Logarithm word problems and answers pdf

USE EXPONENTIAL AND LOGARITHMIC FUNCTIONS To solve exponential or logarithmic word problems, convert the narrative to an equation and solve the equation. We are discussing several types of word problems. Click on what you want to review: 1. Interest rate issues 2. Mortgage problems 3. Population problems 4. Problems with radioactive degradation 5. Earthquake Problems [Exponential Rules] [Logarithms] [Algebra] [Trigonometry] [Complex Variables] S.O.S MATHematics home page Do you need more help? Please post your question on our S.O.S. Mathematics CyberBoard. Author: Nancy Marcus Contact us at Math Medics, LLC. - P.O. Box 12395 - El Paso TX 79913 - U.S. users online in the last hour When solving application problems that involve exponential and logarithmic functions, we need to pay close attention to the position of the variable equation in order to determine the right way to solve the equation we are exploring to solve equations that include exhibitors. Let's say we have an equation in the form: value = coefficient(base) exhibitor We take into account four strategies to solve the equation: STRATEGY: If all is known coefficient, base, and exhibitor, we need to evaluate only the coefficient(base) exhibitor expression to evaluate this value. STRATEGY B: If the variable is a coefficient, evaluate the (base) exhibitor expression. Then it becomes a linear equation that we solve by dividing the variable into isolation. STRATEGY C: If the variable is in the exhibitor, use logariths to solve the equation. STRATEGY D: If the variable is not an exponent but is on the base, use the roots to solve the equation. Below, we will examine each strategy with one or two examples of its use. STRATEGY A: If all factors, base, and exhibitor are known, we only need to evaluate the coefficient(s) exhibitor expression to evaluate this value. Example \(\PageIndex{1}\) Let's say that the share price rises at a rate of 7% a year and that it continues to increase at this rate. If the value of one part of this warehouse is $43 now, find the value of one part of this warehouse after three years. Solution Let \(y\) = value of inventory after \(t\) years: \(y = ab^t\) The problem tells us, that \(a\) = 43 and \(r\) = 0.07, so \(b = 1 + r = 1 + 0.07 = 1.07\) Thus the function is \(y = 43(1.07)^t\). In this case, we know that \(t\) = 3 years, and we must evaluate \(y\) as \(t\) = 3. At the end of 3 years, the value of one part of this share is \[y=43(1.07)^{3}=\$ 52.68 onumber\\] STRATEGY B: If the variable is a coefficient, evaluate the (base) exhibitor expression. Then it becomes a linear equation that we solve by dividing the variable into isolation. Example \(\PageIndex{2}\) The value of a new car depreciates (decreases) after you purchase it. Let's say that according to the exponential degradation model. Let's say that the value of the car is $12,000 at the end of 5 years and that its value has decreased at a rate of 9% per annum. Find the value of the car if it was new. Solution Let \(y\) be auto value after \(t\) years: \(y = ab^t\), \(r\) = -0.09 and \(b = 1+r = 1 +r = 1 +(-0.09) = 0.91\) The function is \(y = a (0.91)^t\) In this case we know that if \(t\) = 5, then \(y\) = 12000; replacing these values gives \[12000 = a(0,91)^5 onumber\\] We must resolve the original value a, the car purchase price, if new. First price (0,91)5 ; then resolves the resulting linear equation to find \(a\). \[1200 = a(0.624) onumber \] \(a=\frac{12000} {0.624} = \$ 19,230.77\); The car's value was $19,230.77 when it was new. STRATEGY C: If the variable is in the exhibitor, use logariths to solve the equation. The example of \(\PageIndex{3}\) national park has a population of 5,000 deer in 2016. Conservationists are concerned because deer populations are declining by 7% a year. If the population continues to decline at this rate, how long will it take to have a population of just 3,000 deer? Solution Let \(y\) be the number of deer in the national park \(t\) years after 2016: \(y = ab^t\) \(r\) = -0.07 and \(b = 1+r = 