# Math-2

Lesson 9-4

Modeling Radioactive Decay Using the Exponential Function

What is the equation of the graph? $g(x) = ab^x + k$

1) horizontal asymptote

y = 1

$g(x) = ab^x + k$

$k = 1$

$y = ab^x + 1$

2) y-intercept $(0, 4)$

Substitute (0, 4) into the equation.

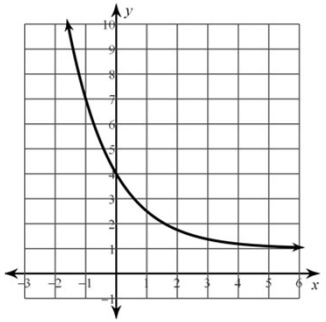
$4 = ab^0 + 1 \qquad a = 3$

$y = 3b^x + 1$

3) "Nice" x-y pair $(-1, 7)$

Substitute (-1, 7) into the equation.

$7 = 3b^{-1} + 1$



$6 = 3b^{-1}$

$2 = b^{-1} \qquad 2 = \frac{1}{b}$

$b = \frac{1}{2}$

$y = 3(\frac{1}{2})^x + 1$

$g(x) = ab^x + k$

1) Horizontal Asymptote: y = 0

$g(x) = ab^x + k \qquad k = 0$

Equation: $y = ab^x$

2) y-intercept: $(0,3)$

$3 = ab^0 \qquad a = 3$

Equation: $y = 3b^x$

3) An x-y pair (preferably with x = 1)

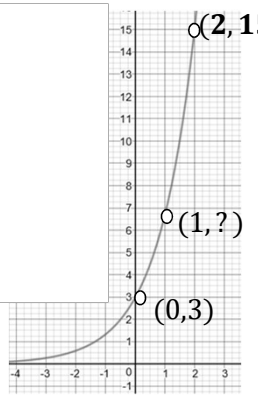
$(\mathbf{2, 15})$

$\mathbf{15 = 3b^2}$

$\mathbf{5 = b^2}$

$\sqrt[2]{b^2} = \sqrt[2]{5}$

$b = 2.236$




$y = 3(2.236)^x$

$g(x) = ab^x + k$

1) Horizontal Asymptote: y = 0

$g(x) = ab^x + k \qquad k = 0$

Equation: $y = ab^x$

2) y-intercept: $(0,3)$

$3 = ab^0 \qquad a = 3$

Equation: $y = 3b^x$

3) An x-y pair (preferably with x = 1)

