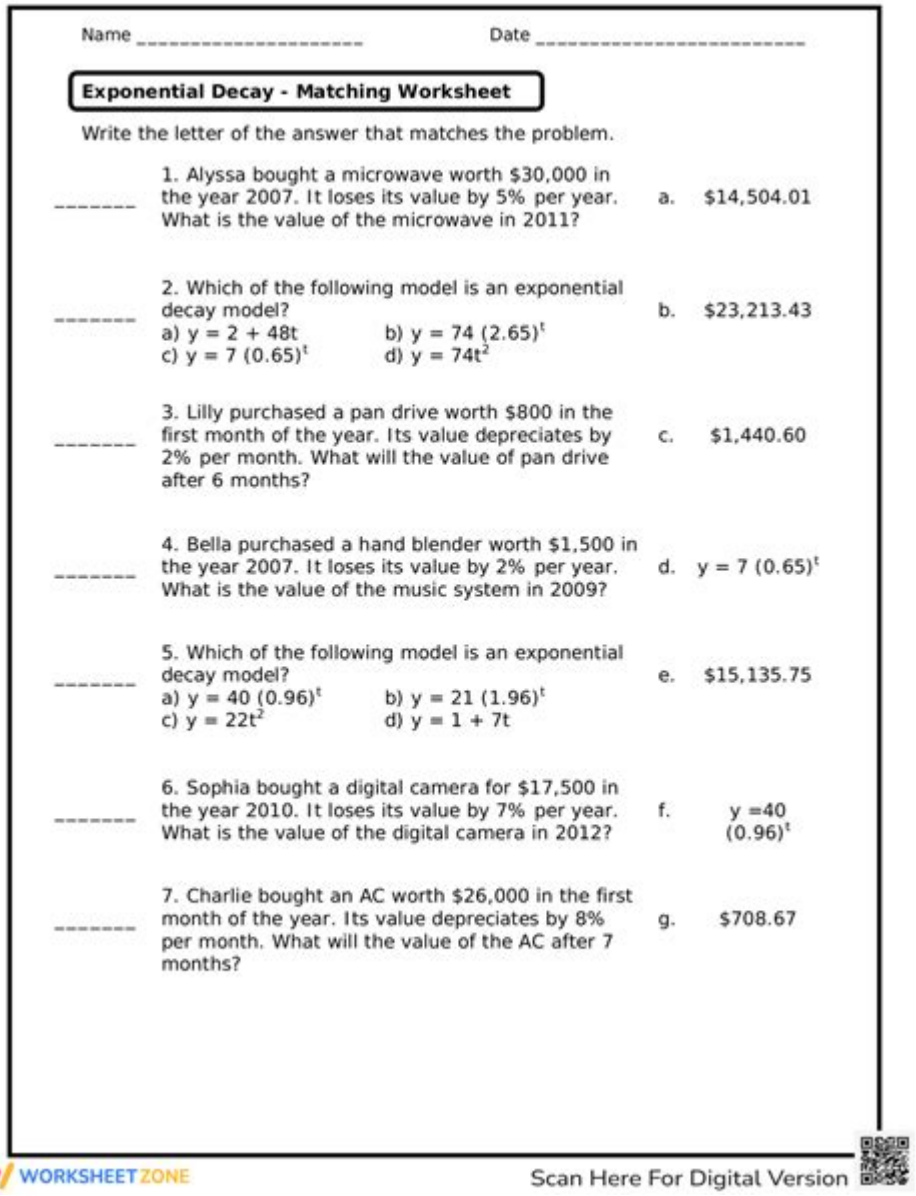
Exponential Growth And Decay Answer Key



Name _____ Date _____

Exponential Decay - Matching Worksheet

Write the letter of the answer that matches the problem.

_____ 1. Alyssa bought a microwave worth $30,000 in the year 2007. It loses its value by 5% per year. What is the value of the microwave in 2011?

