1

Solutions Practice Exam 2

(1) $f(x+h) = \dfrac{3}{2(x+h)-9}$ $\qquad f(x) = \dfrac{3}{2x-9}$

plug $\qquad$ plug

$$f'(x) \overset{\text{def}}{=} \lim_{h\to 0} \frac{f(x+h)-f(x)}{h} = \lim_{h\to 0} \frac{\frac{3}{2(x+h)-9} - \frac{3}{2x-9}}{h} =$$

$$= \lim_{h\to 0} \frac{3\left(\frac{1}{2x+2h-9} - \frac{1}{2x-9}\right)}{h} = 3 \lim_{h\to 0} \frac{\frac{(\cancel{2x}\cancel{-9}) - (\cancel{2x}+2h\cancel{-9})}{(2x+2h-9)(2x-9)}}{\frac{h}{1}} =$$

$$= 3 \lim_{h\to 0} \frac{-2\cancel{h}}{(2x+2h-9)(2x-9)} \cdot \frac{1}{\cancel{h}} = \frac{-6}{(2x+2\cdot 0-9)(2x-9)} = \boxed{-\frac{6}{(2x-9)^2}}$$

(2) $f(x+h) = 2(x+h)^2 - (x+h)$ $\qquad f(x) = 2x^2 - x$

plug $\qquad$ plug

$$f'(x) = \lim_{h\to 0} \frac{f(x+h)-f(x)}{h} = \lim_{h\to 0} \frac{[2(x+h)^2-(x+h)] - [2x^2 - x]}{h} =$$

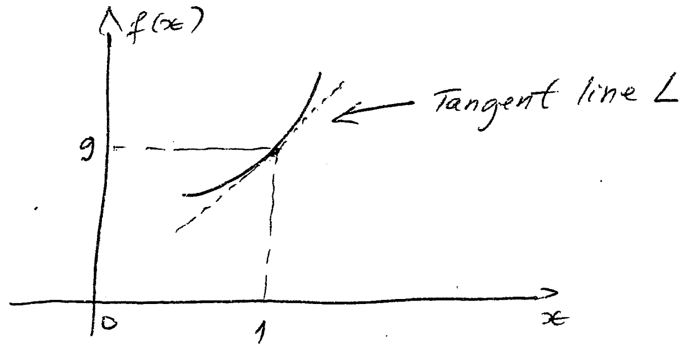
$$= \lim_{h\to 0} \frac{[\cancel{2x^2}+2h^2+4xh \cancel{-x} - h] - [\cancel{2x^2} \cancel{-x}]}{h} = \lim_{h\to 0} \frac{\cancel{h}(2h+4x-1)}{\cancel{h}} =$$

$$= 2\cdot 0 + 4x - 1 = \boxed{4x-1}$$

(3) The x-values where f is not differentiable are:

- $x = -3$ (vertical tangent)
- $x = 1$ (discontinuity)
- $x = 2$ (corner)

4



$f(x) = x^9 + 8x^2 \Rightarrow f(1) = \boxed{9}$

$f'(x) = 9x^8 + 16x \Rightarrow f'(1) = \boxed{25}$ (slope of L)

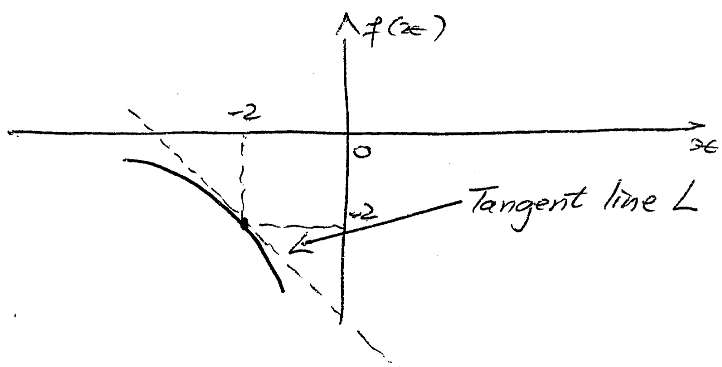
Equation of the line L of slope 25 and passing through $(1, 9)$:

$$\boxed{y - 9 = 25(x - 1)}$$

You can either leave it like this or bring it to its slope-intercept form:

$$\boxed{y = 25x - 16}$$

5 Same procedure:



$f(x) = \frac{4}{x} \Rightarrow f(-2) = \boxed{-2}$

$f'(x) = 4 \cdot \left(-\frac{1}{x^2}\right) = -\frac{4}{x^2} \Rightarrow f'(-2) = \boxed{-1}$ (slope of L)

3

Equation of the line L of slope -1 and passing through $(-2,-2)$:

$$\boxed{y+2=-1(x+2)}$$

Or, in slope-intercept form: $\boxed{y=-x-4}$

6

a) $f'(x)=6x^2+35x^6+11\cdot 13\, x^{12}=\boxed{6x^2+35x^6+143\, x^{12}}$

b) $g'(x)=\boxed{3\cdot\frac{1}{x}+\frac{2}{3}x}$

c) $f'(x)=\boxed{1+4x+9x^2}$

d) $h'(x)=\frac{3}{2}x^{3/2-1}+e^x=\frac{3}{2}x^{1/2}+e^x=\boxed{\frac{3}{2}\sqrt{x}+e^x}$

e) $f'(x)\underset{\substack{\uparrow\\ \text{product rule}}}{=}(x^2+1)'e^x+(x^2+1)(e^x)'=2x\cdot e^x+(x^2+1)\cdot e^x=$

