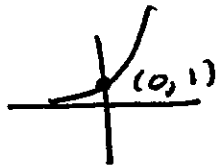
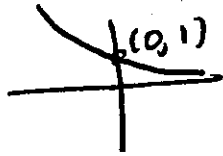


## §4.1 Practice Problems

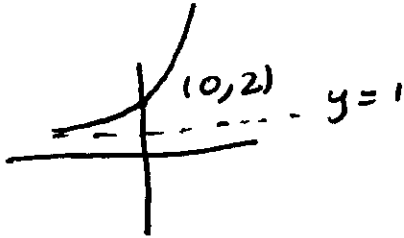
①  $y = e^x$



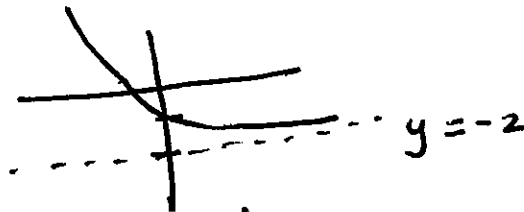
②  $y = e^{-x}$



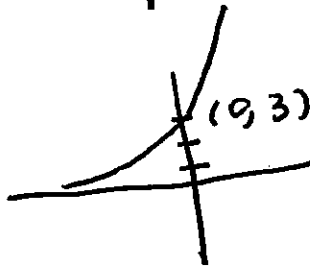
③  $y = e^x + 1$



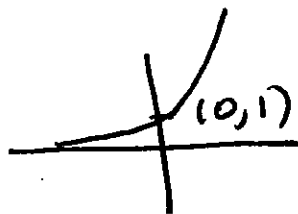
④  $y = e^{-x} - 2$



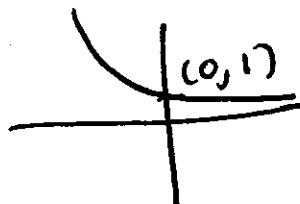
⑤  $y = 3e^x$



⑥  $y = e^{3x}$



⑦  $y = e^{-7x}$

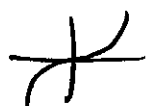


§ 3.5 For the given polynomial:

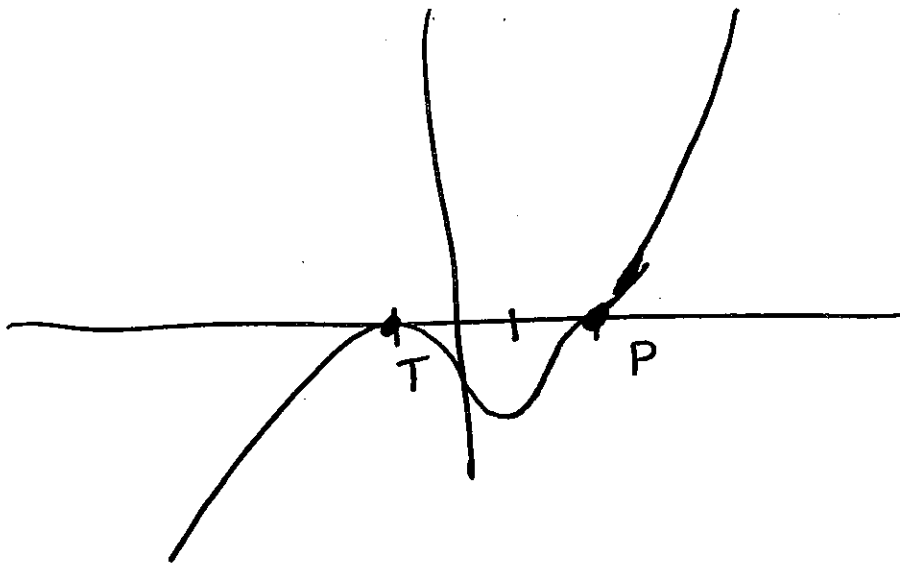
- State the zeros and their multiplicity.
- Give the lead term.
- Sketch the graph.