1+(-0.07) = 0,93\) and the initial population is \(a\) = 5000 Exponential degradation function is \(y = 5000(0,93)^t\) To find when the population is 3000, substitute \(y\) = 3000 \[3000 = 5000(0,93)^t oarv\] Next , part both sides to isolate the exponential expression with 5,000 \[\begin{array}{l} \frac{3000}{5000}=\frac{5000}{5000}(0.93)^{2} \\ 0.6=0.93^{t} \end{array}onumber\] Write equation in logarithmic re-ed in the form of a new form then use the change in the base formula to evaluate. \[t=\log _{0.93}(0.6) onumber\] \(t= \frac{\ln(0.6)}{\ln(0.93)}=7.039\) years; After 7,039 years there are 3,000 deer. Note: In the example \(\PageIndex{3}\), we need to mark the answer to multiple decimal accuracy to maintain accuracy. Assessing the original function with a rounded value of \(t\) = 7 years returns a value that is close to 3000 but not exactly 3000. \[y=5000(0,93)^{7}=3008.5 \text { deer } onumber \] But using \(t\) = 7,039 years produces a value of 3,000 deer population \[y= 5000 (y= 5,000 (y= 5,000 (y= 5,000 (1000)0.93)^{7.039}=3000.0016 \u 3000 \text { deer } onumber\] Example \(\PageIndex{4}\) The video posted on YouTube originally had 80 views as soon as it was posted. The total number of views has increased exponentially according to the exponential growth function \(y = 80e^{0.2t}\), where \(t\) represents the time measured in the days that the video was posted. How many days does it take up to 2,500 people to have viewed this video? Solution Let \(y\) be the total number of views \(t\) days after the video was originally posted. We have been given that exponential function is \(y = 80e^{0.2t}\) and we want to find the value \(t\) for which \(y\) = 2500. Replace \(y\) = 2500 into the equation and use natural log \ (t\) to solve. \[2500 = 80e^{0.12t} oarv\] Part two sides to isolate an exponential expression with a coefficient of 80. \[\begin{array} {c} \frac{2500}{80}=\frac{80}{80} e^{0.12 t} \\31.25=e^{0.12 t} \end{array} oarv\] Rewrite the equation in logarithmic form \[0.12t = \ln(31.25) onumber \] Retype the equation with 0.04 on both sides, to isolate \(t\); then use the calculator and its natural log function to evaluate the expression, and resolve \(t\). \[\begin{ array}{l} \mathrm{t}=\frac{\ln (31.25)} {0.12} \\ \\mathrm{t}=\frac{3.442}{0.442}{{0.12} \\ \mathrm{t} \u 28.7 \text { days } \end{array} onumber\] This video has 2,500 total views about 28.7 days after it was posted. STRATEGY D: If the variable is not an exponent but has a base, we use the roots to solve the equation. It is important to remember that we only use logariths when the variable is an exhibitor. The example \(\PageIndex{5}\) Statistic creates a website to analyze sports statistics. His business plan says his goal is to gather 50,000 followers by the end of 2 years (24 months now). He hopes that if he achieves this goal his site will be purchased by a sports news outlet. The initial user base of people signed up as a result of pre-launch advertising is 400 people. Find the monthly growth rate that is required when the user base is to collect 50,000 users at the end of 24 months. Solution Let \(y\) be the entire user base \(t\) months after you start the site. The growth feature of this site is \(y = 400(1+r)^t\); We do not know the growth rate \(r\). We know that if \(t\) = 24 months, then \(y\) = 50000. Replace the values \(y\) and \(t\); then we have to solve \(r\). \[5000 = 400(1+r)^{24} onumber\] Part with 400, to isolate (1+r)24 equation on one side \[\begin{array}{l} \frac{50000}{400}=\frac{400}{400}(1+r)^{24} \\ 125=(1+r)^{24} \end array{} onumber\] Because the variable in this equation is in the base, we use roots: \[\ start {array}{l} \sqrt[24]{125}=1+r \\ 125^{1 / 24}=1+r \\ 1 2228 \u 1+r \\ 0.22 28 \approx r \end{array} onumber\] The website's user base must collect 50,000 users by the end of 24 months. Example \(\PageIndex{6}\) Fact sheet on caffeine addiction at Johns Hopkins Medical Center says that the half-life of caffeine in the body is between 4 and 6 hours. Assuming that the typical half-life of caffeine in the