$=e^x(x^2+2x+1)=\boxed{e^x(x+1)^2}$

f) $h'(x)\underset{\substack{\uparrow\\ \text{product rule}}}{=}(\sqrt{x})'\cdot\ln x+\sqrt{x}\cdot(\ln x)'=\frac{1}{2\sqrt{x}}\cdot\ln x+\sqrt{x}\cdot\frac{1}{x}=$

$=\frac{1}{2\sqrt{x}}\cdot\ln x+\frac{1}{\sqrt{x}}=\boxed{\frac{1}{\sqrt{x}}\left(\frac{\ln x}{2}+1\right)}$

g) $g'(x)\underset{\substack{\uparrow\\ \text{quotient rule}}}{=}\frac{x'\cdot(\ln x)-x\cdot(\ln x)'}{(\ln x)^2}=\frac{1\cdot\ln x-x\cdot\frac{1}{x}}{(\ln x)^2}=\boxed{\frac{\ln x-1}{(\ln x)^2}}$

h) $$h'(x) \underset{\substack{\uparrow\\ \text{sum rule}}}{=} (e^x \ln x)' + 5' = (e^x \cdot \ln x)' \underset{\substack{\uparrow\\ \text{product rule}}}{=} (e^x)' \cdot \ln x + e^x \cdot (\ln x)' =$$

$$= e^x \cdot \ln x + e^x \cdot \frac{1}{x} = \boxed{e^x \left(\ln x + \frac{1}{x} \right)}.$$

i) $$g'(x) \underset{\substack{\uparrow\\ \text{quotient rule}}}{=} \frac{(x^2)'(x^3+x^4)^2 + x^2\left[(x^3+x^4)^2\right]'}{(x^3+x^4)^4} =$$

$$= \frac{2x \cdot (x^3+x^4)^2 + x^2 \cdot \overbrace{2(x^3+x^4)\cdot(x^3+x^4)'}^{\text{due to chain rule}}}{(x^3+x^4)^4} =$$

$$= 2x\,\cancel{(x^3+x^4)} \cdot \frac{\left[(x^3+x^4) + x(3x^2+4x^3)\right]}{(x^3+x^4)^{\cancel{4}\,3}} =$$

$$= 2x \cdot \frac{5x^4+4x^3}{(x^3+x^4)^3} = \boxed{\frac{2x^4(5x+4)}{(x^3+x^4)^3}}.$$

j) $$h'(x) \underset{\substack{\uparrow\\ \text{product rule}}}{=} (x+2)'\ln x + (x+2)(\ln x)' = 1 \cdot \ln x + (x+2)\cdot\frac{1}{x} =$$

$$= \boxed{\ln x + \frac{x+2}{x}}.$$

k) $$f'(x) \underset{\substack{\uparrow\\ \text{Chain rule}}}{=} 2016 \cdot (x+1)^{2015} \cdot \underbrace{(x+1)'}_{\substack{\parallel\\ 1}} = \boxed{2016 \cdot (x+1)^{2015}}.$$

l) $h'(x) = 5(e^x + x)^4 \cdot (e^x + x)' = \boxed{5(e^x + x)^4 \cdot (e^x + 1)}$.

chain rule

m) $g'(x) = 11(5x + e^x)^{10} \cdot \underbrace{(5x + e^x)'}_{= 5 + e^x} = \boxed{11(5x + e^x)^{10} \cdot (5 + e^x)}$

chain rule

n) $f'(x) = 5(x^3 + 2x - 8)^4 \cdot (x^3 + 2x - 8)' = \boxed{5(x^3 + 2x - 8)^4 (3x^2 + 2)}$.

chain rule

o) $g'(x) = -\dfrac{1}{[(x^3 + 4x)^4]^2} \cdot [(x^3 + 4x)^4]' =$

chain rule

$$= -\frac{1}{(x^3 + 4x)^{\cancel{8}\,5}} \cdot \overbrace{4\cancel{(x^3 + 4x)^3} \cdot (x^3 + 4x)'}^{\text{again due to chain rule}} =$$

$$= -\frac{1}{(x^3 + 4x)^5} \cdot 4(3x^2 + 4) = \boxed{-\frac{4(3x^2 + 4)}{(x^3 + 4x)^5}}$$

p) $f'(x) = 23\left(x^2 + \dfrac{x^3}{3}\right)^{22} \cdot \left(x^2 + \dfrac{x^3}{3}\right)' = 23\left(x^2 + \dfrac{x^3}{3}\right)\left(2x + x^2\right) =$

chain rule

$$= 23x^3\left(1 + \frac{x}{3}\right)(2 + x) = \boxed{23x^3\left(\frac{x^2}{3} + \frac{5x}{3} + 2\right)}.$$

q) $g'(x) = 16(\ln x + 20)^{15} \cdot (\ln x + 20)' = \boxed{16(\ln x + 20)^{15} \cdot \frac{1}{x}}$

chain rule

r) $f'(x) = e^{7x^2-5} \cdot (7x^2-5)' = e^{7x^2-5} \cdot 14x = \boxed{14x\, e^{7x^2-5}}$

chain rule

s) $g'(x) = 3^{4x^3+3} \cdot (4x^3+3)' \cdot \ln 3 = 3^{4x^3+3} \cdot (12x^2) \cdot \ln 3 =$

chain rule

$= \boxed{12(\ln 3) \cdot x^2 \cdot 3^{4x^3+3}}$.