⑧  $y = (x-2)^3(x+1)^2$

SOLUTION: zeros:  $x=2$  m. 3 pass  
 $x=-1$  m. 2 touch

Lead term:  $y = x^3 x^2 = x^5$  


Graph:



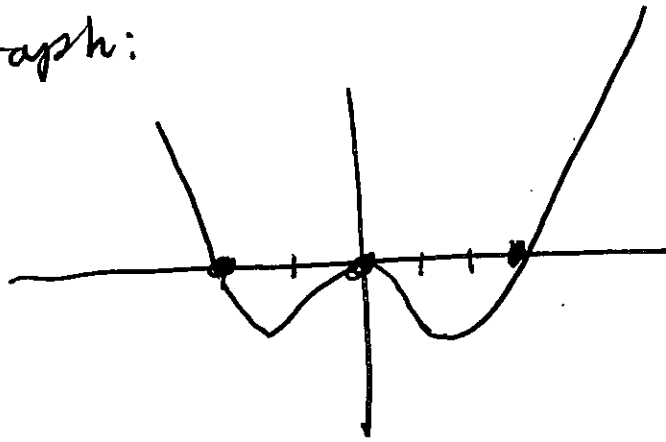
⑨  $y = x^2(x-3)(x+2)$

SOLUTION

zeros:  $x=0$  m. 2 touch  
 $x=3$  m. 1 pass  
 $x=-2$  m. 1 pass

lead term:  $y = x^2 \cdot x \cdot x = x^4$  

graph:



§ 3.5 For the given rational function:

- Find the x-intercepts
- Find the vertical asymptotes
- Find the horizontal or oblique asymptotes
- Make a sign chart.
- Sketch the graph.

