DO NOW

WORK ON WS

## SECTIONS 3.1

# LINEAR FUNCTIONS, THEIR PROPERTIES, & LINEAR MODELS

# Homework

p.132
#14, 16, 20, 22,
24, 29, 31

# OBJECTIVE 1

## GRAPH LINEAR FUNCTIONS

# Graphing Linear Functions...

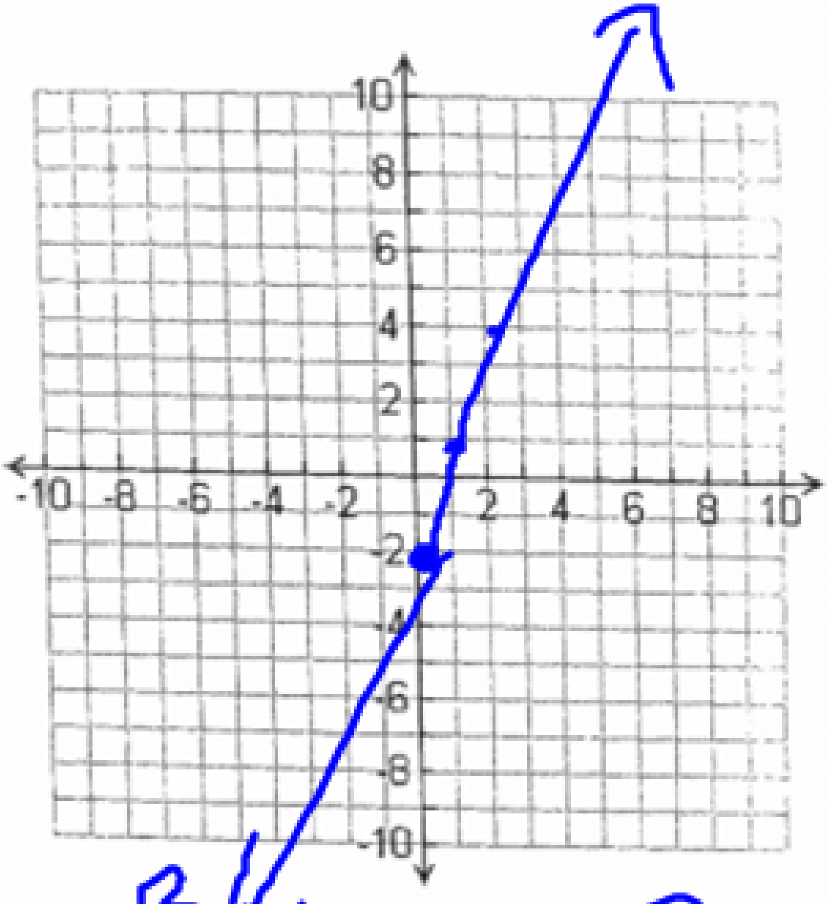
A linear function is a function in the form of:

$$y = \overset{\text{slope}}{m}\, x + b \longleftarrow \text{y-int.}$$

Its domain is a set of all real number, ~~when m≠0~~

Its range is a set of all real number, when m ≠ 0
if m=0, the range is {y|y=b}

1. $y = 3x - 2$



Slope = 3

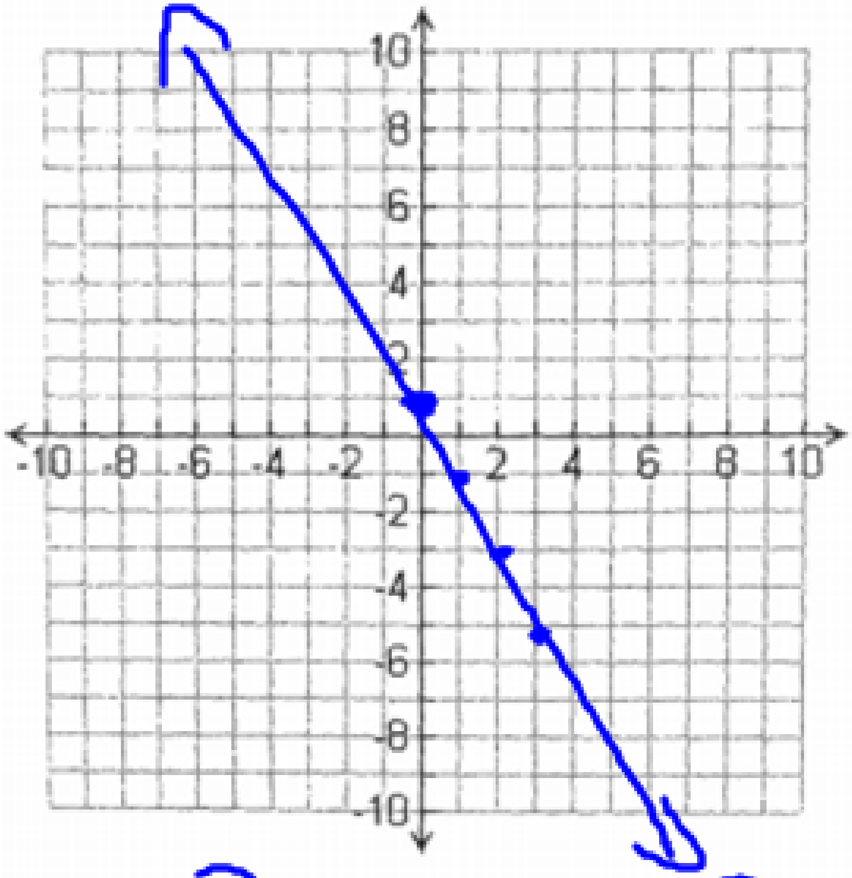
y-int. = -2

[✓ Inc.], Decr. Or Constant?

Domain: ℝ

Range: ℝ

2. $y = -2x + 1$



Slope = -2

y-int. = 1

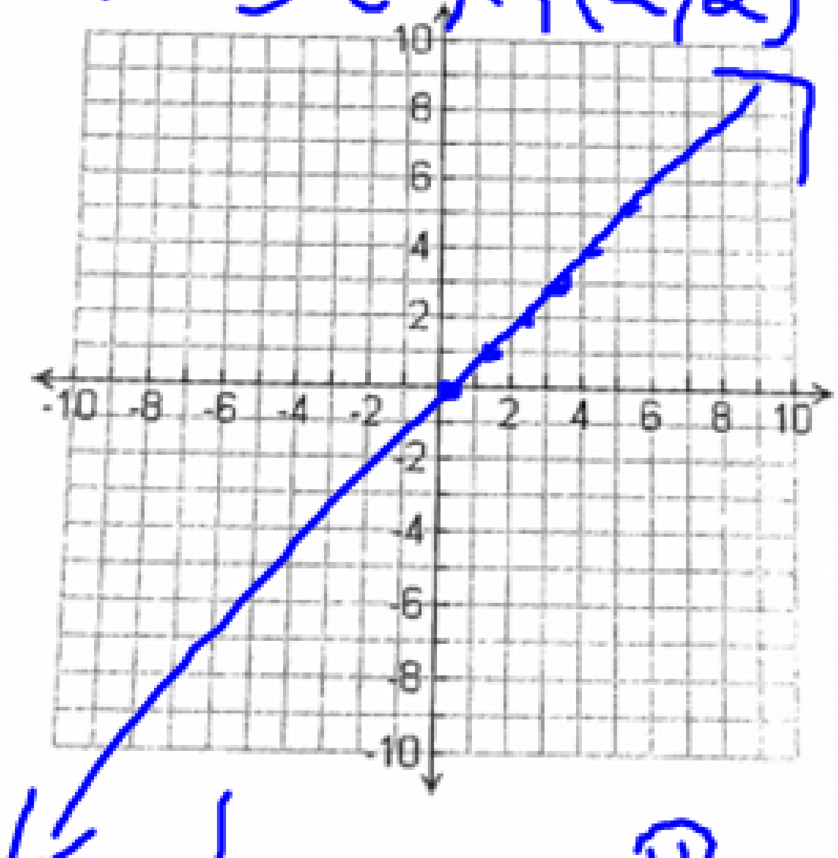
Inc., [✓ Decr.] Or Constant?