t) $h'(x) = 5^{x^2+10} \cdot (x^2+10)' \cdot \ln 5 = 5^{x^2+10} \cdot (2x) \cdot \ln 5 =$

chain rule

$= \boxed{2 \cdot (\ln 5) \cdot x \cdot 5^{x^2+10}}$.

u) $f'(x) = \frac{1}{3x^2+x} \cdot (3x^2+x)' = \boxed{\frac{6x+1}{3x^2+x}}$.

chain rule

(7)

v) $h'(x) = \frac{1}{2x^4 - x} \cdot (2x^4 - x)' \cdot \frac{1}{\ln 3} = \boxed{\frac{1}{\ln 3} \cdot \frac{8x^3 - 1}{2x^4 - x}}$

chain rule

w) $f'(x) = \frac{1}{x^{-1}} \cdot (x^{-1})' \cdot \frac{1}{\ln 10} = \frac{1}{\frac{1}{x}} \cdot (-1 \cdot x^{-2}) \cdot \frac{1}{\ln 10} =$

chain rule

$= x \cdot \left(-\frac{1}{x^2}\right) \cdot \frac{1}{\ln 10} = \boxed{-\frac{1}{(\ln 10) \cdot x}}$.

(7) Domain $f = (-\infty, 0) \cup (0, \infty)$.

a) With quotient rule, f is differentiable at every point of its domain, hence the only critical points can occur where $f'(x) = 0$.

$f'(x) = \frac{(x+5)' x^2 - (x+5) \cdot (x^2)'}{(x^2)^2} = \frac{1 \cdot x^2 - (x+5) \cdot 2x}{x^4} = \boxed{\frac{-x-10}{x^3}}$

quotient rule

$f'(x) = 0 \Leftrightarrow -x - 10 = 0 \Leftrightarrow \boxed{x = -10}$

the only critical value for f

b) We have:

x	$-\infty$		-10		0		$+\infty$
$-x-10$		$+$	0	$-$		$-$	
x^3		$-$		$-$	0	$+$	
$f'(x)$		$-$	0	$+$	$\vert$	$-$	
[illegible]		$\searrow$	$f(-10)$	$\nearrow$	$\vert$	$\searrow$	

(8)

f is increasing on the interval(s) on which $f' > 0$, hence (from the table) $\boxed{\text{on } (-10, 0)}$.

c) f is decreasing on the interval(s) on which $f' < 0$, hence (from the table) $\boxed{\text{on } (-\infty, -10) \cup (0, \infty)}$.

(8)

a) g' is well defined for every $x \in \mathbb{R}$, hence the only critical values for g can occur where $g'(x) = 0$.

$$g'(x) = 0 \iff x^2(x^2 - 1) = 0 \iff \boxed{x \in \{-1, 0, 1\}}$$

So these are the critical values for g.

b) We have:

x	$-\infty$		-1		0		1		$+\infty$
x^2		$+$		$+$	0	$+$		$+$	
x^2-1		$+$	0	$-$		$-$	0	$+$	
$g'(x) = x^2(x^2-1)$		$+$	0	$-$	0	$-$	0	$+$	
$g(x)$		$\nearrow$		$\searrow$		$\searrow$		$\nearrow$	

g is increasing on the interval(s) on which $g' > 0$, hence (from the table) $\boxed{\text{on } (-\infty, -1) \cup (1, \infty)}$.

c) g is decreasing on the interval(s) on which $g' < 0$, hence (from the table) $\boxed{\text{on } (-1, 0) \cup (0, 1)}$.

9) $f'(x) = 4x^3 + 6x^2 - 24x = 2(2x^3 + 3x^2 - 12x)$

$f''(x) = 2(6x^2 + 6x - 12) = 12(x^2 + x - 2) = 12(x+2)(x-1)$

a) We have:

x	$-\infty$		-2		1		$+\infty$
$f''(x) = 12(x+2)(x-1)$		$+$	0	$-$	0	$+$	
$f(x)$		$\cup$	$f(-2)$ inflection	$\cap$	$f(1)$ inflection	$\cup$	

f is concave up where $f'' > 0$, hence $\boxed{\text{on } (-\infty, -2) \cup (1, \infty)}$

f is concave down where $f'' < 0$, hence $\boxed{\text{on } (-2, 1).}$

b) Inflection points: $\boxed{\text{at } x = -2 \text{ and at } x = 1}$, because these are the values where $f''(x)$ becomes equal to 0 and changes sign.