_____ 2. Which of the following model is an exponential decay model?
a) $y = 2 + 48t$ b) $y = 74\ (2.65)^t$
c) $y = 7\ (0.65)^t$ d) $y = 74t^2$

_____ 3. Lilly purchased a pan drive worth $800 in the first month of the year. Its value depreciates by 2% per month. What will the value of pan drive after 6 months?

_____ 4. Bella purchased a hand blender worth $1,500 in the year 2007. It loses its value by 2% per year. What is the value of the music system in 2009?

_____ 5. Which of the following model is an exponential decay model?
a) $y = 40\ (0.96)^t$ b) $y = 21\ (1.96)^t$
c) $y = 22t^2$ d) $y = 1 + 7t$

_____ 6. Sophia bought a digital camera for $17,500 in the year 2010. It loses its value by 7% per year. What is the value of the digital camera in 2012?

_____ 7. Charlie bought an AC worth $26,000 in the first month of the year. Its value depreciates by 8% per month. What will the value of the AC after 7 months?

a. $14,504.01

b. $23,213.43

c. $1,440.60

d. $y = 7\ (0.65)^t$

e. $15,135.75

f. $y = 40\ (0.96)^t$

g. $708.67

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Exponential growth and decay answer key is a crucial topic in mathematics and science that describes the process of change in quantities over time. This concept is not only fundamental in mathematics but also has real-world applications in various fields such as biology, physics, finance, and population studies. Understanding exponential functions allows individuals to predict future values based on current data, making it essential for decision-making and forecasting.

Understanding Exponential Functions

Exponential functions are mathematical expressions in which a constant base is raised to a variable exponent. The general form of an exponential function can be expressed as:

$$
y = a \cdot b^x
$$

- y represents the output value.
- a is a constant that represents the initial value when $x = 0$.
- b is the base of the exponential function.
- x is the exponent, which is typically time in growth and decay scenarios.

Characteristics of Exponential Functions

1. Growth vs. Decay:
- Exponential Growth occurs when the base $b > 1$. This indicates that as x increases, y will increase rapidly.
- Exponential Decay occurs when the base $0 < b < 1$. Here, as x increases, y will decrease rapidly.

2. Continuous Growth/Decay:
- Exponential functions can model continuous growth or decay, commonly expressed using the natural base e (approximately 2.71828).
- The continuous growth formula is given by:
$$
N(t) = N_0 e^{kt}
$$
Where:
- $N(t)$ is the amount at time t.
- N_0 is the initial quantity.
- k is the growth (or decay) constant.
- t is time.

3. Rate of Change:
- The rate of change of an exponential function is proportional to its current value. This property leads to rapid increases or decreases, distinguishing exponential functions from linear functions.

Applications of Exponential Growth

Exponential growth can be observed in numerous real-world scenarios:

1. Population Growth

- Populations can increase exponentially under ideal conditions. The formula for population growth is often modeled as:
$$
P(t) = P_0 e^{rt}
$$

Where:
- $P(t)$ is the population at time t.
- P_0 is the initial population.
- r is the growth rate.
- t is time.

2. Compound Interest

- In finance, compound interest can be modeled using exponential growth. The formula is:
$$
A = P(1 + r/n)^{nt}
$$
Where:
- A is the amount of money accumulated after n years, including interest.
- P is the principal amount (the initial sum of money).
- r is the annual interest rate (decimal).
- n is the number of times that interest is compounded per unit t.
- t is the time the money is invested or borrowed.

3. Technology Adoption

- The spread of technology often follows an exponential growth curve, where the number of users increases rapidly as the technology becomes popular.

Applications of Exponential Decay

Exponential decay is equally important and can be observed in various fields:

1. Radioactive Decay

- The decay of radioactive substances is one of the most common examples of exponential decay. The amount of substance remaining after time t is described by:
$$
N(t) = N_0 e^{-\lambda t}
$$
Where:
- λ is the decay constant specific to the radioactive material.

2. Cooling of Objects

- Newton’s Law of Cooling states that the temperature of an object decreases exponentially over time when in a cooler environment. The formula is:
$$
T(t) = T_0 + (T_{env} - T_0)e^{-\kt}
$$

Where:
- $T(t)$ is the temperature at time t.
- T_0 is the initial temperature.
- T_{env} is the ambient temperature.
- k is a positive constant.