Domain: ℝ

Range: ℝ

**3.** $y = x$

$(0,0)\ (1,1)\ (2,2)$



Slope = 1

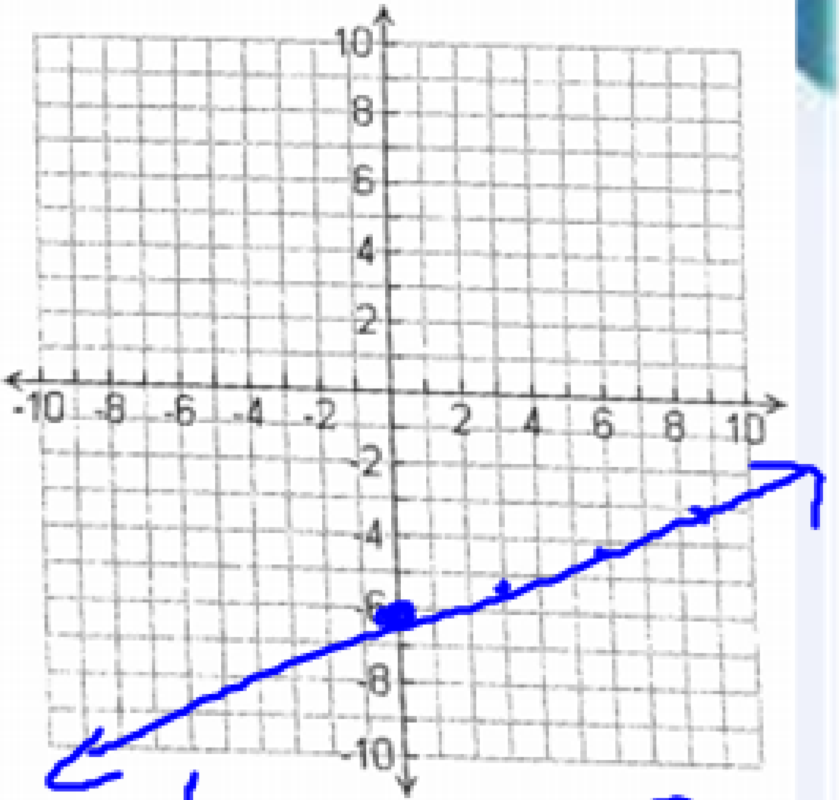
y-int. = 0

Domain: ℝ

Range: ℝ

[✓ Inc.], Decr. Or Constant?

**4.** $y = \frac{1}{3}x - 6$



Slope = $\frac{1}{3}$

y-int. = $-6$

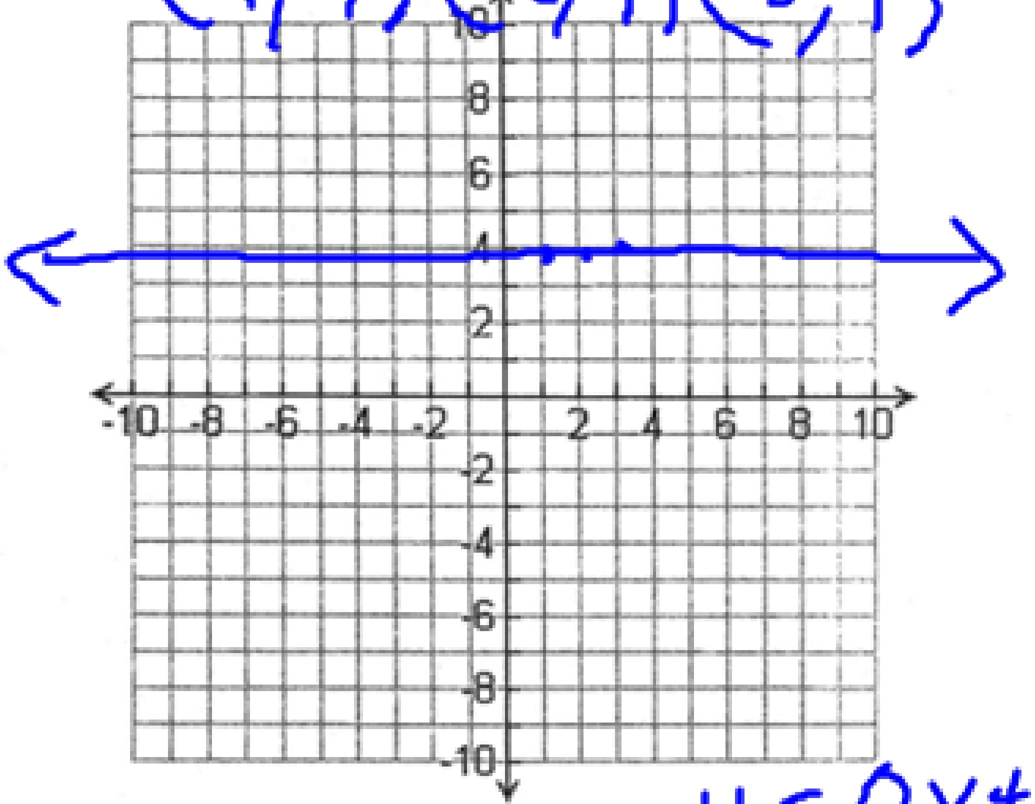
Domain: ℝ

Range: ℝ

[✓ Inc.] Decr. Or Constant?