⑩  $y = \frac{x+3}{2x-4}$

(a) zeros:  $x+3=0$ ,  $x=-3$ . x-int  $(-3, 0)$

(b) Vertical asymptote:  $2x-4=0$

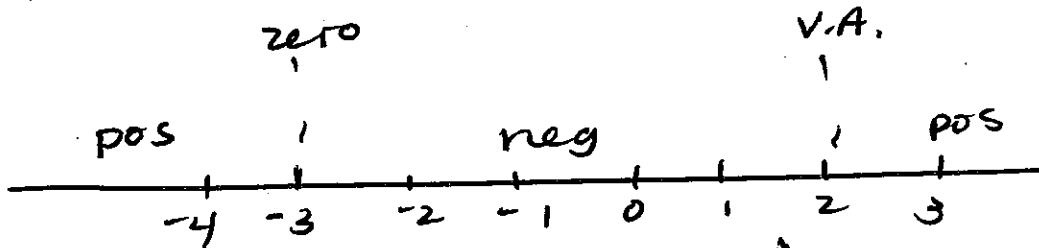
The line  $x=2$

(c) Horiz Asympt.   
 • deg num = deg denom

$$y = \frac{\text{lead coeff num}}{\text{lead coeff denom}} = \frac{1}{2}$$

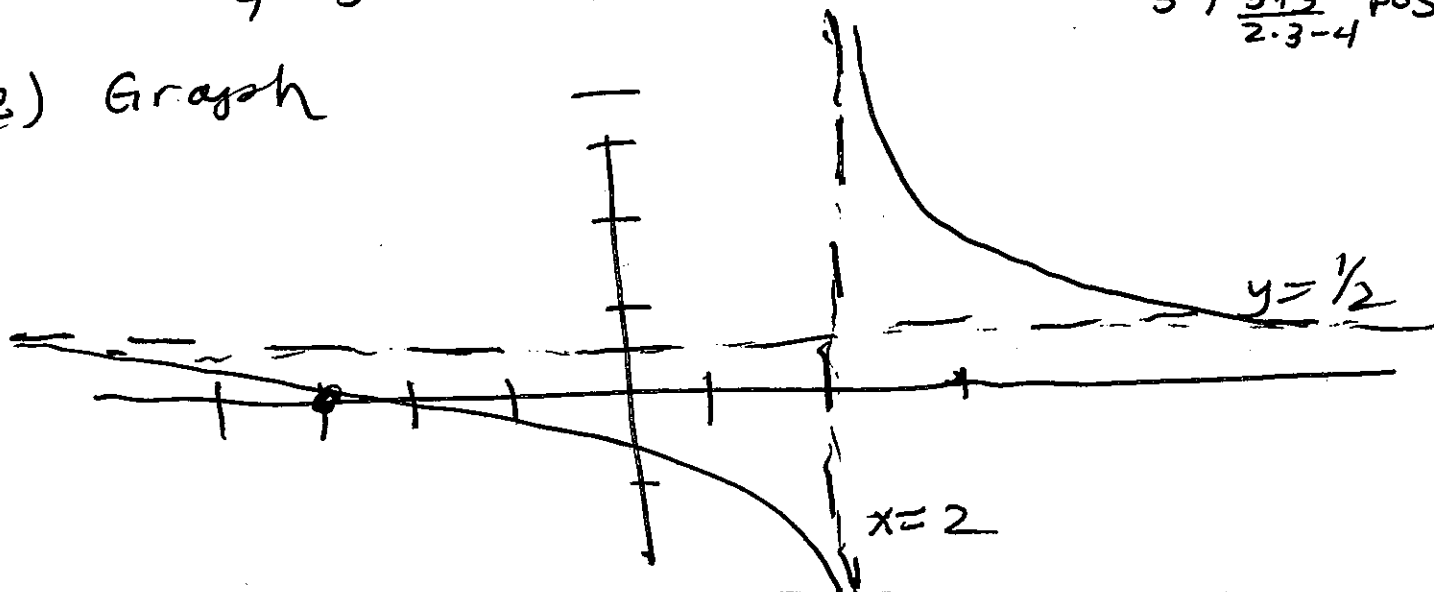
The line  $y = \frac{1}{2}$

(d) sign chart



x	$y = \frac{x+3}{2x-4}$
-4	$\frac{-4+3}{2(-4)-4} = \frac{-1}{-12} = \text{pos}$
0	$\frac{0+3}{2 \cdot 0 - 4} = \frac{3}{-4} = \text{neg}$
3	$\frac{3+3}{2 \cdot 3 - 4} = \frac{6}{2} = \text{pos}$

(e) Graph



①  $y = \frac{x^2 - 6x - 7}{x - 2}$

SOLUTION

a) zeros:  $x^2 - 6x - 7 = 0$   
 $(x-7)(x+1) = 0$   
 $x = 7, x = -1$   
 $(7, 0), (-1, 0)$

b) Vertical Asymptotes:  $x - 2 = 0$   
 $x = 2$   
 The line  $x = 2$

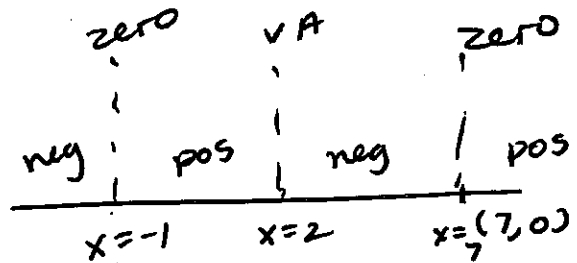
c) Oblique Asympt.

deg num = deg denom + 1  
 $x - 2 \overline{) x^2 - 6x - 7}$   
 $\underline{-x^2 + 2x}$   
 $-4x - 7$   
 $\underline{+4x + 8}$   
 $-15$