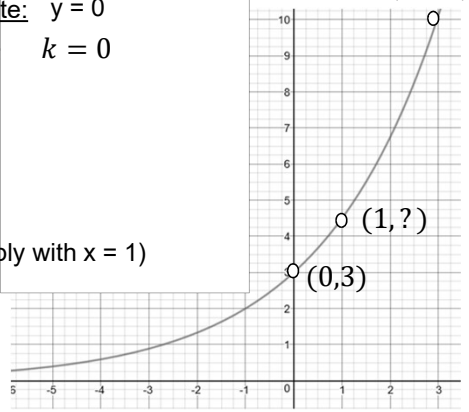
$(\mathbf{3, 10})$

$\mathbf{10 = 3b^3}$

$\mathbf{3.333 = b^3}$

$\sqrt[3]{b^3} = \sqrt[3]{3.3333}$

$b = 1.4938$

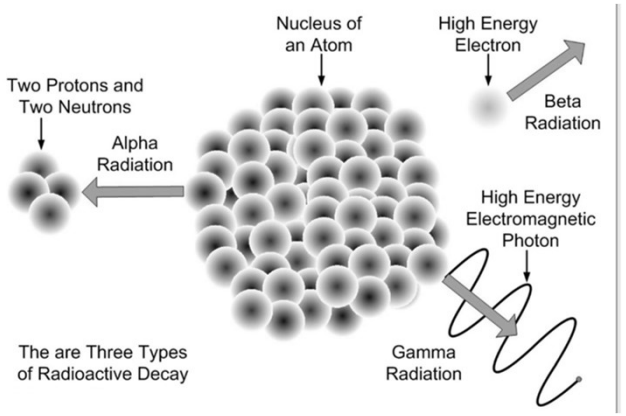


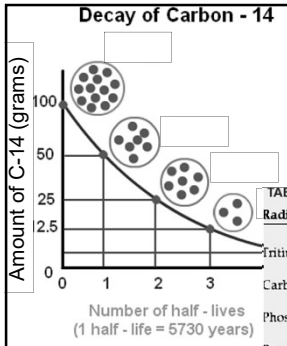

$y = 3(1.4938)^x$

Quantity: a category of measurements in the real world.

Unit of Measure: the unit that is used to measure a quantity.

| Examples of quantities: | Examples of units of measure: |
|---|---|
| Height | (Height) → inches, feet, miles |
| Weight | (Weight) → pounds, kilograms |
| Temperature | (Temperature) → degrees Fahrenheit or Celsius |



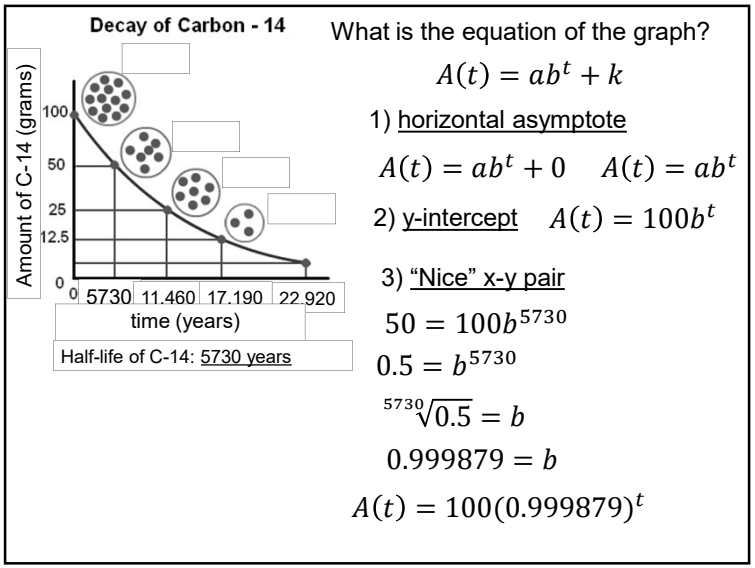

Half-life: the time it takes for an amount of Radioactive material to "decay" away to half of the original amount.

Half life: Every radioactive element has its own unique half-life.

TABLE 22.2 Half-lives of Some Useful Radioisotopes

| Radioisotope | Symbol | Radiation | Half-life | Use |
|---|---|---|---|---|
| Tritium | $^{3}_{1}H$ | $\beta^-$ | 12.33 years | Biochemical tracer |
| Carbon-14 | $^{14}_{6}C$ | $\beta^-$ | 5730 years | Archaeological dating |
| Phosphorus-32 | $^{32}_{15}P$ | $\beta^-$ | 14.26 days | Leukemia therapy |
| Potassium-40 | $^{40}_{19}K$ | $\beta^-$ | $1.28 \times 10^9$ years | Geological dating |
| Cobalt-60 | $^{60}_{27}Co$ | $\beta^-, \gamma$ | 5.27 years | Cancer therapy |
| Technetium-99$m$* | $^{99m}_{43}Tc$ | $\gamma$ | 6.01 hours | Brain scans |
| Iodine-123 | $^{123}_{53}I$ | $\gamma$ | 13.27 hours | Thyroid therapy |
| Uranium-235 | $^{235}_{92}U$ | $\alpha, \gamma$ | $7.04 \times 10^8$ years | Nuclear reactors |

- Uranium-238 decays with a half-life of 4.5 billion years to thorium-234
- which decays with a half-life of 24 days to protactinium-234
- which decays with a half-life of 1.2 minutes to uranium-234
- which decays with a half-life of 240 thousand years to thorium-230
- which decays with a half-life of 77 thousand years to radium-226
- which decays with a half-life of 1.6 thousand years to radon-222
- which decays with a half-life of 3.8 days to polonium-218
- which decays with a half-life of 3.1 minutes to lead-214
- which decays with a half-life of 27 minutes to bismuth-214
- which decays with a half-life of 20 minutes to polonium-214
- which decays with a half-life of 160 microseconds to lead-210
- which decays with a half-life of 22 years to bismuth-210
- which decays with a half-life of 5 days to polonium-210
- which decays with a half-life of 140 days *to lead-206, which is a stable* nuclide.