**5.** $y = 4$

(1, 4) (2, 4) (3, 4)



$y = 0x + 4$

Slope = 0

Domain: ℝ

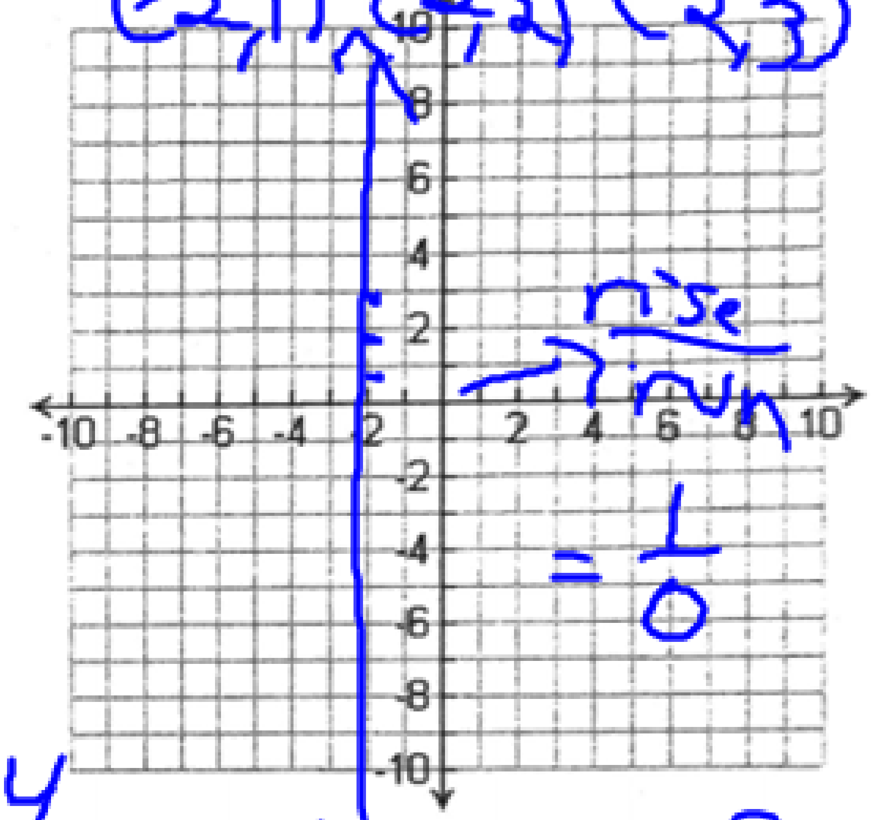
y-int. = 4

Range: 4

Inc., Decr. [✓ Or Constant?]

**6.** $x = -2$

(-2, 1) (-2, 2) (-2, 3)



