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1 Simplify the following expressions. All the letters in the formulas are assumed to be positive.

a)  $4^{\frac{2}{3}} \times 8^{-\frac{1}{2}} \div 16^{-\frac{1}{6}} =$

b)  $(a^{\frac{1}{3}} - 1)(a^{\frac{2}{3}} + a^{\frac{1}{3}} + 1) =$

c)  $(a^x + a^{-x})^2 - (a^x - a^{-x})^2 =$

d)  $\frac{\sqrt[4]{a^3} \sqrt[3]{a^2}}{\sqrt[12]{a^{11}}} =$

e)  $\frac{(ab^{-\frac{5}{2}}) \div (a^{\frac{1}{4}}b^{-\frac{5}{4}})}{(a^{-\frac{3}{2}}b^{\frac{3}{4}}) \div (a^{\frac{9}{4}}b^{-\frac{1}{2}})} =$

2 Arrange each of the following numbers in ascending order.  $0.5^4$ ,  $0.5^{-3}$ ,  $2^{-2}$ .

3 Solve the following inequalities.

a)  $0.3^x > 0.09$

b)  $\left(\frac{1}{2}\right)^{x-1} \geq (\sqrt{2})^x$

4 Letting  $\log_2 3 = a$ , express each of the following in terms of  $a$ .

a)  $\log_4 9$

b)  $\log_3 4$

c)  $\log_9 2$

5 Simplify the following expressions.

a)  $2^{\log_2 3} =$

b)  $\frac{1}{2} \log_5 3 + 3 \log_5 \sqrt{2} - \log_5 \sqrt{24} =$

c)  $(\log_2 3 + \log_4 9)(\log_3 4 + \log_9 2) =$

d)  $\log_2 8 \cdot \log_{27} 5 \cdot \log_5 3 =$

6 Solve the following equations.

a)  $\log_3(x + 1)^2 = 2$

b)  $\log_{0.5}(x + 1)(x + 2) = -1$

In what follows, use  $\log_{10} 2 \doteq 0.3010$ ,  $\log_{10} 3 \doteq 0.4771$  if necessary.

- 7 a) How many digits is  $2^{41}$ ?  
b) Find the highest digits of  $2^{41}$ .

8 It is said that it takes 125 days for the mercury in the body to be excreted outside the body to reach  $\frac{1}{2}$  of the original amount. How many days does it take for mercury in the body to be less than  $\frac{1}{10}$  of the original amount?

9 Suppose we draw a graph of  $y = 2^x$  on a graph paper with a graduation of 1cm. If the domain of  $x$  is  $0 \leq x \leq 10$ , for example, then the range of  $y$  is  $1 \leq y \leq 2^{10}$ , and the length of the graph paper must be longer than 1024cm in the direction of  $y$ -axis. If we set the domain of  $x$  as  $0 \leq x \leq 60$ , how long is the graph paper theoretically required? Choose the closest answer from the following, and give reasons.

- a) 1km                                      b) 100km  
c) Distance from the earth to the moon (about 380,000 km)  
d) Distance from the earth to the sun (about  $1.5 \times 10^{11}$ m)  
e) 1 light year (about  $9.5 \times 10^{15}$ m)

10 The formula for measuring sound intensity in decibels  $D$  is defined by the equation

$$D = 10 \log \left( \frac{I}{I_0} \right)$$

where  $I$  is the intensity of the sound in watts per square meter and  $I_0 = 10^{-12}$  is the lowest level of sound that the average person can hear. How many decibels are emitted from a rock concert with a sound intensity of  $4.7 \times 10^{-1}$  watts per square meter?