10) $g''(x) = \dfrac{(x+2)(x+5)}{(x-4)^2}$

a) We have:

x	$-\infty$	-5		-2		4	$+\infty$
$(x+2)(x+5)$	$+$	0	$-$	0	$+$		$+$
$(x-4)^2$	$+$		$+$		$+$	0	$+$
$g''(x)$	$+$	0	$-$	0	$+$	|	$+$
$g(x)$	$\cup$	$g(-5)$ inflection	$\cap$	$g(-2)$ inflection	$\cup$	|	$\cup$

g is concave up where $g'' > 0$, hence $\boxed{\text{on } (-\infty, -5) \cup (-2, 4) \cup (4, \infty)}$.

g is concave down where $g'' < 0$, hence on $\boxed{(-5, -2)}$.

b) Inflection points : $\boxed{\text{at } x = -5 \text{ and at } x = -2}$, because these are the values of x where $g''(x)$ becomes equal to 0 and changes sign.

11

a) • $$\lim_{x \to +\infty} \frac{16x^2 + 3x^2 + 6}{5x^3 + 6x^2 + 2} = \lim_{x \to +\infty} \frac{\overbrace{19x^2 + 6}^{\text{degree 2}}}{\underbrace{5x^3 + 6x^2 + 2}_{\text{degree 3}}} = 0,$$ as the

degree of numerator is strictly less than the degree of denominator.

As $\lim_{x \to +\infty} f(x) = 0$ (which is finite), the graph f admits horizontal asymptote at $+\infty$ $\boxed{\text{the line } y = 0}$ (the x-axis).

• $\boxed{\text{Similarly at } -\infty.}$

b) • $$\lim_{x \to +\infty} \frac{\overbrace{x^3 + 3x^2}^{\text{degree 3}}}{\underbrace{6x^3 + x}_{\text{degree 3}}} = \frac{1}{6},$$ as the degrees are equal and the dominant coefficients are 1 for the numerator and respectively 6 for the denominator,

As $\lim f(x) = \frac{1}{6}$ (which is finite), the graph f admits horizontal asymptote at $+\infty$ $\boxed{\text{the line } y = \frac{1}{6}}$.

• $\boxed{\text{Similarly at } -\infty.}$

c) • $\lim_{x \to +\infty} \dfrac{21 + 4e^{4x}}{7 + 2e^{4x}} \underset{\substack{\text{change of variable} \\ e^{4x} = y}}{=\!=} \lim_{y \to \infty} \dfrac{\overbrace{21 + 4y}^{\text{degree 1}}}{\underbrace{7 + 2y}_{\text{degree 1}}} = \dfrac{4}{2} = 2.$

(as $x \to \infty$, we have also $y \to \infty$)

As $\lim_{x \to +\infty} f(x) = 2$ (finite number) $\Rightarrow$ $\boxed{\text{the line } y = 2}$ represents horizontal asymptote for graph f $\boxed{\text{at } +\infty.}$

• $\lim_{x \to -\infty} \dfrac{21 + 4e^{4x}}{7 + 2e^{4x}} \underset{\substack{\text{change of variable} \\ e^{4x} = y}}{=\!=} \lim_{y \to 0} \dfrac{21 + 4y}{7 + 2y} = \dfrac{21 + 4 \cdot 0}{7 + 2 \cdot 0} = 3.$

(as $x \to -\infty$, we have $e^{4x} \to 0$)

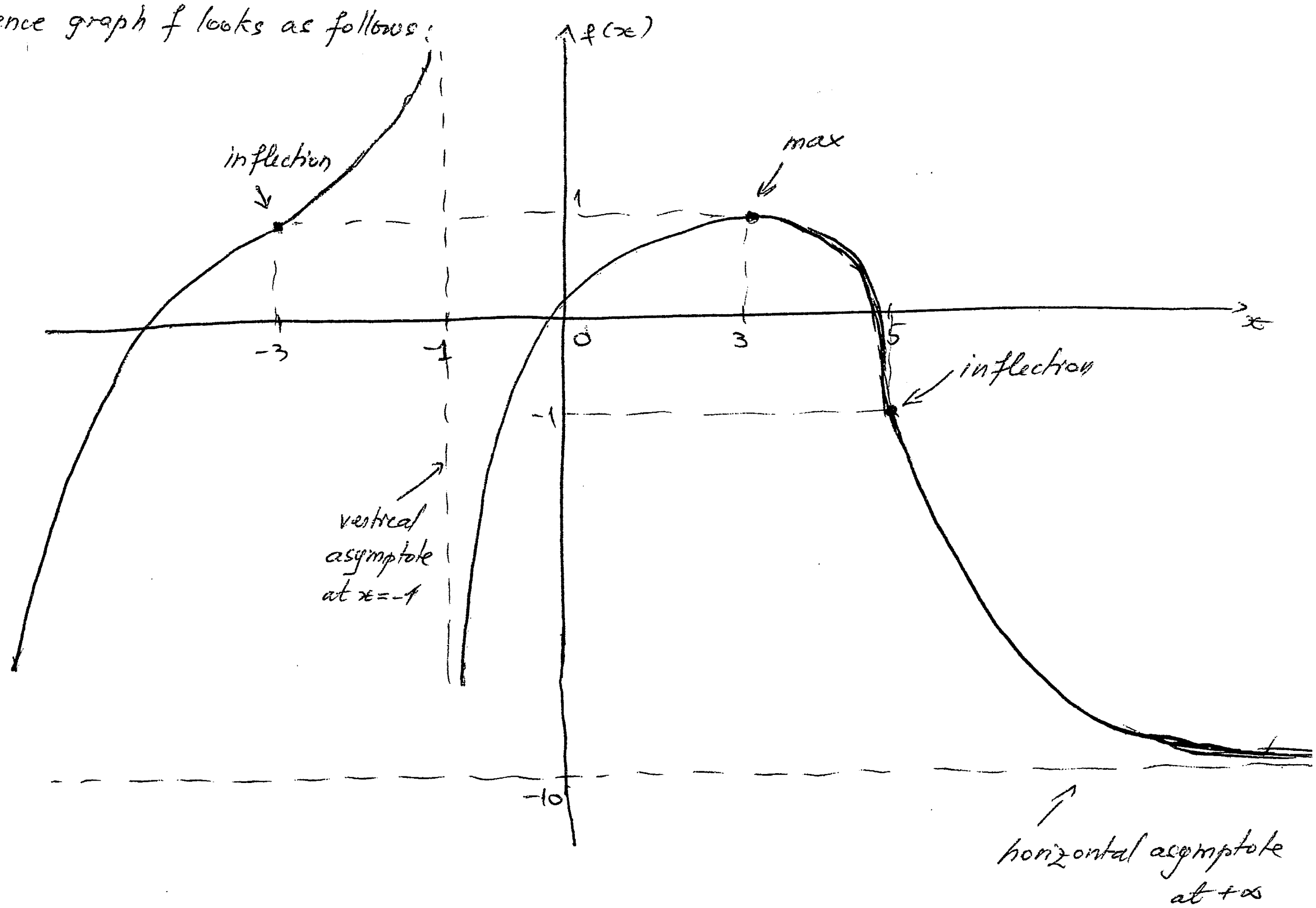
As $\lim_{x \to -\infty} f(x) = 3$ (finite number) $\Rightarrow$ $\boxed{\text{the line } y = 3}$ represents horizontal asymptote for graph f $\boxed{\text{at } -\infty}$.

