

- ① Exponential growth or decay?
- Ⓐ $y = 2\left(\frac{1}{4}\right)^x$ Ⓑ $y = 2(4)^x$
-

Solve:

② $3^{x-2} = 27$

③ $\log_9(3x+14) - \log_9 5 = \log_9 2x$

④ State the 3 Logarithm Rules

- ① Ⓐ decay Ⓑ growth

② $3^{x-2} = 3^3 \therefore x-2 = 3 \therefore \boxed{x=5}$

CK $3^{(5)-2} \stackrel{?}{=} 3^3 \checkmark$

③ $\log_9\left(\frac{3x+14}{5}\right) = \log_9(2x)$

$\frac{3x+14}{5} = 2x \therefore 3x+14 = 10x$

$14 = 7x$

CK $\log_9(3(2)+14) - \log_9 5 \stackrel{?}{=} \log_9 2(2) \quad \boxed{2=x}$

$\log_9\left(\frac{20}{5}\right) \stackrel{?}{=} \log_9(4) \checkmark$

④ $\boxed{\log_b m + \log_b N = \log_b mN}$ $\boxed{\log_b m - \log_b N = \log_b\left(\frac{m}{N}\right)}$ $\boxed{N \log_b m = \log_b m^N}$

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$$\textcircled{7} \log_3 42 - \log_3 N = \log_3 7$$

$$\log_3 \left(\frac{42}{N} \right) = \log_3 (7)$$

$$\therefore \frac{42}{N} = 7 \quad \therefore 7N = 42$$

$$\boxed{N = 6}$$

$$\underline{\text{CK}} \log_3 42 - \log_3 (6) \stackrel{?}{=} \log_3 7$$

$$\log_3 \left(\frac{42}{6} \right) \stackrel{?}{=} \log_3 7 \quad \checkmark$$

$$\textcircled{8} \log_2 3x + \log_2 5 = \log_2 30$$

$$\log_2 (15x) = \log_2 (30)$$

$$\therefore 15x = 30 \quad \therefore \boxed{x = 2}$$

$$\underline{\text{CK}} \log_2 3(2) + \log_2 5 \stackrel{?}{=} \log_2 30$$

$$\log_2 (6 \cdot 5) \stackrel{?}{=} \log_2 30 \quad \checkmark$$

$$(9) \quad 2 \log_3 X = \log_5 9$$

$$\log_5 X^2 = \log_5 9$$

$$\therefore X^2 = 9 \quad \therefore X = \pm 3$$

$$\begin{matrix} \text{CK} \\ X=3 \end{matrix} 2 \log_5 3 \stackrel{?}{=} \log_5 9$$

$$\log_5 3^2 = \log_5 9 \checkmark$$

$$\left. \begin{matrix} \text{CK} \\ X=-3 \end{matrix} \right\} 2 \log_5 (-3) = \log_5 9$$

UNDEFINED
↓
(No)

$$\therefore \boxed{X = +3}$$

$$(10) \quad \log_{10} a + \log_{10} (a+21) = 2$$

$$\log_{10} (a^2 + 21a) = 2$$

$$10^2 = a^2 + 21a$$

$$a^2 + 21a - 100 = 0$$

$$\left. \begin{array}{l} \text{sum} \Rightarrow 21 \\ \text{prod} \Rightarrow -100 \\ \quad \quad \quad \uparrow \\ \quad \quad \quad -4 + 25 \end{array} \right\} (a-4)(a+25) = 0$$

$$a = 4, -25$$

$$\begin{matrix} \text{CK} \\ a=4 \end{matrix} \log_{10} 4 + \log_{10} [(4)+21] \stackrel{?}{=} 2$$

$$\log_{10} (4 \cdot 25) \stackrel{?}{=} 2 \checkmark$$

$$\begin{matrix} \text{CK} \\ a=-25 \end{matrix} \log_{10} 25 + \log_{10} [-25+21] \stackrel{?}{=} 2$$

$$\log_{10} [25 - 4] \stackrel{?}{=} 2$$

No
UNDEFINED

$$\therefore \boxed{a=4}$$

EXPANDING LOGARITHMS

$$\begin{aligned} \textcircled{1} \log_6 (XY^2)^6 &= 6 \log_6 (XY^2) \\ &= 6 [\log_6 X + \log_6 Y^2] \\ &= 6 [\log_6 X + 2 \log_6 Y] \\ &= \boxed{6 \log_6 X + 12 \log_6 Y} \end{aligned}$$

