MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Determine whether the growth (or decay) is linear or exponential, and answer the associated question.

1) The value of your house is rising by 11% per year. If it is worth $272,192 today, what will it be worth in three years?

\[
\text{Value }(t) = 272,192 \left(1 + \frac{11}{100}\right)^t
\]

\[
t = 3, \quad \text{Value }(3) = 272,192 \left(1 + \frac{11}{100}\right)^3 = \$372,258.22
\]

A) Linear; $332,074.24  
C) Exponential; $372,258.22  
B) Linear; $362,015.36  
D) Exponential; $303,244.38

Solve.

2) Use the bacteria parable to determine what fraction of the bottle is full at 11:10?

\[
\text{If } \frac{4}{5} \text{ of the bottle is full at 11:00, fraction of bottle is full at 11:10:} \\
\frac{4}{5} \times \frac{4}{5} = \frac{16}{25}
\]

A) \(\frac{1}{251}\) full  
B) \(\frac{1}{250}\) full  
C) \(\frac{1}{5}\) full  
D) \(\frac{1}{249}\) full

Provide an appropriate response.

3) The Consumer Price Index is increasing at a rate of 7% per year. What is its doubling time? Use the approximate doubling time formula (rule of 70).

\[
\frac{70}{R} = 10  \quad \text{years}
\]

A) 128 years  
B) 14 years  
C) 10 years  
D) 4.9 years
4) In 2000, the population of Littletown was 18 thousand. Use the given doubling time to predict the population in 2010. Assume a double time of 43 years.

\[ P(t) = P_0 \cdot 2^{t/43} \]
\[ \text{in years} = 43 \text{ years}, \quad t = \text{Year} - 2000 \]
\[ t = 2010 - 2000 = 10 \]
\[ P(10) = 18 \cdot 2^{10/43} = 21.15 \text{ thousand} \]

A) 21.1 thousand  B) 7740 thousand  C) 24.8 thousand  D) 1.2 thousand

5) Poaching is causing a population of elephants to decline by 7% per year. Use the approximate half-life formula to determine the fraction that remains in 74 years if there are 13,142 elephants today.

\[ P(t) = P_0 \cdot \left(\frac{1}{2}\right)^{t/T_{1/2}} \]
\[ T_{1/2} = \frac{\log(1/2)}{\log(2)} = 0.7 \] years

\[ P(74) = 13,142 \cdot \left(\frac{1}{2}\right)^{74/0.7} = 77.81 \text{ elephants} \]

A) 78 elephants  B) 48,625 elephants  C) 12,262 elephants  D) 6316 elephants

6) Real populations sometimes increase beyond their environment's carrying capacity in a relatively short period of time. What is the name of this phenomenon?

A) Collapse  B) Logistic growth  C) Annual growth rate  D) Overshoot

7) The following table gives the birth and death rates for four countries in three different years:

<table>
<thead>
<tr>
<th>Town</th>
<th>Birth rate (per 100)</th>
<th>Death rate (per 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simpleton</td>
<td>1.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Normalton</td>
<td>2.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Ruralton</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Littleton</td>
<td>1.4</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Find Normalton's net growth rate due to births and deaths in 1990.

\[ \text{Normalton's net growth rate} = \frac{\text{Birth rate} - \text{Death rate}}{100} \]
\[ = 2.4 - 0.6 = 1.8 \text{ per 100} \]

A) 0.6 per 100  B) 0.4 per 100  C) 1.8 per 100  D) 0.9 per 100
8) Use the growth rate of 0.3% to estimate the population of a growing country in 2099. Start from the 2000 population of 32 million. Use the approximate doubling time formula.

\[ T_{doubling} = \frac{\ln 2}{0.3} = \frac{2.333}{0.3} = 7.777 \text{ years} \]

\[ \ln(\text{Population}) = \ln(32) + 7.777 \times 0.003 = 3.4777 \times 7.777 \]

\[ \text{Population} = e^{3.4777 \times 7.777} = 48.94 \text{ million} \]

A) 85.3 million  
B) 163.9 million  
C) 75.5 million  
D) 42.9 million

Use the decibel scale to answer the question.

9) What is the loudness, in decibels, of a sound 69 million times as loud as the softest audible sound?

\[ \frac{I}{I_{ref}} = 10^{69} \]

\[ 10 \log \left( \frac{I}{I_{ref}} \right) = 10 \log (10^{69}) = 690 \text{ dB} \]

A) 94 dB  
B) 63 dB  
C) 78 dB  
D) 110 dB

Use the pH scale to answer the question.

10) What is the pH of a solution with a hydrogen ion concentration of 0.01 mole per liter? Is this solution an acid or a base?

\[ \text{pH} = -\log(0.01) = 2 \]

A) pH = 7; neutral  
B) pH = 2; acid  
C) pH = 8; base  
D) pH = 3; acid

Provide an appropriate response.

11) What is comprised of the values of the independent variable?

A) Domain  
B) Model  
C) Range  
D) Periodic function

Use the decibel scale to answer the question.

12) How does the intensity of sound from a concert speaker at a distance of 4 meters compare to the intensity at a distance of 16 meters?

A) Factor of 40 weaker at 16 m.  
B) Factor of 64 weaker at 16 m.  
C) Factor of 16 weaker at 16 m.  
D) Factor of 4 weaker at 16 m.

\[ \frac{I_{4m}}{I_{16m}} = \frac{\frac{P_0}{16}}{\frac{P_0}{4}} = \frac{1}{4} \]

A) Factor of 40 weaker at 16 m.  
B) Factor of 64 weaker at 16 m.  
C) Factor of 16 weaker at 16 m.  
D) Factor of 4 weaker at 16 m.

Provide an appropriate response.

13) Consider a population that begins growing exponentially at a base rate of 8% per year and then follows a logistic growth pattern. If the carrying capacity is 48 million, find the actual growth rate when the population is 9 million.

A) 6.96%  
B) 6.50%  
C) 7.35%  
D) 5.85%

\[ r = \ln \left( 1 - \frac{K}{P(t)} \right) = \ln \left( 1 - \frac{48}{9} \right) = -0.655 = -65.5\% \]