(12) Let's concentrate the given info in the following table:

12

x	$-\infty$		-3		-1		3		5		$+\infty$
$f'(x)$		$+$		$+$	|	$+$	0	$-$		$-$	
$f''(x)$		$-$	0	$+$	|	$-$		$-$	0	$+$	
$f(x)$	$-\infty$	$\nearrow$ $\cap$	1 inflection	$\nearrow$ $\cup$	$+\infty$ | $-\infty$ undefined	$\nearrow$ $\cap$	1 max	$\searrow$ $\cap$	-1 inflection	$\searrow$ $\cup$	-10

Hence graph f looks as follows:

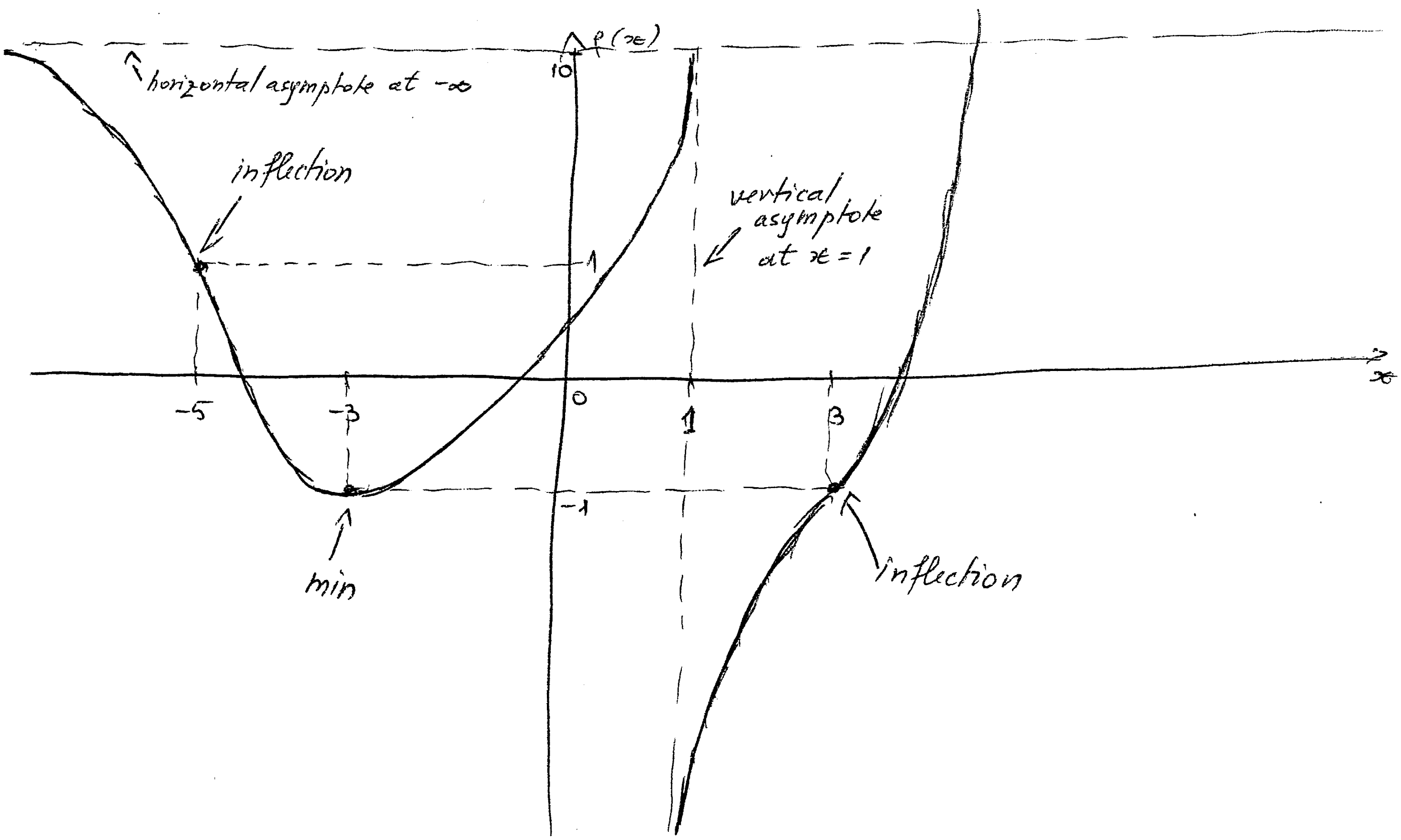


(13) Let's concentrate the given info in the following table:

13

x	$-\infty$		-5		-3		1		3		$+\infty$
$f'(x)$		$-$		$-$	0	$+$	$\vert$	$+$		$+$	
$f''(x)$		$-$	0	$+$		$+$	$\vert$	$-$	0	$+$	
$f(x)$	10	$\searrow$	1	$\searrow$	-1	$\nearrow$	$+\infty \mid -\infty$	$\nearrow$	-1	$\nearrow$	$+\infty$
		$\frown$	inflection	$\smile$	min	$\smile$	undefined	$\frown$	inflection	$\smile$	

Hence the graph f looks as follows :



14

a) $\boxed{\text{Domain } f = \mathbb{R}}$ (all reals)

b) x - intercept : $f(x) = 0 \iff x^2 \underbrace{(x^2 + 8x + 18)}_{\substack{\text{no real roots } (\Delta < 0); \\ \text{is } > 0 \text{ for all real } x}} = 0 \iff \boxed{x = 0}$.

y - intercept: $f(0) = \boxed{0}$

c) As Domain $f = \mathbb{R}$, we'll have no vertical asymptotes
As $\lim_{x \to \infty} f(x) = \lim_{x \to -\infty} f(x) = +\infty$ (not finite), we won't have horizontal asymptotes.

