**Rules for Exponents and Logarithms**

**Properties of Exponents**

1. **Exponentiation by Zero:**

 $x^{0}=1 $ $-x^{0}= -1$

1. **Negative Exponents:**

$x^{-a}= \frac{1}{x^{a}}$ $x^{a}=\frac{1}{x^{-a}}$ $\frac{x^{-a}}{y^{-b}}= \frac{y^{b}}{x^{a}}$ $\left(\frac{x}{y}\right)^{-a}=\left(\frac{y}{x}\right)^{a}$

1. **Product Rule:**

$$x^{a}∙x^{b}=x^{a+b}$$

1. **Quotient Rule:**

$$\frac{x^{a}}{x^{b}}=x^{a-b}= \frac{1}{x^{b-a}}$$

1. **Power Rules:**

$\left(x^{a}\right)^{b}=x^{a∙b}$$\left(xy\right)^{a}=x^{a}∙y^{a}$ $\left(\frac{x}{y}\right)^{a}= \frac{x^{a}}{y^{a}}$

$$\sqrt[a]{x^{b}}=x^{\frac{b}{a}}= \sqrt[a]{x}^{b}$$

NB: If *n* is odd, then $-x^{n} \ne \left(-x\right)^{n}$

**Properties** **of Logarithms**

1. **Definition:**

$n= log\_{b}(m$)is, by definition, equivalent to $b^{n}=m$

 Note: $ln⁡(x)= log\_{e}(x)$ and $log⁡(x)= log\_{10}(x)$

1. **Zero Property:**

$$log\_{b}\left(1\right)=0$$

1. **Identity Property:**

$$log\_{b}\left(b\right)=1$$

1. **Inverse Rules:**

$log\_{b}\left(b^{m}\right)=m$ $b^{log\_{b}\left(m\right)}=m$

1. **Product Rule:**

$$log\_{b}\left(m∙n\right)=log\_{b}\left(m\right)+ log\_{b}\left(n\right)$$

1. **Quotient Rule:**

$$log\_{b}\left(\frac{m}{n}\right)= log\_{b}\left(m\right)- log\_{b}\left(n\right)$$

1. **Exponent Rule:**

$$log\_{b}\left(m^{a}\right)=a∙log\_{b}\left(m\right)$$

1. **Change of Base:**

$$log\_{b}\left(m\right)=\frac{log\_{a}(m)}{log\_{a}(b)}$$