$\frac{15}{x-2} \rightarrow 0$  as  $x \rightarrow \infty$

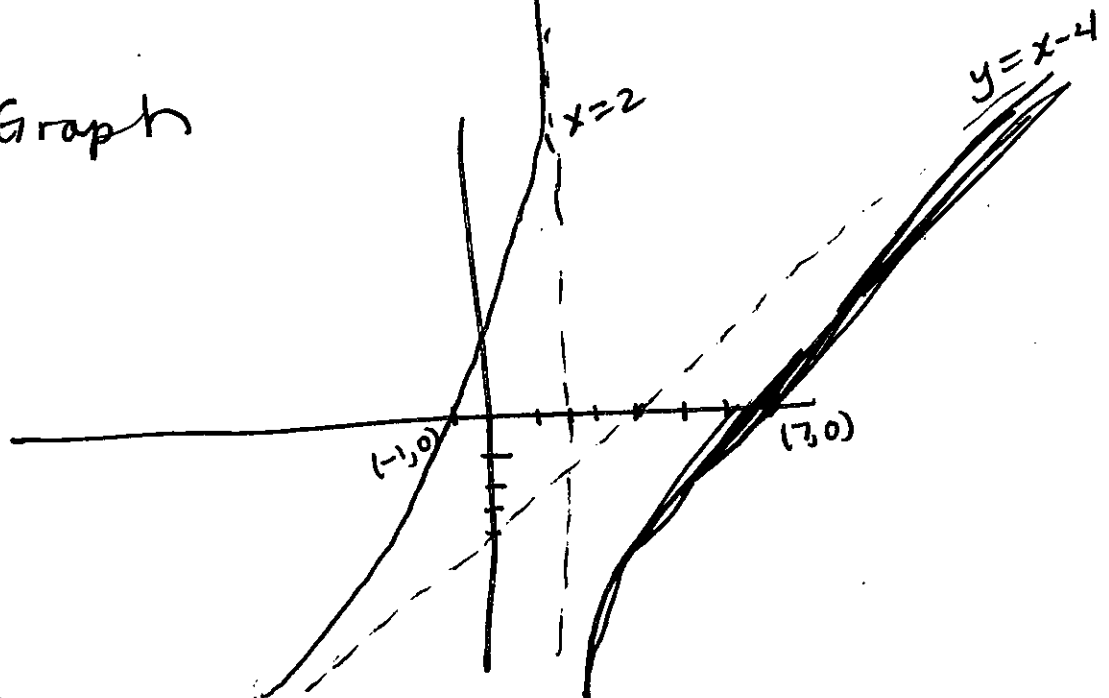
The line  $y = x - 4$

Sign Chart  
 $y = \frac{(x-7)(x+1)}{x-2}$



x	y
-2	$\frac{(-2-7)(-2+1)}{-2-2}$ neg
0	$7/2$ pos
3	-16 neg
8	$9/6$ pos

e) Graph



§ 4.2 Write as a logarithm.

(12)  $2^x = 3$

SOL  $\log_2 3 = x$

(13)  $10^{2x} = 7$

SOL  $\log_{10} 7 = 2x$

$\log 7 = 2x$

Write as an exponent.

(15)  $4 = \log 10000$

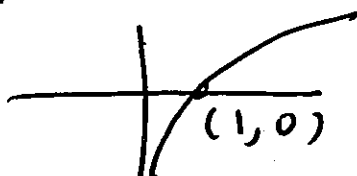
SOL  $10^4 = 10,000$

(16)  $-3 = \log_2 (1/8)$

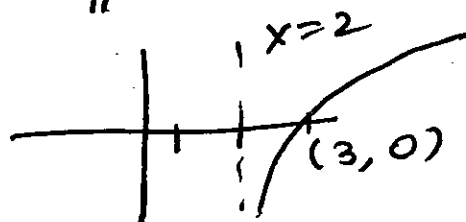
SOL  $2^{-3} = 1/8$

Sketch the graph

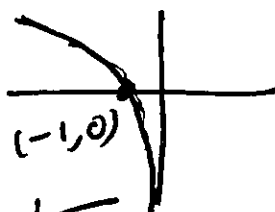
(17)  $y = \ln x$



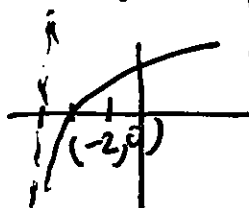
(18)  $y = \ln(x-2)$



(19)  $y = \ln(-x)$



(20)  $y = \ln(x+3)$



§ 4.3 Write as a single logarithm.

$$(21) \quad 3 \log 2 - 2 \log 3$$

$$= \log 2^3 - \log 3^2$$

$$= \log \left( \frac{2^3}{3^2} \right) = \log \left( \frac{8}{9} \right)$$

$$(22) \quad \frac{1}{2} \ln(x+1) - 2 \ln(x-2) - 3 \ln(x+5)$$

$$= \ln(x+1)^{1/2} - \ln(x-2)^2 - \ln(x+5)^3$$

$$= \ln \frac{(x+1)^{1/2}}{(x-2)^2 (x+5)^3}$$

Write in terms of  $\ln x$ ,  $\ln y$ , and  $\ln z$ .