d) $f'(x) = 4x^3 + 24x^2 + 36x = 4x(x^2 + 6x + 9) = \boxed{4x(x+3)^2}$

$f'(x) = 0$ for $\boxed{x = -3 \text{ and } x = 0}$.

x	$-\infty$		-3		0		$+\infty$
$f'(x)$		$-$	0	$-$	0	$+$	
$f(x)$		$\searrow$	$f(-3)$	$\searrow$	$f(0)$ min	$\nearrow$	

f is increasing where $f' > 0$, hence on $(0, \infty)$.
f is decreasing where $f' < 0$, hence on $(-\infty, -3) \cup (-3, 0)$.
Local extrema are where $f'(x) = 0$ and changes sign, so at $\boxed{x = 0}$, which is a relative minimum.

e) $$f''(x) = 4\left[x \cdot (x+3)^2\right]' \underset{\text{product rule}}{=} 4\left[x' \cdot (x+3)^2 + x \cdot \left((x+3)^2\right)'\right] =$$

$$= 4\left[1 \cdot (x+3)^2 + x \cdot \underbrace{2(x+3)^1 \cdot (x+3)'}_{\text{due to chain rule}}\right] = 4\left[(x+3)^2 + 2x(x+3)\right] =$$

$$= 4(x+3)\left[(x+3) + 2x\right] = 4(x+3)(3x+3) = \boxed{12(x+3)(x+1)}$$

$f''(x) = 0$ for $\boxed{x = -3 \text{ and } x = -1}$.

x	$-\infty$		-3		-1		$+\infty$
$f''(x)$		+	0	−	0	+	
$f(x)$		∪	$f(-3)$ inflection	∩	$f(-1)$ inflection	∪	

f is $\boxed{\text{concave up}}$ where $f'' > 0$, so $\boxed{\text{on } (-\infty, -3) \cup (-1, +\infty).}$

f is $\boxed{\text{concave down}}$ where $f'' < 0$, so $\boxed{\text{on } (-3, -1).}$