$\frac{\text{rise}}{\text{run}} = \frac{1}{0}$

Slope = Und

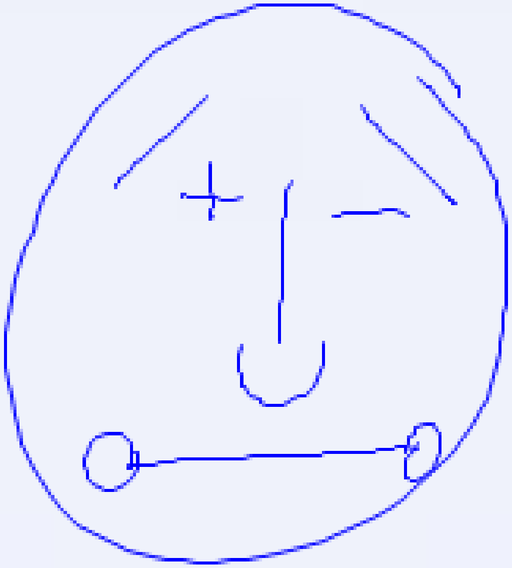
Domain: -2

y-int. = /

Range: ℝ

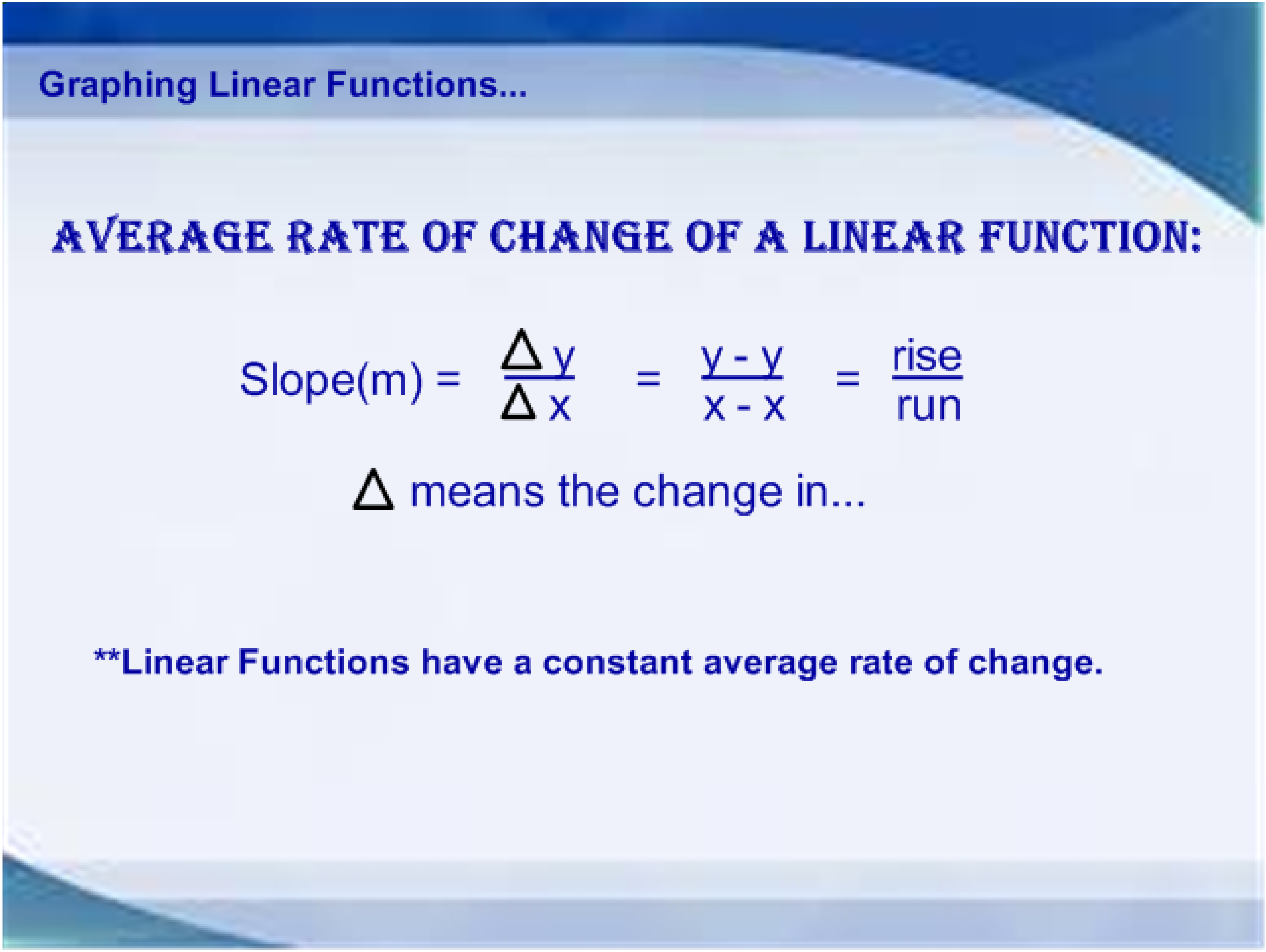
~~Inc., Decr. Or Constant?~~

# The Slope Guy



# OBJECTIVE 2

## USE AVERAGE RATE OF CHANGE TO IDENTIFY LINEAR FUNCTIONS



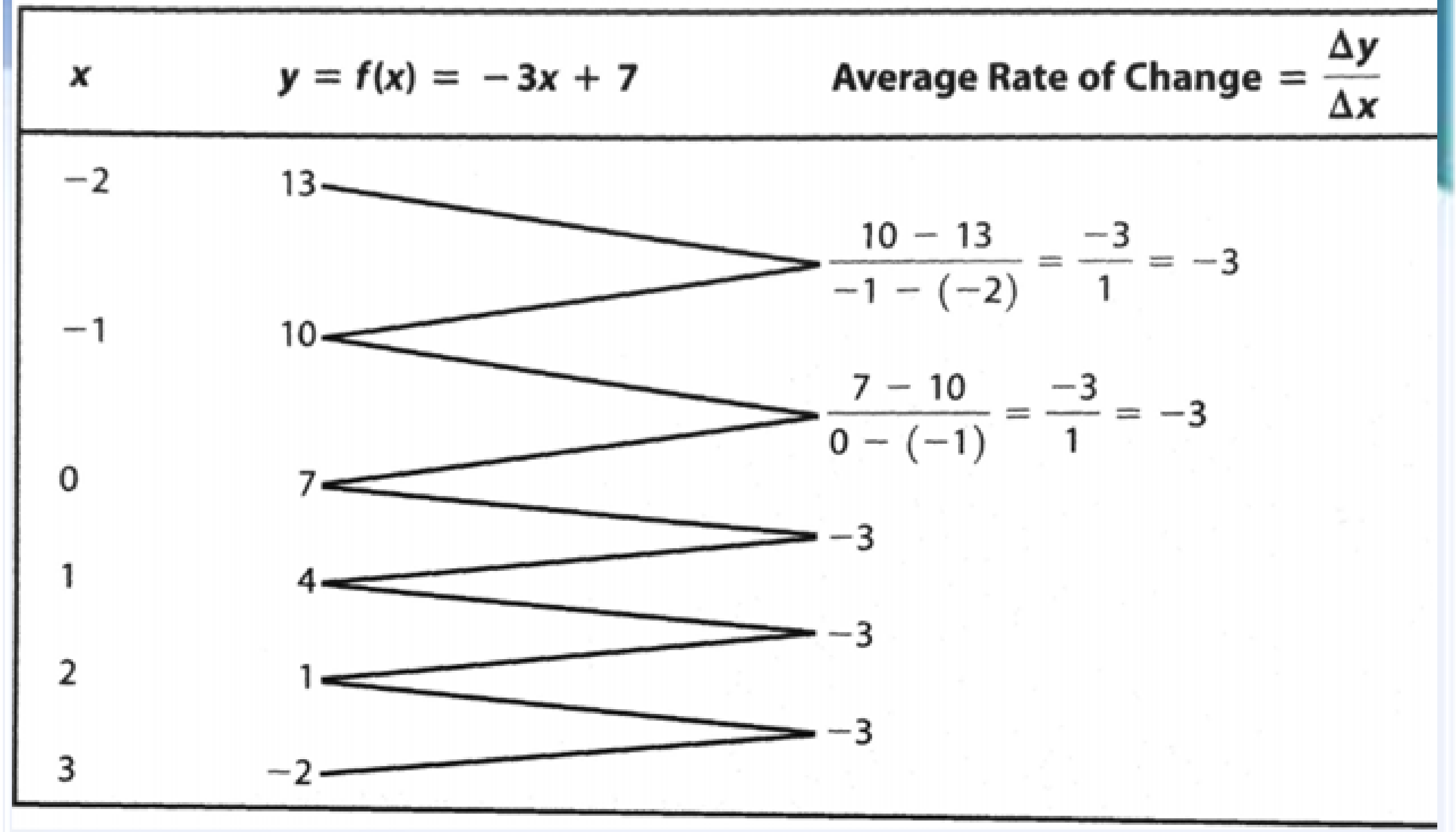
Graphing Linear Functions...

## AVERAGE RATE OF CHANGE OF A LINEAR FUNCTION:

$$\text{Slope}(m) = \frac{\Delta y}{\Delta x} = \frac{y - y}{x - x} = \frac{\text{rise}}{\text{run}}$$

$\Delta$ means the change in...

****Linear Functions have a constant average rate of change.**



| $x$ | $y = f(x) = -3x + 7$ | Average Rate of Change $= \frac{\Delta y}{\Delta x}$ |
|---|---|---|
| $-2$ | $13$ | |
| | | $\frac{10 - 13}{-1 - (-2)} = \frac{-3}{1} = -3$ |
| $-1$ | $10$ | |
| | | $\frac{7 - 10}{0 - (-1)} = \frac{-3}{1} = -3$ |
| $0$ | $7$ | |
| | | $-3$ |
| $1$ | $4$ | |
| | | $-3$ |
| $2$ | $1$ | |
| | | $-3$ |
| $3$ | $-2$ | |

Notice how the slope of CONSTANTLY -3 in this linear function.