$$(23) \quad \ln \left( \frac{x^2 y^3}{z^5} \right) \stackrel{\text{sol}}{=} \ln x^2 + \ln y^3 - \ln z^5$$
$$= 2 \ln x + 3 \ln y - 5 \ln z$$

$$(24) \quad y = \ln \left( \frac{\sqrt{x}}{y^5 z^7} \right) = \ln \sqrt{x} - \ln y^5 - \ln z^7$$
$$= \frac{1}{2} \ln x - 5 \ln y - 7 \ln z$$

## Simplify

$$\textcircled{25} \quad \ln e^7 = 7$$

$$\textcircled{26} \quad e^{\ln 8} = 8$$

$$\textcircled{27} \quad \ln 1 = 0$$

$$\textcircled{28} \quad \ln e = 1$$

#### § 4.4 Find all real solutions

$$(26) \log_{10}(3x+1) = 2$$

$$10^2 = 3x+1$$

$$100 = 3x+1$$

$$3x = 99$$

$$x = 33$$

$$(27) \log_2(x+2) + \log_2(x-2) = 5$$

$$\log_2(x+2)(x-2) = 5$$

$$2^5 = (x+2)(x-2)$$

$$32 = x^2 - 4$$

$$x^2 = 36$$

$$x = \pm 6$$

$$\text{Answer } \boxed{x=6}$$

$\log_2(-6+2)$   
is undef.

$$(28) \ln x - \ln(x+1) = \ln(x+3) - \ln(x+5)$$

$$\ln\left(\frac{x}{x+1}\right) = \ln\left(\frac{x+3}{x+5}\right)$$

$$\frac{x}{x+1} = \frac{x+3}{x+5}$$

$$x(x+5) = (x+1)(x+3)$$

$$\cancel{x^2} + 5x = \cancel{x^2} + 4x + 3$$

$$x = 3$$

(29)

$$2^{x-1} = 7$$

$$\ln 2^{x-1} = \ln 7$$

$$(x-1) \ln 2 = \ln 7$$

$$(x-1) = \frac{\ln 7}{\ln 2}$$

$$x = \frac{\ln 7}{\ln 2} + 1$$

(30)

$$9 = e^{-3x}$$

$$\ln 9 = \ln e^{-3x}$$

$$\ln 9 = -3x$$

$$x = \frac{-\ln 9}{3}$$

(31)

$$2^x = 3^{x-1}$$

$$\ln 2^x = \ln 3^{x-1}$$

$$x \ln 2 = (x-1) \ln 3$$

$$x \ln 2 = x \ln 3 - \ln 3$$

$$x \ln 2 - x \ln 3 = -\ln 3$$

$$x (\ln 2 - \ln 3) = -\ln 3$$

$$x = \frac{-\ln 3}{\ln 2 - \ln 3}$$

$$= \frac{\ln 3}{\ln 3 - \ln 2}$$

32) How long does it take  
2.4 g of carbon 14 to be  
reduced to 1.3 g of carbon-14  
by radioactive decay?

$$A_0 = 2.4 \text{ g}, \quad A = 1.3 \text{ g}$$

$$A = A_0 e^{-kt}, \quad k = \frac{\ln 2}{h}, \quad h = 5730 \text{ yrs}$$

$$1.3 = 2.4 e^{-\left(\frac{\ln 2}{5730}\right)t}$$

$$\ln\left(\frac{1.3}{2.4}\right) = -\left(\frac{\ln 2}{5730}\right)t$$

$$\frac{1.3}{2.4} = e^{-\left(\frac{\ln 2}{5730}\right)t}$$

$$\ln\left(\frac{1.3}{2.4}\right) = \ln e^{-\left(\frac{\ln 2}{5730}\right)t}$$

$$\ln\left(\frac{1.3}{2.4}\right) = -\frac{\ln 2}{5730} t$$

$$t = \frac{-5730 \ln\left(\frac{1.3}{2.4}\right)}{-\ln 2}$$

$$t \approx 5078 \text{ yrs.}$$