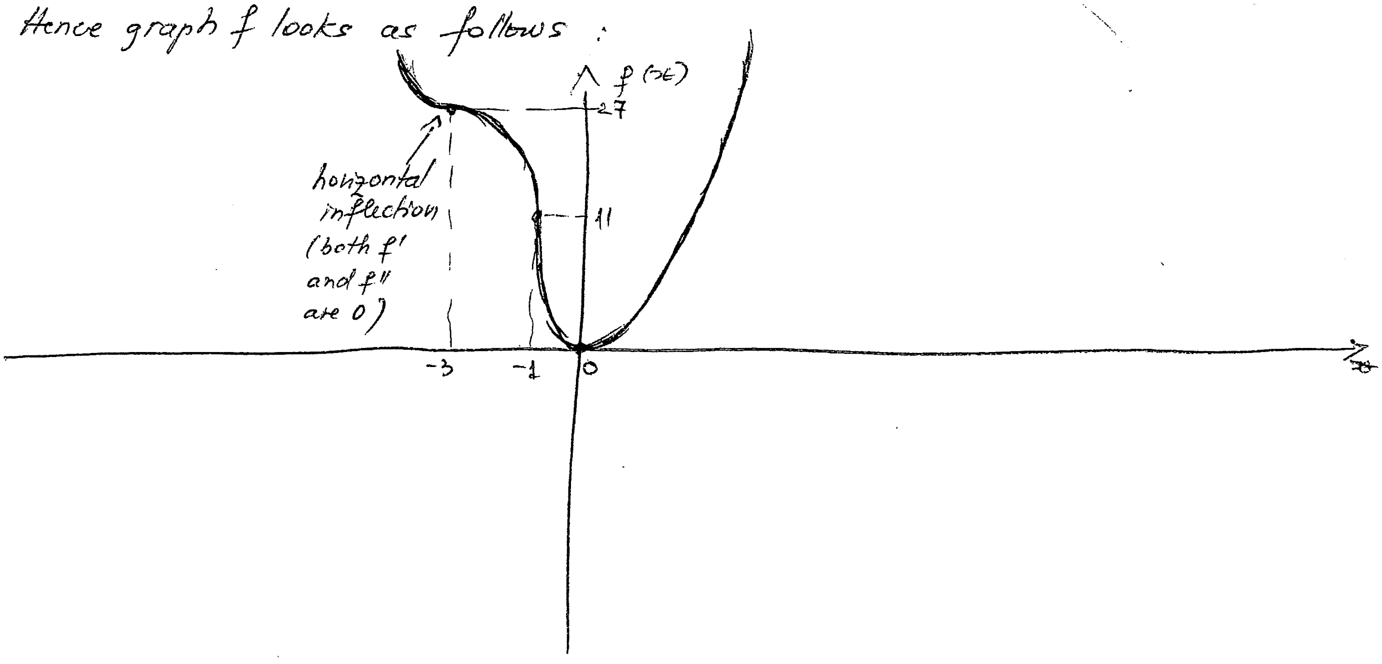
$\boxed{\text{Inflection points}}$ are where $f''(x) = 0$ and changes sign, so at

$\boxed{x = -3 \text{ and } x = -1}$.

f) Let's concentrate the above two tables in one single table:

x	$-\infty$		-3		-1		0		$+\infty$
$f'(x)$		−	0	−		−	0	+	
$f''(x)$		+	0	−	0	+		+	
$f(x)$	$+\infty$	↘ ∪	$f(-3)=27$ inflection	↘ ∩	$f(-1)=11$ inflection	↘ ∪	$f(0)=0$ min	↗ ∪	$+\infty$

Hence graph f looks as follows:



15

a) Existence condition : $x^2 - 4 \neq 0$.

Equivalently : $x \neq \pm 2$.

So $\boxed{\text{Domain } f = (-\infty, -2) \cup (-2, 2) \cup (2, \infty)}$.

b) x - intercept : $f(x) = 0 \iff \dfrac{x}{x^2-4} = 0 \iff \boxed{x = 0}$.

y - intercept : $f(0) = \boxed{0}$.

c) Horizontal asymptotes :

$$\lim_{x \to \pm\infty} f(x) = \lim_{x \to \pm\infty} \frac{x}{x^2-4} = 0 \implies \text{The } \boxed{\text{line } y = 0}$$

degree 1

degree 2

$\boxed{\text{is horizontal asymptote at } \pm \infty}$.

Vertical asymptotes :

$$\left.\begin{aligned} \lim_{x \to -2^-} f(x) &= \lim_{x \to -2^-} \frac{x}{x^2-4} = \frac{-2}{0^+} = -\infty \\ \lim_{x \to -2^+} f(x) &= \lim_{x \to -2^+} \frac{x}{x^2-4} = \frac{-2}{0^-} = +\infty \end{aligned}\right\} \implies \boxed{\text{the line } x = -2 \text{ is vertical asymptote}} \text{ for graph } f$$

$$\left.\begin{aligned} \lim_{x \to 2^-} f(x) &= \lim_{x \to 2^-} \frac{x}{x^2-4} = \frac{2}{0^-} = -\infty \\ \lim_{x \to 2^+} f(x) &= \lim_{x \to 2^+} \frac{x}{x^2-4} = \frac{2}{0^+} = +\infty \end{aligned}\right\} \implies \boxed{\text{the line } x = 2 \text{ is vertical asymptote}} \text{ for graph } f$$

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

quotient rule

$= \boxed{-\dfrac{x^2+4}{(x^2-4)^2}}$ ← always < 0 on its domain

f' never becomes 0 on its domain.