# Example...

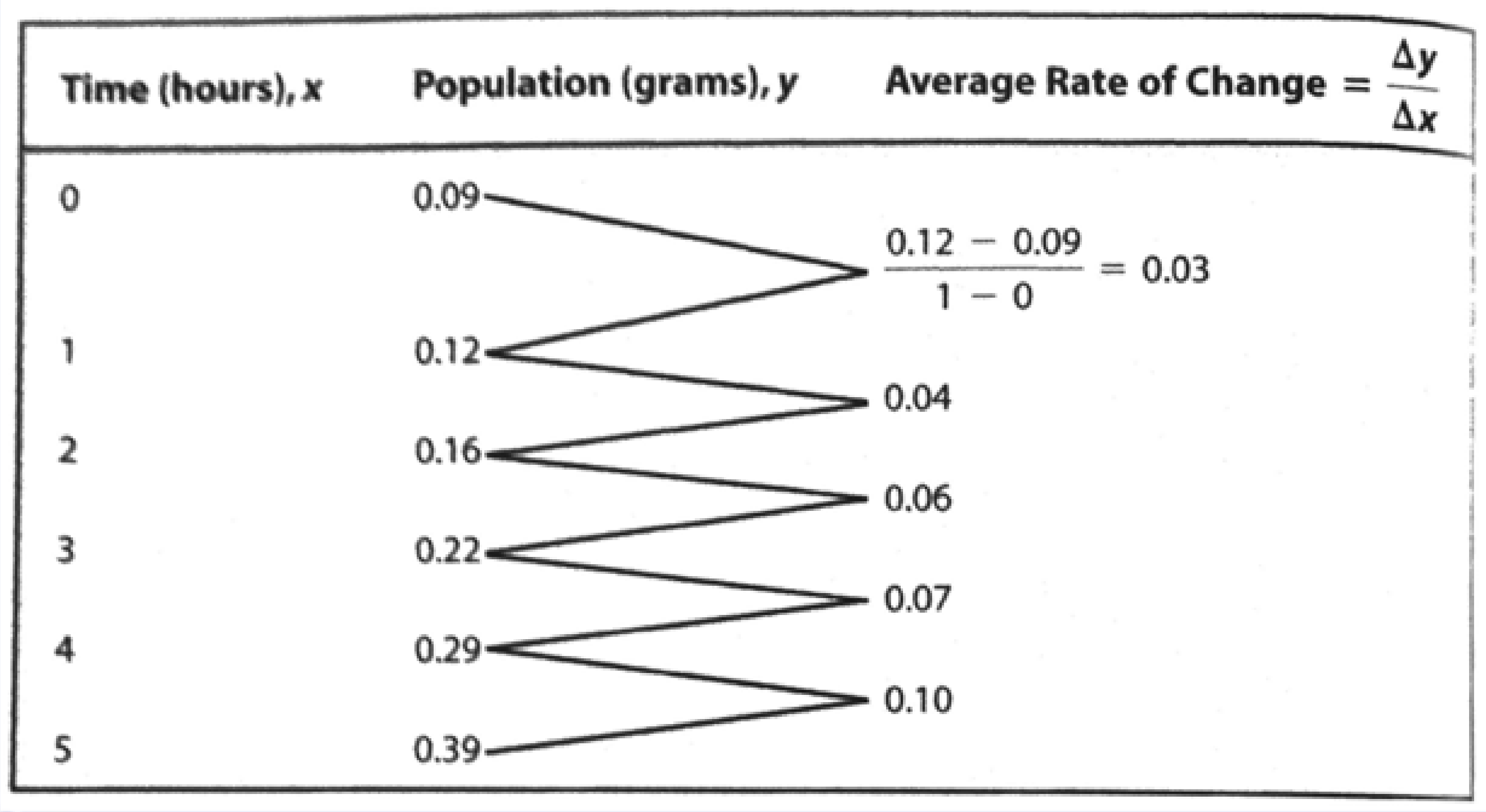
## Using average rate of change to identify linear function

A strain of E-coli Beu 397-recA441 is placed into a petri dish at 30 degrees celsius and allowed to grow. The data shown in the table below is collected. The population is measured in grams and the time in hours. Use the average rate of change to determine whether a function is linear.