What is the equation of the graph?

$A(t) = ab^t + k$

1) horizontal asymptote

$A(t) = ab^t + 0 \quad A(t) = ab^t$

2) y-intercept $\quad A(t) = 100b^t$

3) "Nice" x-y pair

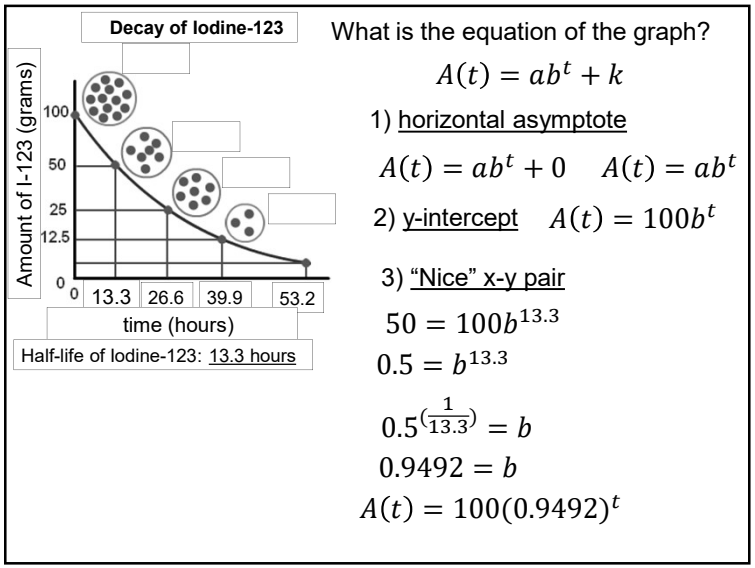
$50 = 100b^{5730}$

$0.5 = b^{5730}$

$\sqrt[5730]{0.5} = b$

$0.999879 = b$

$A(t) = 100(0.999879)^t$

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2) y-intercept $\quad A(t) = 100b^t$