e) $\boxed{f''(x)} = (-1)\cdot \dfrac{(x^2+4)'(x^2-4)^2 - (x^2+4)\left[(x^2-4)^2\right]'}{(x^2-4)^4} =$

quotient rule

$= (-1)\cdot \dfrac{2x\,(x^2-4)^2 - (x^2+4)\cdot \overbrace{2\,(x^2-4)\cdot 2x}^{\text{due to chain rule}}}{(x^2-4)^4} \underset{\text{simplifications}}{\overset{\text{after}}{=}}$

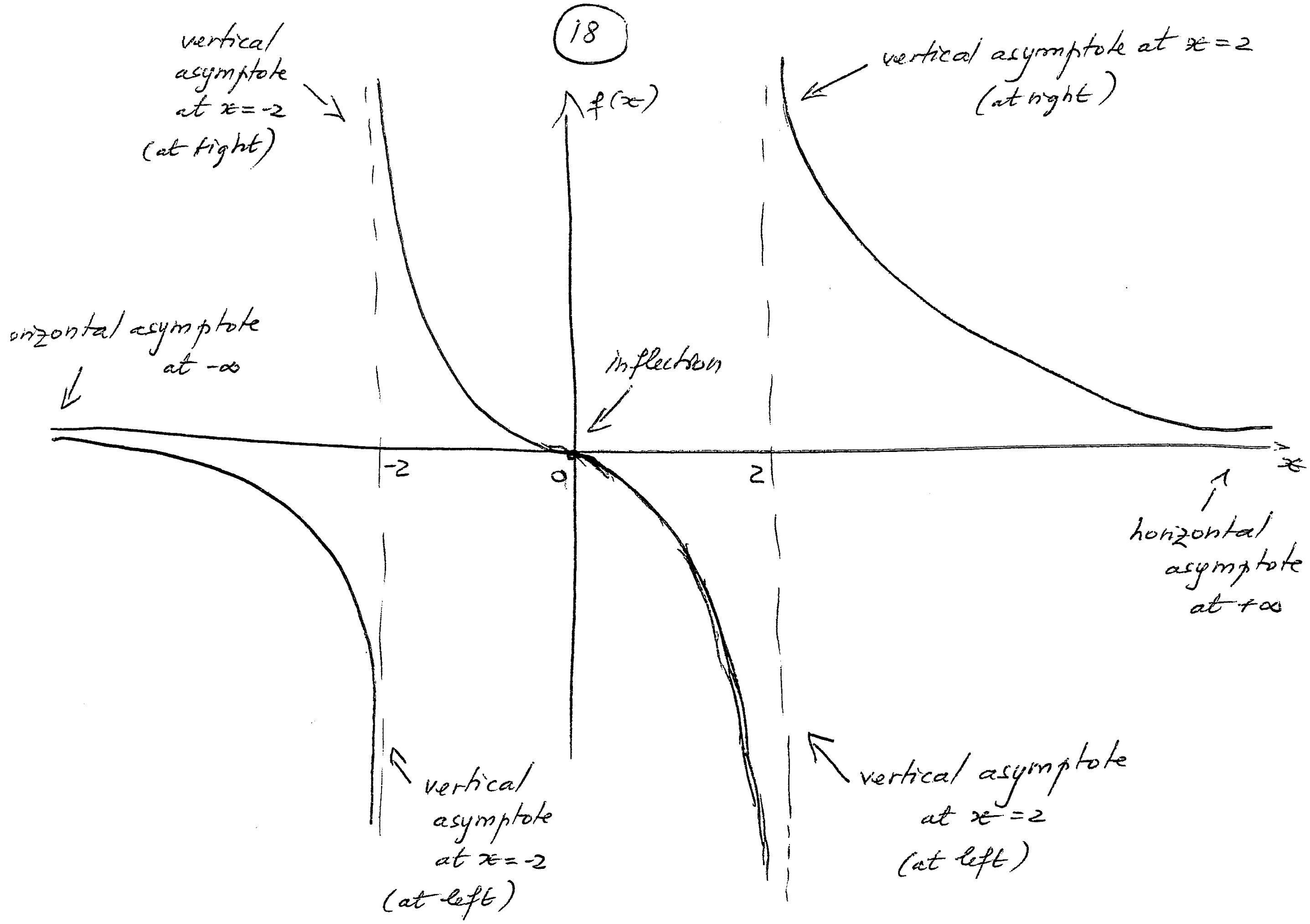
$= \boxed{2\,\dfrac{x\,(x^2+12)}{(x^2-4)^3}}$ ← Becomes 0 only for $x = 0$.

f) Let's concentrate in the following table the behavior of f', f'' and f:

x	$-\infty$		-2		0		2		$+\infty$
$f'(x)$		$-$	$\vert$	$-$		$-$	$\vert$	$-$	
$f''(x)$		$-$	$\vert$	$+$	0	$-$	$\vert$	$+$	
$f(x)$	0	↘ ⌒	$-\infty \vert +\infty$	↘ ∪	0 inflection	↘ ⌒	$-\infty \vert +\infty$	↘ ∪	0

Hence graph f looks like this :

18


vertical asymptote at $x=-2$ (at right)
vertical asymptote at $x=2$ (at right)
$f(x)$
orizontal asymptote at $-\infty$
inflection
-2
0
2
x
horizontal asymptote at $+\infty$
vertical asymptote at $x=-2$ (at left)
vertical asymptote at $x=2$ (at left)