Table of Contents

Population Models **Pages 2-3**
Financial Models **Pages 4-5**
Pharmaceutical Models **Pages 6-7**

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Growth Lesson #5: *Population Models* *Name* _____

- **From Growth Lesson #4:** Zauren found that the average Natural Growth Rate (due to births and deaths) in Kenya was 2.4% per year. His demographer friend, Grace, however, suggested that populations are more accurately predicted using months or day.
  - Why does it make sense to calculate changes due to births and deaths at the end of each month or each day instead of each year?
    Response

  - Should migration also be calculated at the end of each month or day rather than at the end of each year? Why or why not?
    Response

  - Recall that a growth rate of 2.4% is represented by a multiplier of 102.4%. Converting that to a monthly multiplier requires splitting the 102.4% into 12 equal multipliers. In other words, solving the equation $x^{12} = 102.4\%$ *or* $x^{12} = 1.024$. What mathematical operation reverses raising a number to the 12th power? How do you represent that? If you aren't sure, look at this resource
    Response

  - Use this idea to complete the table below:

Yearly Growth Rate	2.4%	-15%			
Yearly Multiplier	102.4%		111%		
Monthly Multiplier	$(102.4\%)^{1/12}$			100.643403011%	
Daily Multiplier					101%

- **Variations in Growth and Migration**: In reality, the Natural Growth Rate (from births and deaths) and the number of migrants in a country varies from year to year. As a result, predictions of future populations are not precise. For example, here is some data from Kenya

Year	1960	1970	1980	1990	2000	2010	2020
Birth Rate (Yearly)	5.5%	5.3%	4.9%	4.4%	4.0%	3.5%	2.8%
Death Rate (Yearly)	1.9%	1.4%	1.0%	0.9%	1.1%	0.8%	0.7%
Natural Growth Rate (Yearly)	3.6%	3.9%	3.9%	3.5%	2.9%	2.7%	2.1%
Net Migration	2140	-13059	-56314	-11341	5407	-21076	-17106

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(Yearly)							

-

- Find the MEAN (or AVERAGE) Natural Growth Rate and Net Migration from the data above:
  Response

- Write the recursive model that would result from using the Means you just calculated (for now, stick with YEARLY calculations). Please show your thinking.
  Response

- Do you think this model is appropriate for predicting future populations of Kenya? Explain why or why not.
  Response

- Demographers often want to create a range of predictions for a population, kind of a best and worst case scenario. To do this, we need the concept of STANDARD DEVIATION. You likely learned about this way back in Algebra 1-2 but that was a long time ago. Look up STANDARD DEVIATION and write below what it means in your own words.
  Response

- The Standard Deviation of the Natural Growth Rates for Kenya is 0.63% and 18784 for Net Migrations. A common rule of thumb is to use a MEAN - 2* STANDARD DEVIATION as a lower bound and MEAN + 2* STANDARD DEVIATION as an upper bound. Use this Rule to write recursive equations that would represent the lower bound estimate of Kenya's Population and the upper bound estimate of Kenya's Population.
  Response

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Growth Lesson #5: *Financial Models* *Name* _____

- **From Growth Lesson #4:** Harris found that the average % Growth Rate of Intel's Stock was 0.6% per year. His financial friend, Millie, however, suggested that investments are more accurately predicted using monthly or daily growth %..
    - Why does it make sense to calculate changes in investment values at the end of each month or each day instead of each year?
      Response

    - Would it make financial sense for Harris to also make his regular contributions of $600 per year to his investment fund at the end of each month or day rather than at the end of each year? Why or why not?
      Response

    - Recall that a growth rate of 0.6% is represented by a multiplier of 100.6%. Converting that to a monthly multiplier requires splitting the 100.6% into 12 equal multipliers. In other words, solving the equation $x^{12} = 100.6\%$ *or* $x^{12} = 1.006$. What mathematical operation reverses raising a number to the 12th power? How do you represent that? If you aren't sure, look at this resource
      Response

    - Use this idea to complete the table below:

Yearly Growth Rate	2.4%	-15%			
Yearly Multiplier	102.4%		111%		
Monthly Multiplier	$(102.4\%)^{1/12}$			100.643403011%	
Daily Multiplier					101%