3) "Nice" x-y pair

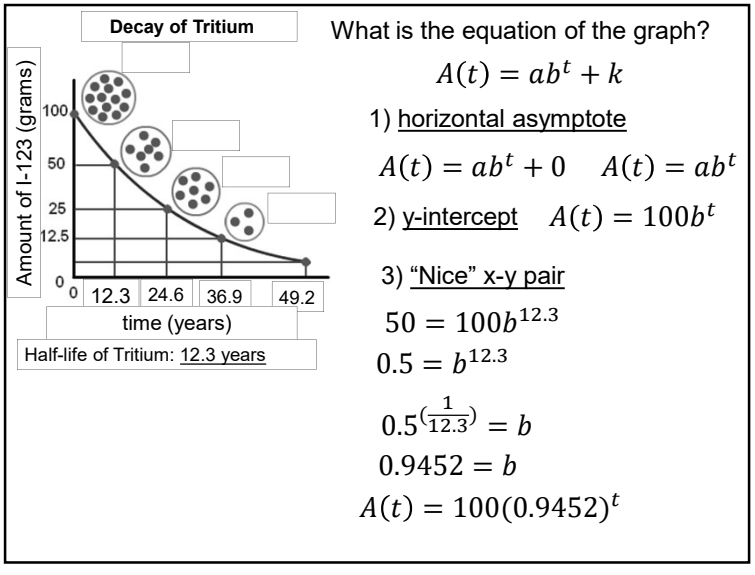
$50 = 100b^{13.3}$

$0.5 = b^{13.3}$

$0.5^{(\frac{1}{13.3})} = b$

$0.9492 = b$

$A(t) = 100(0.9492)^t$

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1) horizontal asymptote

$A(t) = ab^t + 0 \quad A(t) = ab^t$

2) y-intercept $\quad A(t) = 100b^t$

3) "Nice" x-y pair

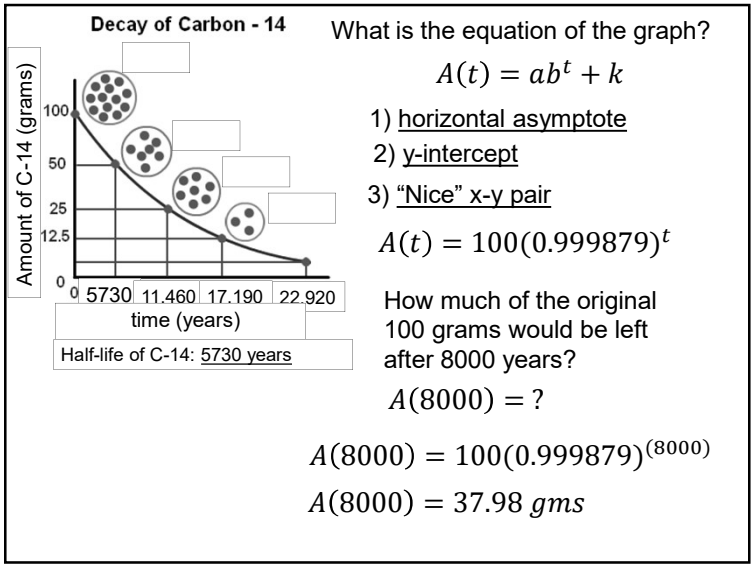
$50 = 100b^{12.3}$

$0.5 = b^{12.3}$

$0.5^{(\frac{1}{12.3})} = b$

$0.9452 = b$

$A(t) = 100(0.9452)^t$




What is the equation of the graph?

$A(t) = ab^t + k$

1) horizontal asymptote

2) y-intercept

3) "Nice" x-y pair

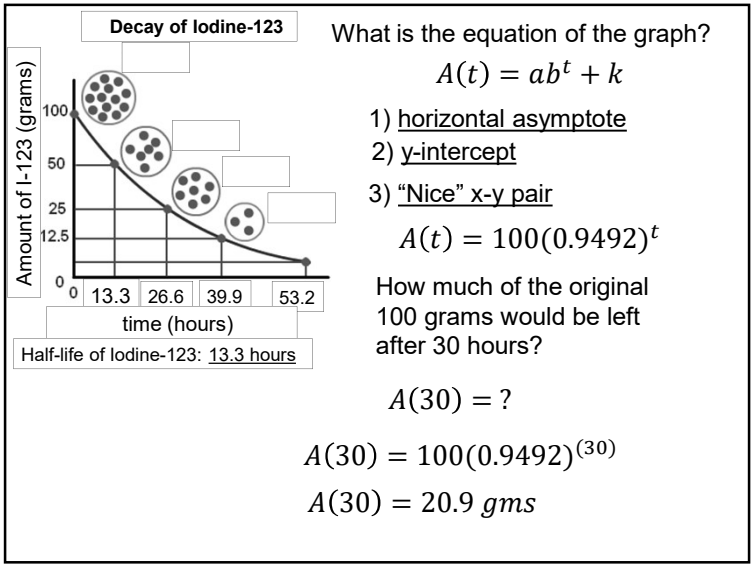
$A(t) = 100(0.999879)^t$

How much of the original 100 grams would be left after 8000 years?

$A(8000) = ?$

$A(8000) = 100(0.999879)^{(8000)}$

$A(8000) = 37.98\ gms$




What is the equation of the graph?