$\textcircled{\text{or}} = \log_6 (X^6 Y^{12})$
 $= \log_6 X^6 + \log_6 Y^{12}$
 $= \boxed{6 \log_6 X + 12 \log_6 Y}$
✓

$$\begin{aligned} \textcircled{2} \log_5 (10^2 \cdot 7^3) &= \log_5 10^2 + \log_5 7^3 \\ &= \boxed{2 \log_5 10 + 3 \log_5 7} \end{aligned}$$

$$\begin{aligned} \textcircled{3} \log_5 \sqrt{a \cdot b \cdot c} &= \log_5 (a \cdot b \cdot c)^{\frac{1}{2}} \\ &= \log_5 a^{\frac{1}{2}} b^{\frac{1}{2}} c^{\frac{1}{2}} \\ &= \boxed{\frac{1}{2} \log_5 a + \frac{1}{2} \log_5 b + \frac{1}{2} \log_5 c} \end{aligned}$$

$$\textcircled{\text{or}} \left(\frac{\log_5 a}{2} + \frac{\log_5 b}{2} + \frac{\log_5 c}{2} \right)$$

$$\begin{aligned}
 \textcircled{4} \quad \log_4 \left(\frac{X^4}{Y} \right)^4 &= \log_4 \left(\frac{X^{16}}{Y^4} \right) \\
 &= \log_4 X^{16} - \log_4 Y^4 \\
 &= \boxed{16 \log_4 X - 4 \log_4 Y}
 \end{aligned}$$

Condensing Logarithms

$$\textcircled{5} \quad 6 \log_2 12 - 2 \log_2 7$$

$$\log_2 12^6 - \log_2 7^2 = \boxed{\log_2 \left(\frac{12^6}{7^2} \right)}$$

$$\textcircled{6} \quad \frac{\log_9 10}{3} + \frac{\log_9 3}{3} + \frac{\log_9 11}{3}$$

$$\frac{1}{3} \log_9 10 + \frac{1}{3} \log_9 3 + \frac{1}{3} \log_9 11$$

$$\log_9 10^{\frac{1}{3}} + \log_9 3^{\frac{1}{3}} + \log_9 11^{\frac{1}{3}}$$

$$\log_9 \left[10^{\frac{1}{3}} \cdot 3^{\frac{1}{3}} \cdot 11^{\frac{1}{3}} \right]$$

$$\boxed{\log_9 [330]^{\frac{1}{3}}}$$

$$\text{or } \boxed{\log_9 \sqrt[3]{330}}$$

Classwork / Homework \Rightarrow Practice Worksheet (12 problems)

Practice - Logarithms

Expand each logarithm.

1) $\log_2 (8^3 \cdot 7)^4$

2) $\log_9 (8 \cdot 5 \cdot 7^5)$

3) $\log_8 (u^2 \cdot v)^4$

4) $\log_8 \sqrt[3]{a \cdot b \cdot c}$

Condense each expression to a single logarithm.

5) $6 \log_7 2 - 36 \log_7 5$

6) $10 \log_6 u + 2 \log_6 v$

7) $6 \log_6 3 + \frac{\log_6 7}{3}$

8) $5 \log_5 x - 10 \log_5 y$

Solve each equation.

9) $\log_8 (x^2 - 9) - \log_8 2 = 1$

10) $\log_2 x - \log_2 (x - 4) = 3$

11) $\log_4 x - \log_4 (x - 1) = 3$

12) $\log_5 5x^2 - \log_5 9 = 3$