

## Objective 1 - Identify Type of Model

*Note: There are no textbook or videos directly to this section. If you want to review a certain type of model, you will need to go back to that Module.*

We summarize the types of models we've looked at below.

### Linear Model:

- Used when we have a *constant* variation between two quantities.
- $y = mx + b$ . Can be multiple lines added together.
- Phrases to look for: constant, steadily increasing/decreasing, adding/subtracting  $[/, /,]$  every  $[/, /,]$ .

### Direct Variation:

- Used when we have a *direct* variation between two quantities (as one quantity increases, the other increases).
- $y = kx^n$ . Joint variation may have more than one variable (like  $y = kx^n z^m$ ).
- Phrases to look for: vary directly, directly proportional, "as one increases, so does the other".

### Inverse Variation:

- Used when we have an *indirect* variation between two quantities (as one quantity increases, the other decreases).
- $y = \frac{k}{x^n}$ . Combined with joint variation, there may be more than one variable (like  $PV = nRT$ ).
- Phrases to look for: vary indirectly, indirectly proportional, "as one increases, the other decreases".

### Logarithmic Model:

- Used when we have a **rapid** early growth, then slower growth later.
- $y = \log(kx)$ . Remember that  $\ln(x) = \log_e(x)$ .

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Learning outcomes:  
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- Phrases to look for: rapid early growth/decay, no bound on growth/decay.

### Exponential Model:

- Used when we have a slow initial growth, then *rapid* growth later.
- $y = a^{kx}$ . Common bases are 2, 3, and  $e$ .
- Phrases to look for: rapid late growth/decay, bounds on growth/decay.

Determine the type of model that would be most appropriate for each situation below. Answers will be either:

- Linear
- Direct
- Indirect
- Logarithmic
- Exponential
- General (if we are going to use the general form of a particular function)

**Question 1** Your bank offers a savings account that will increase your total balance by 0.2% annually. You want to decide how much to initially deposit and if the initial deposit makes a big difference in the long run.  $S$

*Exponential*

**Question 2** A ball is dropped from the top of Century Tower. The ball steadily picks up speed before hitting the ground. You want to figure out what the ball's height is at a certain time.

*Direct*

**Question 3** Chemists commonly create a solution by mixing two products of differing concentrations together. For example, a chemist could have large amounts of a 10% acid solution and a 30% acid solution, but need a 10 liter 15% solution.

*Linear*

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**Question 4** *Kepler's Third Law: The square of the time,  $T$ , required for a planet to orbit the Sun is directly proportional to the cube of the mean distance,  $a$ , that the planet is from the Sun.*

Direct

**Question 5** *The rate of vibration of a string under constant tension,  $r$ , varies inversely with the length of the string,  $l$ .*

Indirect

**Question 6** *A population of bacteria doubles every hour.*

Exponential

**Question 7** *Radiocarbon dating is used to calculate the approximate date a plant or animal died by noting the percentage of carbon-14,  $r$  in the object. The age of the object  $t$ , in years, is directly proportional to the natural log of the percentage of carbon-14,  $r$  in the object.*

Logarithmic

**Question 8** *The weight of an object above the surface of Earth varies inversely with the square of the distance from the center of Earth.*

Indirect

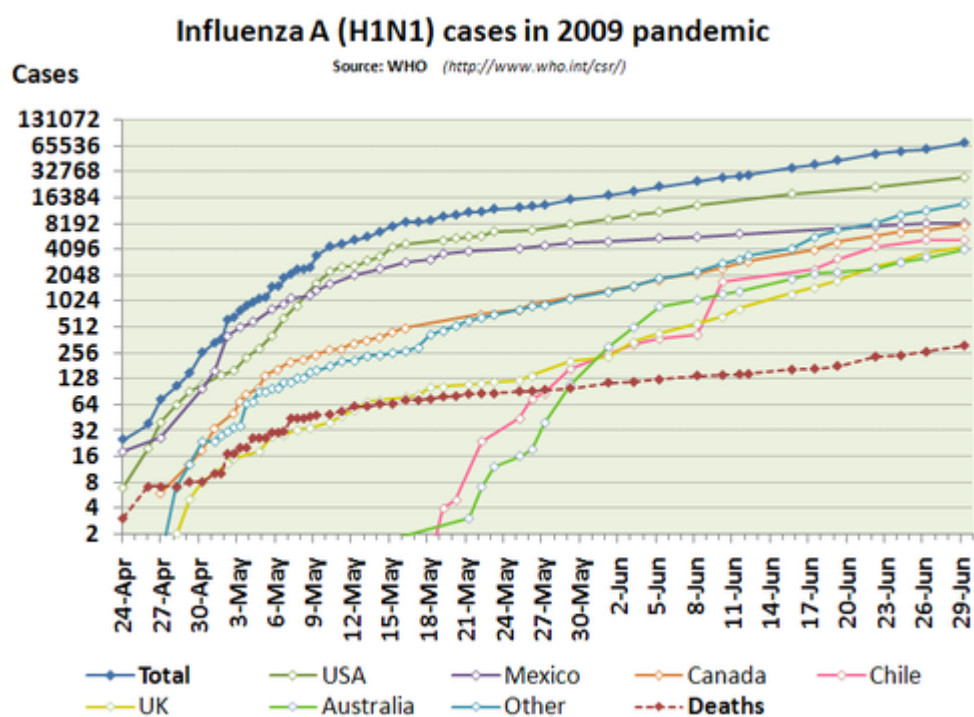
**Question 9** *The kinetic energy  $K$  of a moving object varies jointly with its mass  $m$  and the square of its velocity  $v$ .*