$A(t) = ab^t + k$

1) horizontal asymptote
2) y-intercept
3) "Nice" x-y pair

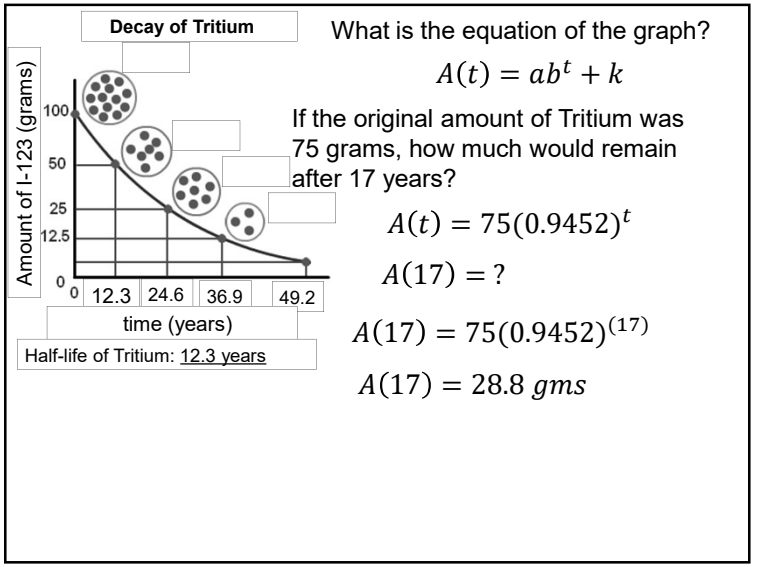
$A(t) = 100(0.9492)^t$

How much of the original 100 grams would be left after 30 hours?

$A(30) = ?$

$A(30) = 100(0.9492)^{(30)}$

$A(30) = 20.9\ gms$




What is the equation of the graph?

$A(t) = ab^t + k$

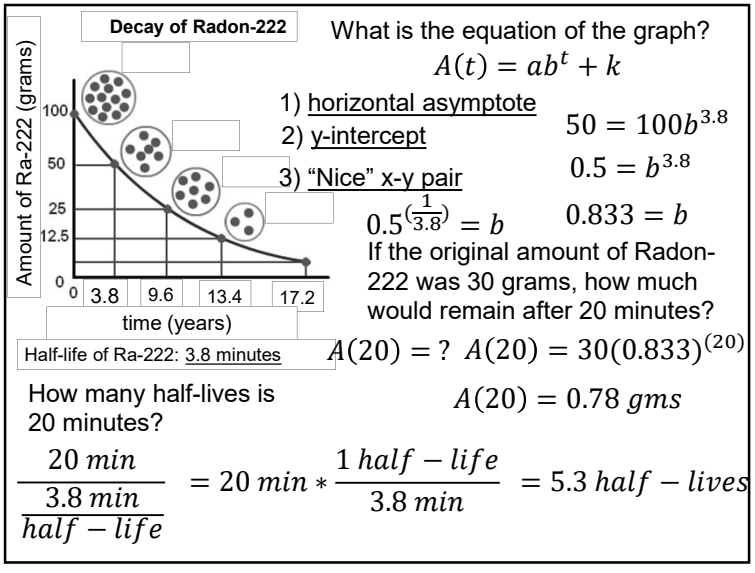
If the original amount of Tritium was 75 grams, how much would remain after 17 years?

$A(t) = 75(0.9452)^t$

$A(17) = ?$

$A(17) = 75(0.9452)^{(17)}$

$A(17) = 28.8\ gms$




What is the equation of the graph?

$A(t) = ab^t + k$

1) horizontal asymptote
2) y-intercept
3) "Nice" x-y pair

$50 = 100b^{3.8}$

$0.5 = b^{3.8}$

$0.5^{(\frac{1}{3.8})} = b$

$0.833 = b$

If the original amount of Radon-222 was 30 grams, how much would remain after 20 minutes?

$A(20) = ?$ $A(20) = 30(0.833)^{(20)}$

$A(20) = 0.78\ gms$

How many half-lives is 20 minutes?

$$\frac{20\ min}{\frac{3.8\ min}{half-life}} = 20\ min * \frac{1\ half-life}{3.8\ min} = 5.3\ half-lives$$