body is 5 hours for the average person and that a typical cup of coffee is 120 mg of caffeine. Write the decomposition function. Find the hourly rate for which caffeine leaves your body. How long will it take until only 20 mg of caffiene is still in the body? Solution a. Let \(y\) be the full amount of caffeine in your body \(t\) hours after drinking coffee. The exponential degradation function \(y = ab^t\) models in this situation. The initial amount of caffeine is \(a\) = 120. We do not know \(b\) or \(r\), but we know that the half-life of caffeine in the body is 5 hours. This tells us that if \(t\) = 5, then half of the original amount of caffeine remained in the body. \[\begin{array}{l} y=120 b^{t} \\ \frac{1}{2}(120)=120 b^{5} \\ 60=120 b^{5} \end{array} onumber\] Part with 120 on both sides to isolate the expression \(b^5\) that contains the variable. \[\begin{array}{l} \frac{60}{120}=\frac{120}{120} \mathrm{b}^{5} \\ 0.5=\mathrm{b}^{5} \end{array} onumber\\] The variable is in the base and the exhibitor is a number. Using Roots \(b\): \[\begin{array}{l} \sqrt[5] {0.5}=\mathrm{b} \\ 0.5^{1 / 5}=\mathrm{b} \\ 0.87=\mathrm{b} \end{array} onumber\0.5^{1/ 5}=\mathrm{b} \\ 0.87=\mathrm{b} \end{array} onumber\\onumber\\] Now we can write the amount of caffeine (mg.) left on the body \(t\) hours after drinking a cup of coffee with 120 mg of caffeine \[y=f(t)=120 (0,87)^{t} oarv \] b. Use \(b = 1 + r\) to find the rate of degradation. Because \(b = 0.87 < 1\) and the amount of caffeine in the body decreases over time, the value \(r\) is negative. \[\begin{array}{l} 0.87=1+r \\ r=-0.13 \end{array} onumber\] Degradation rate is 13%; caffeine in the body decreases by 13% per hour. c. To find a time when only 20 mg of caffeine remains in the body, replace \(y\) = 20 and resolve the corresponding value \(t\). \[\begin{ array} {l} y=120 (.87)^{t} \\ 20=120(.87)^{t} \end{array} onumber\] Use both parties with 120 to isolate the exponential expression. \[\begin{array}{l} \frac{20}{120}=\frac{120}{120}\left (0.87^{t}\right) \\ 0.1667=0.87^{t} \end{array} onumber\] Rewrite expression in logarithmic format and use base formula change \[\begin{}{}{l} t} t =\log _{0.87}(0.1667) \\ t=frac{\ln (0,1667)}{\ln (0.87)} \approx 12.9 \text { hours } \array{} oarv\] After 12.9 hours, 20 mg of caffeine remains in the body. Now that we have developed our equation solving skills, we will look again at the question of how to express the exponential functions that are equivalent in forms \(y = ab^t\) and \(y = ae^{kt}\) We have already determined that if the given form \(y = ae^{kt}\), it is easy to find \(b\). Example \(\PageIndex{7}\) For the following examples, assume that \(t\) is measured in years. Express \(y = 3500e^{0.25t}\) in the form \(y = ab^t\) and find the annual growth percentage. Express \(y = 28000e^{-0.32t}\) in the form \(y = ab^t\) and find the percentage of annual degradation. Solution a. Express \(y = 3500e^{0.25t}\) in the form \(y = ab^t\) \[\begin{array}{l} y=a e^{k t}=a b^{t} \\ a\left(e^l^) {k }\right)^{t}=a b^{t} \end{array} onumber\] Thus \(e^k=b\) In this example \(b=e^{0.25} \u 1.284\) We rewd the growth\(e^k=b\) if y = 3500 (1.284t) To find \(r\), remember, to \(b= 1+r\) \[\begin{aligned&1.284=1+r\\&0.284=\mathrm{r} \end{aligned} onumber\] The continuous growth rate is \(k\) = 0.25 and the annual growth percentage. B. Express \(y = 28000e^{-0.32t}\) in the form \(y = ab^t\) \[\begin{array}{l} y=a e^{k t}=a b^t}=a b^{t} \\ a\left(e^{k}\parem)^{t}=a b^{t} \\a\left(e^{k}\right)^{t}=a b^{t}=a b^{t} \\a\left(e^{k}\right)^{t}=a b^{t} \\ a\left(e^{k}\right)^{t}=a b^{t} \\a\left(e^{k}\right)^{t}=a b^{t}=a b^{t} \\a\left(e^{k}\right)^{t}=a b^{t} \\a\left(e^{k}\right)^{t}=a b^{t} \\a\left(e^{k}\right)^{t}=a b^{{t} \end{array} onumber\] Thus \(e^k=b\) In this example \(\mathrm{b}=e^{-0.32} \approx. 