)(x-b)^2$. The graph of f'' is shown above. For what values of x does the graph of f have a point of inflection?

(A) 0 and a only (B) 0 and m only (C) b and j only (D) 0, a, and b (E) b, j, and k

14. Over which interval(s) are the signs of both f' and f'' the same for $f(x) = 3x^4 - 4x^3 + 6$?

in context: this would be speeding up!

(A) $(0, \frac{2}{3})$
(B) $(-\infty, 0)$
(C) $(-\infty, 0) \cup (\frac{2}{3}, +\infty)$
(D) $(0, \frac{2}{3}) \cup (1, +\infty)$
(E) $(\frac{2}{3}, +\infty)$

$f' = 12x^3 - 12x^2 = 0$
$12x^2(x-1) = 0$
$x = 0, 1$

f': − 0 − 1 +

$f'' = 36x^2 - 24x = 0$
$12x(3x-2) = 0$
$x = 0, 2/3$

f'': + 0 − $2/3$ +