Direct

**Question 10** *Carlos has taken an initial dose of a prescription medication orally. The medicine is absorbed rapidly by the large intestine and absorbed slowly as it is digested otherwise.*

Exponential

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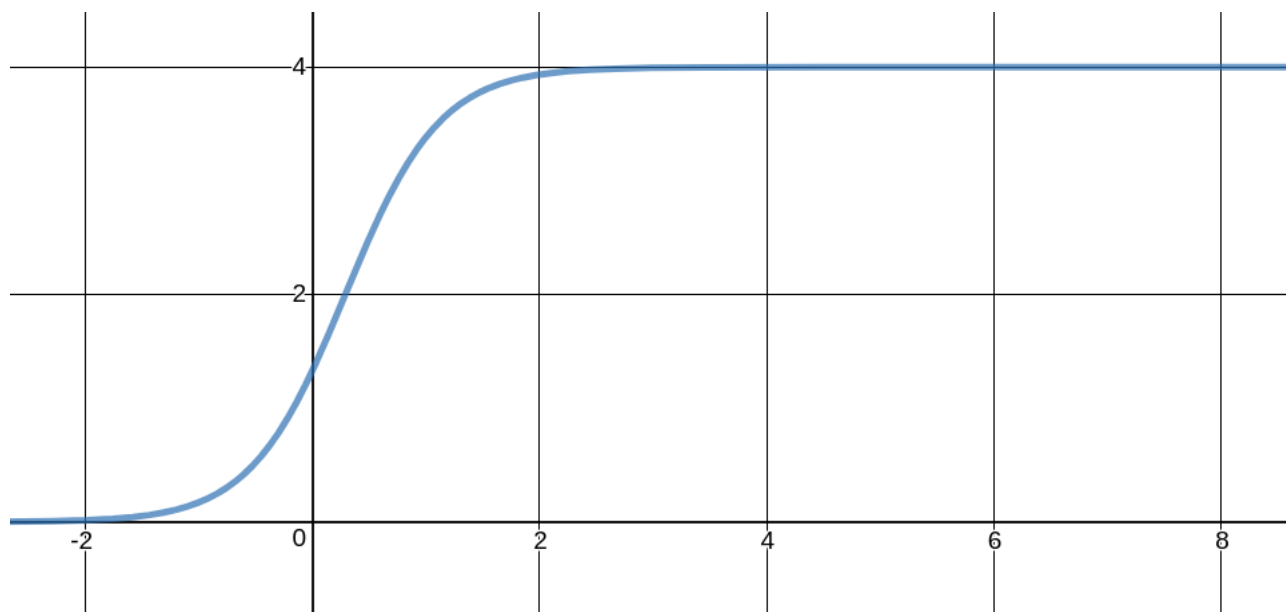


Figure 1: A sigmoidal curve.

**Question 11**

**Question 12** A ball is dropped from the top of Century Tower. The ball steadily picks up speed before hitting the ground. You want to figure out what the ball's speed is at a certain time.

**Question 13**

**Question 14** Kappa Delta is hosting an all-you-can-eat pancake fundraiser to support the prevention of child abuse. Adult (18+) tickets are \$10 and teen (10-17) tickets are \$5. Children under 10 are let in without a ticket. The ticket-sellers only keep track of the total number of tickets sold and total revenue, but want to know how many adult and teen tickets were sold.