

#7 h

$$2^x = 8$$

$$x = 3$$

Ex. $8^x = 16^{x-3}$

$$(2^3)^x = (2^4)^{x-3}$$

$$2^{3x} = 2^{4x-12}$$

$$3x = 4x - 12$$

$$12 = x$$

Ex. $25^x = 625^{x-1}$

$$(5^2)^x = (5^4)^{x-1}$$

$$5^{2x} = 5^{4x-4}$$

$$\Rightarrow \begin{matrix} 2x & = & 4x-4 \\ -2x+4 & & -2x+4 \end{matrix}$$

$$4 = 2x$$

$$\boxed{2 = x}$$

EX, $16^{3x} = 32^x$

$$(2^4)^{3x} = (2^5)^x$$

$$2^{12x} = 2^{5x}$$

$$x = 0$$

$$\text{Ex. } 16^{3x} = 32$$

$$(2^4)^{3x} = 2^5$$

$$2^{12x} = 2^5$$

check

$$12x = 5$$

$$\begin{aligned} 16^{3 \cdot \frac{5}{12}} &= 16^{5/4} \\ &= 2^5 \\ &= 32 \end{aligned}$$

$$\boxed{x = \frac{5}{12}}$$

$$\textcircled{8} \quad \textcircled{a} \quad 2^x = 9$$

$$x \cdot \ln 2^x = \ln 9$$

$$\boxed{x = \frac{\ln 9}{\ln 2}} \approx 3.17$$

$$(b) \quad 3^x = 5$$

$$\frac{x \cdot \cancel{\ln 3}}{\cancel{\ln 3}} = \frac{\ln 5}{\ln 3}$$

$$x = \frac{\ln 5}{\ln 3}$$

~~$\frac{\ln 5}{\ln 3}$~~
 ~~$\ln 5 + \ln 3$~~

$$(c) \quad 2^{x+2} = 3^{x-1}$$

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

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

$$x \cdot \ln 2 + \underline{2 \ln 2} = \underline{x \cdot \ln 3} - \ln 3$$

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

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

$$\frac{x(\cancel{\ln 2} - \cancel{\ln 3})}{\cancel{\ln 2} - \cancel{\ln 3}} = \frac{-\ln 3 - 2\ln 2}{\ln 2 - \ln 3}$$

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

$$(d) \quad 3^{2x+1} = 5^{3x-4}$$

$$(2x+1)\ln 3 = (3x-4)\ln 5$$

$$2x \cdot \ln 3 + \ln 3 = 3x \cdot \ln 5 - 4\ln 5$$

$$2x\ln 3 - 3x\ln 5 = -4\ln 5 - \ln 3$$

$$x(2\ln 3 - 3\ln 5) = -4\ln 5 - \ln 3$$

$$x = \frac{-4\ln 5 - \ln 3}{2\ln 3 - 3\ln 5}$$

HW quiz 11-5-18

Find exact solutions.

① $5^x = 15$

② $3^{x+2} = 5^x$

Exponential Growth & Decay

population problems

Exponential Growth: $y = a \cdot b^x$

where $b = 1 + r$

↑
growth
rate

Ex. A town with 40000 people at time $t=0$ is growing at 5.2% each year.

(a) Predict the pop. in 6 years.

* (b) How long until the pop. reaches 46000?

1st step: Write an equation.

$$P(t) = a \cdot b^t$$

↑
initial value

$$P(t) = 40000 b^t$$

$$\underline{\underline{P(t) = 40000 (1.052)^t}}$$

$$\begin{aligned} b &= 1+r \\ &= 1 + 0.052 \\ &= 1.052 \end{aligned}$$

$$(a) P(6) = 40000(1.052)^6 \\ = 54219$$

$$(b) \frac{46000}{40000} = \frac{40000(1.052)^t}{40000}$$

$$\frac{23}{20} = 1.052^t \\ \ln\left(\frac{23}{20}\right) = \frac{t \cdot \ln 1.052}{\ln 1.052}$$

$$t = \frac{\ln \frac{23}{20}}{\ln 1.052} \approx 2.76 \text{ yrs.}$$

HW # 5-6