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$$log_{b}(\mathbf{x}^{p}) = log_{b}\left(b^{log_{b}(\mathbf{x}) \cdot p}\right)$$

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Proof:

$$\mathsf{x}^{p} = \left(\mathsf{b}^{\mathsf{log}_{b}(\mathsf{x})}\right)^{p} = \mathsf{b}^{\mathsf{log}_{b}(\mathsf{x}) \cdot p}$$

$$log_{b}(\mathbf{x}^{p}) = log_{b}(b^{log_{b}(\mathbf{x}) \cdot p}) = log_{b}(\mathbf{x}) \cdot p$$

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Proof:

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$$\log_{b}(\mathbf{x}^{p}) = \log_{b}\left(\frac{b^{\log_{b}(\mathbf{x}) \cdot p}}{p}\right) = \log_{b}(\mathbf{x}) \cdot p = p \cdot \log_{b}(\mathbf{x})$$

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$$x = b^{\log_b(x)}$$

Proof:

$$\mathsf{x}^{p} = \left(\mathsf{b}^{\log_{b}(\mathsf{x})}\right)^{p} = \mathsf{b}^{\log_{b}(\mathsf{x}) \cdot p}$$

Taking the logarithm of both sides, we get:

$$\log_{b}(\mathbf{x}^{p}) = \log_{b}\left(\frac{b^{\log_{b}(\mathbf{x}) \cdot p}}{b}\right) = \log_{b}(\mathbf{x}) \cdot p = p \cdot \log_{b}(\mathbf{x})$$

This leaves us with our result:

$$\log_{b}(x^{p}) = p \cdot \log_{b}(x)$$