4.5 Exponential Growth & Decay

GOALS:

1. Use exponential equations to model growth and decay: $f(t) = A = A_0 e^{kt}$
   a) Growth when $k > 0$
   b) Decay when $k < 0$
2. Recognize that growth is limited: need a logistic model to represent carrying capacity

Study 4.5 CVC # 1-6 all; # 1-5, 15, 17, 27,31,37

Exponential Functions

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4.5 Exponential Growth & Decay

Given: Population Growth for Iraq $A = 31.5\, e^{0.019t}$
where A is in millions
and t is the numbers of years after 2010

Find: Population of Iraq in 2010

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4.5 Exponential Growth & Decay

Given: Population Growth for Iraq $A = 31.5\, e^{0.019t}$
where A is in millions
and t is the numbers of years after 2010

Find: Population of Iraq in 2010

31.5 million

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4.5 Exponential Growth & Decay

Given:
India: $A = 1173.1\, e^{0.008t}$
Iraq: $A = 31.5\, e^{0.019t}$
Japan: $A = 127.3\, e^{-0.006t}$
Russia: $A = 141.9\, e^{-0.005t}$

Find: Which countries have a decreasing population?

Find: By what percentage is the population decreasing each year?

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4.5 Exponential Growth & Decay

Given: India: $A = 1173.1\, e^{0.008t}$
Iraq: $A = 31.5\, e^{0.019t}$
Japan: $A = 127.3\, e^{-0.006t}$
Russia: $A = 141.9\, e^{-0.005t}$

Find: Which countries have a decreasing population?

Russia and Japan, because k < 0

Find: By what percentage is the population decreasing each year?

Russia 0.6%, bec. k=-0.006 = - 0.6% or 0.6% decline
Japan 0.5%, bec. k=-0.005 = - 0.5% or 0.5% decline

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4.5 Exponential Growth & Decay

Given: India: $A = 1173.1\, e^{0.008t}$

Find: When will India's population be 1491 million?

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4.5 Exponential Growth & Decay

Given: India: $A = 1173.1\, e^{0.008t}$

Find: When will India's population be 1491 million?

2040

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4.5 Exponential Growth & Decay

Given: An artifact has 16 gms of C-14. The decay model below describes the amount of C-14 present after t years. $A = 16\, e^{-0.000121t}$

Find: How many gms of C-14 will be present in 11,430 years?

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4.5 Exponential Growth & Decay

Given: An artifact has 16 gms of C-14. The decay model below describes the amount of C-14 present after t years.

$$A = 16\, e^{-0.000121t}$$

Find: How many gms of C-14 will be present in 11,430 years?

~4gm

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4.5 Exponential Growth & Decay

$$A = A_o\, e^{r\,t}$$

Given: The half-life of Plutonium-239 is 25,000 years.

Find: If 16 gm of plutonium-239 are initially present, how many grams are present after 25,000 yrs? after 50,000 yrs? after 65,000 yrs?

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4.5 Exponential Growth & Decay

Given: The half-life of Plutonium-239 is 25,000 years.

Find: If 16 gm of plutonium-239 are initially present, how many grams are present after 25,000 yrs? after 50,000 yrs? after 65,000 yrs?

in 25,000 year, half left:

$$A = 16\ gm / 2 = 8\ gm$$

in 50,000 year, half of 25,000 yr am't left:

$$A = 8\ gm / 2 = 4\ gm$$

65,000 not multiple of 25,000

need to use equation $A = A_o e^{r t}$

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4.5 Exponential Growth & Decay

Given: The half-life of Plutonium-239 is 25,000 years.

Find: If 16 gm of plutonium-239 are initially present, how many grams are present after 25,000 yrs? after 50,000 yrs? after 65,000 yrs?

$$A_o/2 = A_o e^{r\,(25{,}000)}$$

$$1/2 = e^{r\,(25{,}000)}$$

$$A = A_o e^{r t}$$

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4.5 Exponential Growth & Decay

Given: The half-life of Plutonium-239 is 25,000 years.

Find: If 16 gm of plutonium-239 are initially present, how many grams are present after 25,000 yrs? after 50,000 yrs? after 65,000 yrs?

$A_o/2 = A_o e^{r(25,000)}$ $\qquad A = A_o e^{rt}$

$1/2 = e^{r(25,000)}$

$\ln(1/2) = \ln(e^{25,000r})$

$\ln 1 - \ln 2 = 25,000r \ln e = 25,000r$

$r = \frac{\ln 1 - \ln 2}{25,000} = -0.00002773$

$A = 16 e^{-0.00002773t}$

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4.5 Exponential Growth & Decay

Given: The half-life of Plutonium-239 is 25,000 years.

Find: If 16 gm of plutonium-239 are initially present, how many grams are present after 25,000 yrs? after 50,000 yrs?

after 65,000 yrs?

$A = 16 e^{-0.00002773t}$ $\qquad A = A_o e^{rt}$

$A = 16 e^{-0.00002773(65,000)}$

$= 2.638 \text{ gm}$

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