3. Depreciation of Assets

- The value of assets like cars or machinery typically decreases exponentially over time, which can be modeled using exponential decay functions.

Graphing Exponential Functions

Graphing exponential functions helps visualize their behavior. Here are key points to consider:

- Exponential Growth:
- The graph rises steeply as x increases.
- The y-intercept is at $(0, a)$.
- The function approaches the horizontal axis but never touches it (asymptote).

- Exponential Decay:
- The graph declines steeply as x increases.
- The y-intercept is at $(0, a)$.
- Similar to growth, it approaches the horizontal axis but does not touch it.

Key Concepts in Solving Exponential Growth and Decay Problems

1. Identify the Initial Value: This is often given in the problem statement.
2. Determine the Growth/Decay Rate: This may be provided or calculated from given data.
3. Use the Correct Formula: Depending on whether you are dealing with growth or decay, choose the appropriate exponential model.
4. Solve for the Desired Variable: This could involve finding the value at a specific time or determining how long it will take to reach a certain value.

Practice Problems and Solutions

To master exponential growth and decay, it is helpful to practice with various problems. Below are examples along with solutions.

Example 1: Population Growth Problem

A population of 1,000 rabbits is growing at a rate of 5% per year. What will the population be in 10 years?

- Solution:
$$
P(t) = P_0 e^{rt} = 1000 e^{0.05 \cdot 10} \approx 1000 e^{0.5} \approx 1000 \cdot 1.6487 \approx 1648.72
$$
The population will be approximately 1,649 rabbits.

Example 2: Radioactive Decay Problem

A substance has a half-life of 3 years. If you start with 80 grams, how much will remain after 9 years?

- Solution:
After 9 years, which is three half-lives:
$$
N(t) = N_0 \left(\frac{1}{2} \right)^{t/h} = 80 \left(\frac{1}{2} \right)^{9/3} = 80 \left(\frac{1}{2} \right)^{3} = 80 \cdot \frac{1}{8} = 10 \text{ grams}
$$
After 9 years, 10 grams of the substance will remain.

Conclusion

Exponential growth and decay are powerful concepts that help us understand various phenomena in nature and industry. By mastering the underlying mathematics, individuals can apply these concepts to real-world situations, enabling better predictions and informed decision-making. Whether it’s forecasting population changes, understanding financial investments, or studying the behavior of radioactive materials, the principles of exponential functions are invaluable tools in both academic and practical contexts. With practice and application, anyone can become proficient in solving problems related to exponential growth and decay.

Frequently Asked Questions

What is exponential growth and how is it mathematically represented?

Exponential growth occurs when the increase of a quantity is proportional to its current value, commonly represented by the formula y = a e^(kt), where 'a' is the initial amount, 'k' is the growth rate, and 't' is time.

What is the difference between exponential growth and exponential decay?

Exponential growth refers to a situation where a quantity increases rapidly over time, while exponential decay describes a process where a quantity decreases by a consistent percentage over time. Mathematically, decay is represented by the formula y = a e^(-kt).

What are some real-world examples of exponential growth?

Real-world examples of exponential growth include population growth in a conducive environment, compound interest in finance, and the spread of diseases, such as viral infections, where the number of cases can increase rapidly.

How can exponential decay be observed in nature?

Exponential decay can be observed in processes such as radioactive decay, where unstable isotopes decrease in quantity over time, and in the cooling of substances, where the rate of heat loss decreases as the temperature difference reduces.

What role does the constant 'e' play in exponential functions?

The constant 'e', approximately equal to 2.71828, is the base of natural logarithms and is crucial in exponential functions as it provides a natural growth rate that occurs in various continuous growth processes, making calculations simpler in calculus.

How can you determine the half-life of a substance undergoing exponential decay?

The half-life of a substance can be determined using the formula t(1/2) = ln(2) / k, where 'k' is the decay constant. This gives the time required for half of the substance to decay, reflecting its rate of decay.

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