0.7261\) We rewrw the growth function in the form y = 28000(0.7261t) To find \(r\), remember, to \(b = 1 +r\) \[\begin{array}{l} 0.7261=1+r \\ 0.2739=r \end{array} onumber\] The continuous degradation rate is \(k\) = - 0.32 and annual degradation rate in percentage is 27.39% per annum. In the sentence, we leave a negative sign out, indicating the annual rate of degradation because we have used the word break-up, which indicates that r is negative. Example \(\PageIndex{8}\) Express \(y= 4200 (1.078)^t\) in the form \(y=ae^{kt}\) Express \(y = 150 (0,73)^t\) in the form \(y=ae^{kt}\) a solution. Express \(y = 4200 (1,078)^t\) in the form \(y =ae^{kt}\) \[\begin array}{l} \mathrm{y}=\mathrm{a} e ^{\mathrm{k} t}=\mathrm{ab}^{\mathrm{t}} \\ \\mathrm{a}\left(e^{\mathrm{k}}\right)^{\mathrm{t}}=\mathrm{ab}^{\mathrm{t}} \\ e^{\mathrm{k}}=\mathrm{b} \\ e^{k}=1.078\end{array} onumber\] Therefore \(\mathrm{k}=\ln 1.078 \u 0.0751\) We rewd the growth function as \(y = 3500e^{0.0751t}\) b. Express in \(y =150 (0.73)^t\) in the form \(y = ae^{kt}\) \[\begin array}{l} y=a e^{k t}=a b^{t} \\a\left(e^{k}\right)^{t}=a b^{t} \\ e{k}=b\\e \k}=0.73 \end{array} onumber\] Therefore \(\mathrm{k}=\ln 0.73 \u 0.3147\) We rewdd the growth function as \(y = 150e^{-0.3147t}\) Let's say we invest $10,000 today and we want to know how long it takes to accumulate to the specified amount. , for example, $15,000. The time required to achieve future value \(t\) is a logarithmic function of future value: \(t= g(y)\) Example \(\PageIndex{9}\) Let's say Vinh invests $10,000 in an investment that earns 5% a year. He wants to know how long it would take for his investments to accumulate $12,000, and how long it would take to raise $15,000. Solution We begin by writing an exponential growth function that models the value of this investment as a function of time from $10,000 first investing \[y=10000(1.05)^{t} onumber\] We divide both sides with $10,000 to isolate the exponential expression on the one hand. \[\frac{y}{10000}=1.05^{t} onumber\] Next, we re-rewrite it in logarithmic form to express the time as a function of the accumulated future value. We use the function to mark and call this function \(g(y)\). \[\mathrm{t}=\mathrm{g}(\mathrm{y})=\log _{1.05}\left(\frac{\mathrm{y}}{10000}\right) onumber \] Use change \] Use the change to express the base formula as \(t\) function \(y\) using the natural logarithm: \[\mathrm{t}=\mathrm{g}(\mathrm{y})=\frac{\ln (1.05)} onumber\] Now we can use this function to answer Vinh's questions. To find the number of years until this investment is worth $12,000, replace \(y\) = $12,000 as \(g\) and evaluate \(t\): \[\mathrm{t}=\mathrm{g}(12000)=\frac{\ln\left(\frac{12000}{10000}\right)}{\ln (1.05)}=\frac{\ln (1.2)}{\ln (1.05)}=3.74\text { years } oarv\] To find the number of years until the value of this investment is $15,000, we will replace \(15,000), really\) = $15,000 for function \(g\) and we rate \(t\): \[\mathrm{t}=\mathrm{g}(15,000)=\frac{\Ln\left frac{15000}{10000}\right)}{\ln (1.05)}=\frac{\ln (1.5)}{\ln (1.05)}=8.31 \text { years } oarv\] Before completing this section, we will examine the function graph \(\mathrm{t}=\mathrm{g}(\mathrm{y})=\frac{\ln\left(\frac{\mathrm{y}}{10000}\right)}{\ln (1.05)}\). We can see that the function is the general shape of the logarithmic functions that we studied in section 5.5. From the points entered in the graph, we can see that the \(g\) function is a growing function, but it increases very slowly. If we only consider the function \(\mathrm{t}=\mathrm{g}(\mathrm{y})=\frac{\ln\left(\frac{\mathrm{y}}{10000}\right)}{\ln (1.05)}}\)), the domain is \(y > 0\), all positive real numbers and the \(t\) range would be all real numbers. In the context of this investment issue, initial investment time \(t\) = 0 is \(y\) =$10,000. Negative time values don't make sense. Investment values that are less than the initial amount of $10,000 also don't make sense for an investment that has increasing value. Therefore, the function and graph because it concerns this issue in relation to the investment is domain \(y ≥ 10000\) and the range \(t ≥ 0\). The following graph is limited to the domain and scope that are practical when investing in this problem. Problem.

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