AGS 3 Name: ______________________________ Period: _____ Date: ___________

## Notes 2.1 – Intro to Logs

Warmup – Find the value of each exponential expression, write answers as whole numbers or fractions.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | $2^4$ | 2. | $5^{-1}$ | 3. | $4^3$ | 4. | $4^{-2}$ | 5. | $\frac{1}{2}^{-2}$ |
| | 16 | | $\frac{1}{5}$ | | 64 | | $\frac{1}{16}$ | | 4 |
| 6. | $10^4$ | 7. | $10^{-3}$ | 8. | $3^5$ | 9. | $\frac{1}{4}^2$ | 10. | $(-3)^3$ |
| | 10,000 | | $\frac{1}{1000}$ | | 243 | | $\frac{1}{16}$ | | -27 |

## Investigation

Our number system uses 10 digits, so a common base for logarithms is base 10.

$10^1 = 10$ so, $\log_{10} 10 = 1$ or $\log 10 = 1$

$10^2 = 100$ so, $\log_{10} 100 = 2$

$10^3 = 1000$ so, $\log_{10} 1000 = 3$

So, taking the log of a given value returns what exponent gave that value. We can rewrite between exponential and logarithmic forms.

$$b^x = y \quad \Leftrightarrow \quad \log_b y = x$$

Rewrite #1-3 from the warmup in logarithmic form.

1. $\log_2 16 = 4$
2. $\log_5 \frac{1}{5} = -1$
3. $\log_4 64 = 3$

Rewrite these logarithms in exponential form.

4. $\log_7 49 = 2$

   $7^2 = 49$

5. $\log_{10}\left(\frac{1}{10}\right) = -1$

   $10^{-1} = \frac{1}{10}$

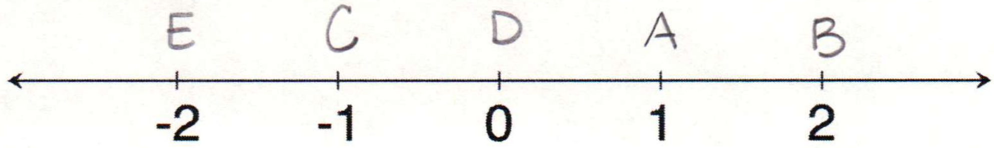
6. $\log_2 32 = 5$

   $2^5 = 32$

Use rewriting to help you find where on the number line the value of each logarithm would be. If the value is a decimal, you only need to put it between the two correct whole numbers, ex. 1.5 is between 1 and 2.

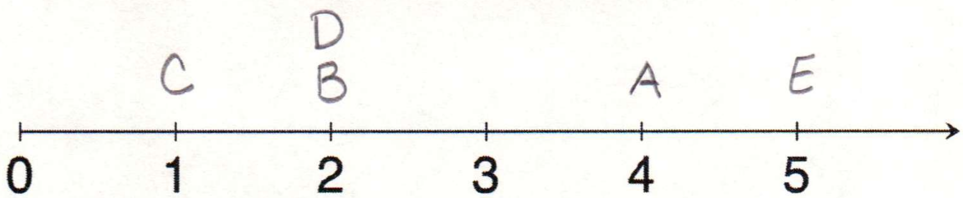
$3^x = 3$ $\quad$ $3^x = 9$ $\quad$ $3^x = \frac{1}{3}$ $\quad$ $3^x = 1$ $\quad$ $3^x = \frac{1}{9}$

A. $\log_3 3$ $\quad$ B. $\log_3 9$ $\quad$ C. $\log_3 \frac{1}{3}$ $\quad$ D. $\log_3 1$ $\quad$ E. $\log_3 \frac{1}{9}$



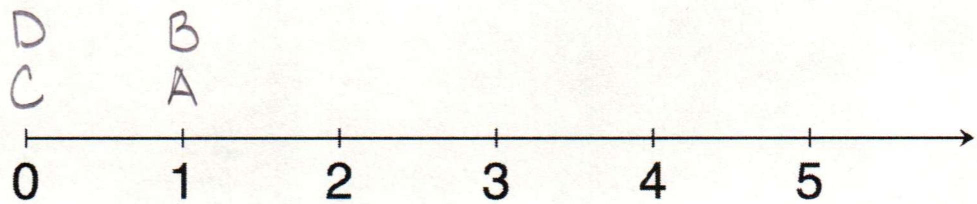

$3^x = 81$ $\quad$ $10^x = 100$ $\quad$ $8^x = 8$ $\quad$ $5^x = 25$ $\quad$ $2^x = 32$

