**Exponential Growth and Decay Model**:

 *k*: exponential growth/decay factor (if given as a percent convert to decimal)

 For growth: *k* > 0 (positive *k*)

 For decay: *k* < 0 (negative *k*)

 *t*: time, often in years

 *A*o: Initial amount (when *t* = 0)

 *A*: Amount after time *t*.

1. In the year 2000 the world population was 6.1 billion. The estimated growth rate was 1.4% per year.

If the population continues to grow at this rate, when will the population reach 15 billion? *Round to the nearest year.*

1. In 1990 the population of Africa was 643 million and by 2006 it had grown to 906 million.

Set up the respective exponential growth model with *t* being the number of years after 1990.

*Round k to 5 decimal places.*

 By which year will Africa’s population be projected to reach 2 billion people? (That’s the same as

2000 million.)

**Half-Life of a substance:**

Half-Life: The amount of time it takes a given amount of substance to decay to half of its original amount.

So in this and 

1. Create a general formula for *k*
2. The half-life of a particular radioactive element is 32 years.

Find the constant of decay, *k*. *Round k to 5 decimal places.*

Suppose you start with 50 grams of this element. How many years will pass until only 15 grams remain? *Round to one decimal place*.

**Carbon-14 (Radiocarbon) is used to predict the age of fossils or artifacts:**

Archaeologists can use this method to determine the age of ancient objects or animals (as long as former living organisms were involved). Carbon dioxide in the atmosphere contains a fixed fraction of radioactive carbon (carbon-14) over non-radioactive carbon (carbon-12). Plants absorb radioactive carbon from the atmosphere, which also makes its way into animals through the food chain. Thus all living creatures contain the same fixed proportion of the radioactive to the non-radioactive carbon. Absorption stops when the animal dies and carbon-14 begins to decay at an exponential rate. The half-life of carbon-14 is approximately 5715 years. The time elapsed since the organism died can be measured by how much carbon-14 is left in a fossil or artifact.

Note: Only an age up to 80,000 years can be dated. Older objects do not have enough carbon-14 left to

 determine the age accurately.

1. Find *k* for carbon-14, which has a half-life time of approximately 5715 years. *Round to 6 decimal places.*

Use *k* to set-up the exponential decay model for carbon-14.

Prehistoric cave paintings (made from plant based paint) were discovered in the Lascaux cave in France. The paint contained 15% of the original carbon-14. Estimate the age of the paintings at the time of the discovery. *Round to the closest hundred years*.

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**Homework ch 4.5:**

**p.469 – 473: # 7, 11, 17, 20** (for # 20 use the carbon dating model given above the problem or found in

 part (E) of these lecture notes), **23, 29, 31**

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Selected homework answers:

p. 470 # 20: approximately 1056 years old