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## Proofs of Logarithm rules

### Multiplication Rule

$$\log_a xy = \log_a x + \log_a y$$

*Proof:* let  $\log_a x = p \Rightarrow a^p = x$  ①

and let  $\log_a y = q \Rightarrow a^q = y$  ②

$$\therefore xy = a^p a^q = a^{p+q}$$

$$\therefore \log_a xy = p + q$$

$$\therefore \log_a xy = \log_a x + \log_a y$$

### Division Rule

$$\log_a \frac{x}{y} = \log_a x - \log_a y$$

*Proof:*

$$\frac{x}{y} = \frac{a^p}{a^q} = a^{p-q}$$

$$\therefore \log_a \frac{x}{y} = p - q$$

$$\therefore \log_a \frac{x}{y} = \log_a x - \log_a y$$

### Power Rule

$$\log_a x^n = n \log_a x$$

*Proof:*  $\log_a x^n = \log_a x_1 x_2 x_3 \dots x_n$   
 $= \log_a x_1 + \log_a x_2 + \dots + \log_a x_n$   
 $= n \log_a x$

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