A. $\log_3 81$ $\quad$ B. $\log_{10} 100$ $\quad$ C. $\log_8 8$ $\quad$ D. $\log_5 25$ $\quad$ E. $\log_2 32$



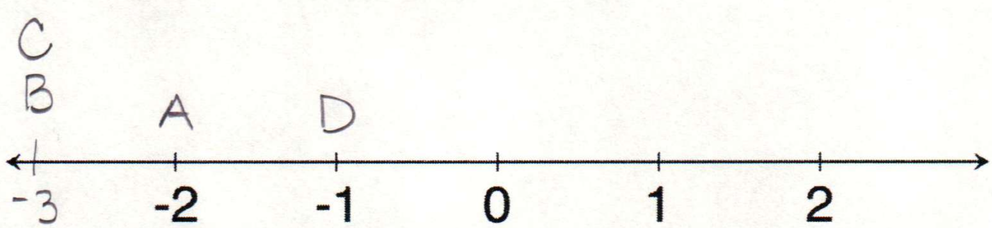

$7^x = 7$ $\quad$ $9^x = 9$ $\quad$ $11^x = 1$ $\quad$ $10^x = 1$

A. $\log_7 7$ $\quad$ B. $\log_9 9$ $\quad$ C. $\log_{11} 1$ $\quad$ D. $\log_{10} 1$



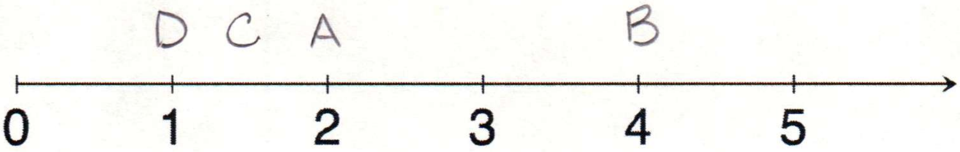

$2^x = \frac{1}{4}$ $\quad$ $10^x = \frac{1}{1000}$ $\quad$ $5^x = \frac{1}{125}$ $\quad$ $6^x = \frac{1}{6}$

A. $\log_2 \left(\frac{1}{4}\right)$ $\quad$ B. $\log_{10} \left(\frac{1}{1000}\right)$ $\quad$ C. $\log_5 \left(\frac{1}{125}\right)$ $\quad$ D. $\log_6 \left(\frac{1}{6}\right)$



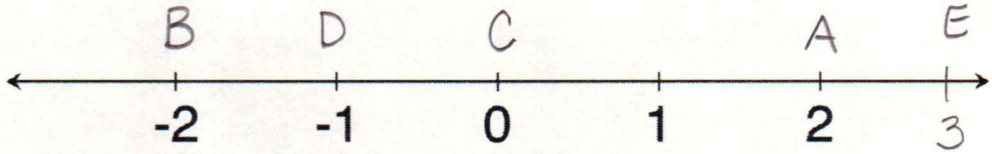
$4^x=16$ $\quad$ $2^x=16$ $\quad$ $8^x=16$ $\quad$ $16^x=16$

A. $\log_4 16$ $\quad$ B. $\log_2 16$ $\quad$ C. $\log_8 16$ $\quad$ D. $\log_{16} 16$




$3^x=9$ $\quad$ $5^x=\frac{1}{25}$ $\quad$ $6^x=1$ $\quad$ $4^x=\frac{1}{4}$ $\quad$ $2^x=8$

A. $\log_3 3^2$ $\quad$ B. $\log_5 5^{-2}$ $\quad$ C. $\log_6 6^0$ $\quad$ D. $\log_4 4^{-1}$ $\quad$ E. $\log_2 2^3$




How does rewriting expressions help you understand the relationship between those expressions?

A log function returns the value of the exponent.

The value of the exponential form is what you take the log of.

Use what you learned from rewriting the logarithms to determine if the given statements are always true, sometimes true, or never true. Explain your reasoning.

a. The value of $\log_b a$ is positive.

Sometimes true, exponents can be negative

$\log_2 \frac{1}{2}$ is $-1$ because $2^{-1}=\frac{1}{2}$

b. $\log_b a$ is not a valid expression if $a$ is a negative number.

always true, bases must be positive, and no exponent will return a negative value.

c. $\log_b 1 = 0$ for any base, b > 0.

$b^x = 1$ always true

any base to the zero power has a value of 1

d. $\log_b b = 1$ for any base, b > 0.

$b^x = b$ always true

any base to the first power is equal to itself

e. $\log_2 a < \log_3 a$ for any value of $a$.

Sometimes true

$\underbrace{2^x = 4 \quad 3^x = 4 \quad x = 2 \quad x = 1.?}_{\text{False}}$ $\underbrace{2^x = \frac{1}{2} \quad 3^x = \frac{1}{2} \quad x = -1 \quad -.?}_{\text{true}}$

f. $\log_b b^n = n$ for any base, b > 0.

always true $b^x = b^n \Rightarrow x = n$

Vocabulary

| Word | Meaning/Notation | Example |
|---|---|---|
| Logarithm | The inverse function of an exponential expression or equation | $\log_2 64 = x$ solves $2^x = 64$ |