- **Variations in Investment Returns**: In reality, the % Return on an Investment varies from year to year. As a result, predictions of the value of future investment funds are not precise. For example, here is some data from Intel:

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023
Growth Rate	-5.07%	5.28%	27.27%	1.67%	27.53%	-16.76%	3.37%	-48.68%	90.12%

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(Yearly)									

-
- Find the MEAN (or AVERAGE) Growth Rate from the data above:
  Response

- Write the recursive model that would result from using the Mean you just calculated including his $600 yearly contribution. For the moment stick with YEARLY calculations.
  Response

- Do you think this model is appropriate for predicting future values of Harris Investment fund? Explain why or why not.
  Response

- Financial Analysts often want to create a range of predictions for a fund, kind of a best and worst case scenario. To do this, we need the concept of STANDARD DEVIATION. You likely learned about this way back in Algebra 1-2 but that was a long time ago. Look up STANDARD DEVIATION and write below what it means in your own words.
  Response

- The Standard Deviation of Intel's Yearly Growth Rates is 37.99%. A common rule of thumb is to use a MEAN - 2* STANDARD DEVIATION as a lower bound and MEAN + 2* STANDARD DEVIATION as an upper bound. Use this Rule to write recursive equations that would represent the lower bound estimate of Harris's Intel Fund Value and the upper bound estimate of Harris's Intel Fund Value (be sure to include his $600 yearly contribution).
  Response

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Growth Lesson #5: Pharmaceutical Models *Name* _____

- **From Growth Lesson #4:** Asa found that the average daily metabolic rate of cetirizine hydrochloride (the active ingredient in Zyrtec) is 81.1%. His pharmacologist friend, Molly, however, suggested that medication blood levels are more accurately predicted using hours or even minutes.
  - Why does it make sense to calculate changes in medication blood levels at the end of each hour or each minute instead of each day?
    Response

  - Should the addition by taking a new dose also be calculated at the end of each hour or minute rather than at the end of each year? Why or why not?
    Response

  - Recall that a decay rate of 81.1% is represented by a daily multiplier of 18.9%. Converting that to an hourly multiplier requires splitting the 18.9% into 24 equal multipliers. In other words, solving the equation $x^{24} = 18.9\%$ *or* $x^{24} = 0.189$. What mathematical operation reverses raising a number to the 24th power? How do you represent that? If you aren't sure, look at this resource
    Response

  - Use this idea to complete the table below:

Daily Decay Rate	-2.4%	-15%			
Daily Multiplier	97.6%		42%		
Hourly Multiplier	$(97.6\%)^{1/24}$			99.3%	
Minute Multiplier					99.82%

- **Variations in Metabolic Rates**: In reality, the rate at which medications metabolize in the human body varies from person to person. As a result, predictions of the level of a medication in someone's blood are not precise. For example, here is some data about cetirizine hydrochloride

	Infants	Children	Adults	Elderly
Multiplier (Daily)	99.5%	95.1%	86.5%	75%

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- Find the MEAN (or AVERAGE) Metabolic Rate from the data above:
  Response

- Write the recursive model that would result from using the Mean you just calculated and an initial dose of 20 mg with an additional 10 mg dose each day. For the moment, stick with daily calculations.
  Response

- Do you think this model is appropriate for predicting the amount of cetirizine hydrochloride in the bloodstream? Explain why or why not.
  Response

- Pharmacologists often want to create a range of predictions for the level of a medication in people's blood, kind of a best and worst case scenario. To do this, we need the concept of STANDARD DEVIATION. You likely learned about this way back in Algebra 1-2 but that was a long time ago. Look up STANDARD DEVIATION and write below what it means in your own words.
  Response

- The Standard Deviation of the rates for cetirizine hydrochloride is 10.79%. A common rule of thumb is to use a MEAN - 2* STANDARD DEVIATION as a lower bound and MEAN + 2* STANDARD DEVIATION as an upper bound. Use this Rule to write recursive equations that would represent the lower bound estimate of the level of cetirizine hydrochloride and the upper bound estimate cetirizine hydrochloride.
  Response

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