| Time (hours), $x$ | Population (grams), $y$ | $(x, y)$ |
|---|---|---|
| 0 | 0.09 | (0, 0.09) |
| 1 | 0.12 | (1, 0.12) |
| 2 | 0.16 | (2, 0.16) |
| 3 | 0.22 | (3, 0.22) |
| 4 | 0.29 | (4, 0.29) |
| 5 | 0.39 | (5, 0.39) |

$$\frac{y-y}{x-x} = \frac{.12-.09}{1-0} = .03$$

$$\frac{y-y}{x-x} = \frac{.16-.12}{2-1} = .04$$

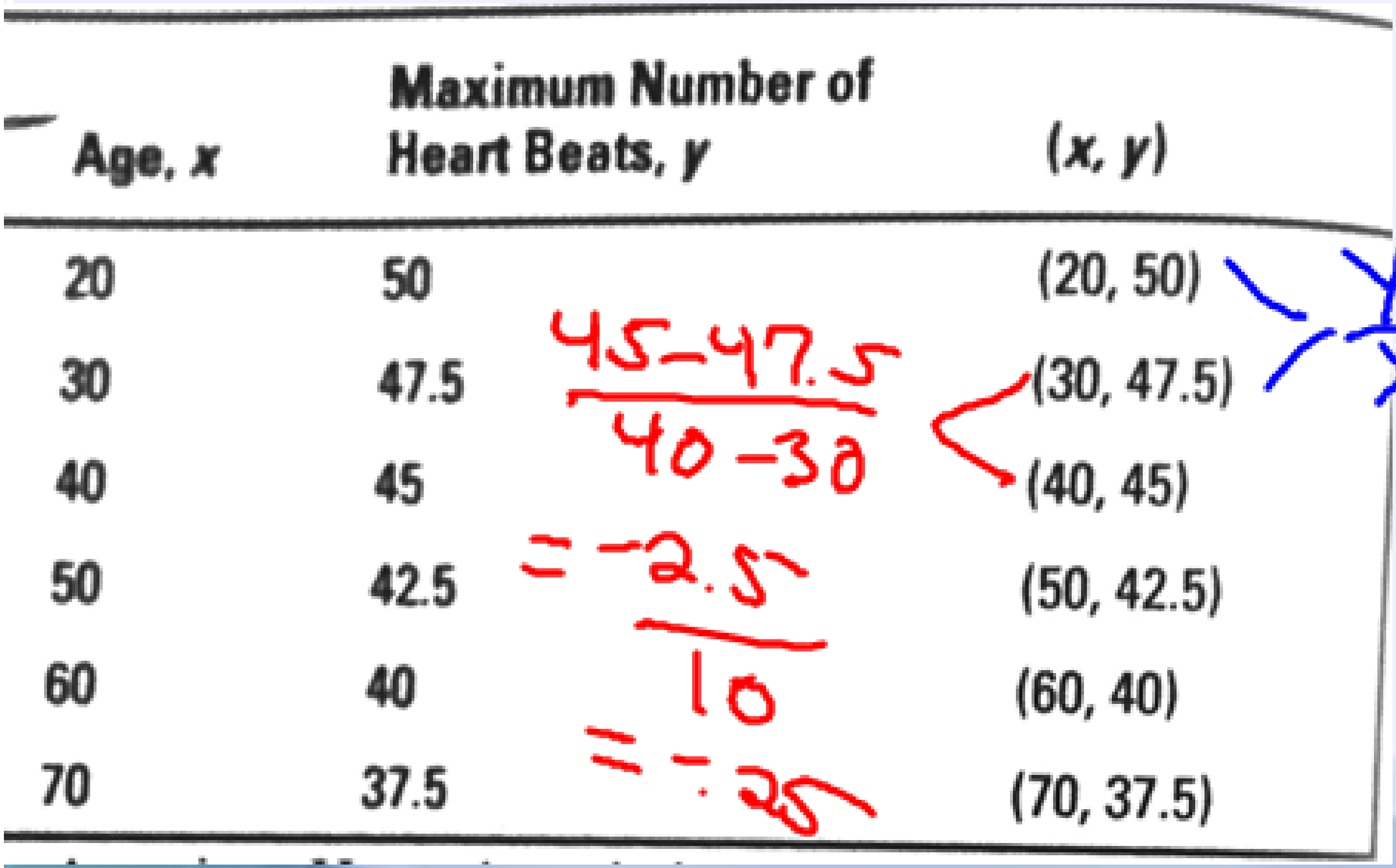


| Time (hours), $x$ | Population (grams), $y$ | Average Rate of Change $= \frac{\Delta y}{\Delta x}$ |
|---|---|---|
| 0 | 0.09 | |
| | | $\frac{0.12 - 0.09}{1 - 0} = 0.03$ |
| 1 | 0.12 | |
| | | 0.04 |
| 2 | 0.16 | |
| | | 0.06 |
| 3 | 0.22 | |
| | | 0.07 |
| 4 | 0.29 | |
| | | 0.10 |
| 5 | 0.39 | |

## Example...

### Using average rate of change to identify linear function

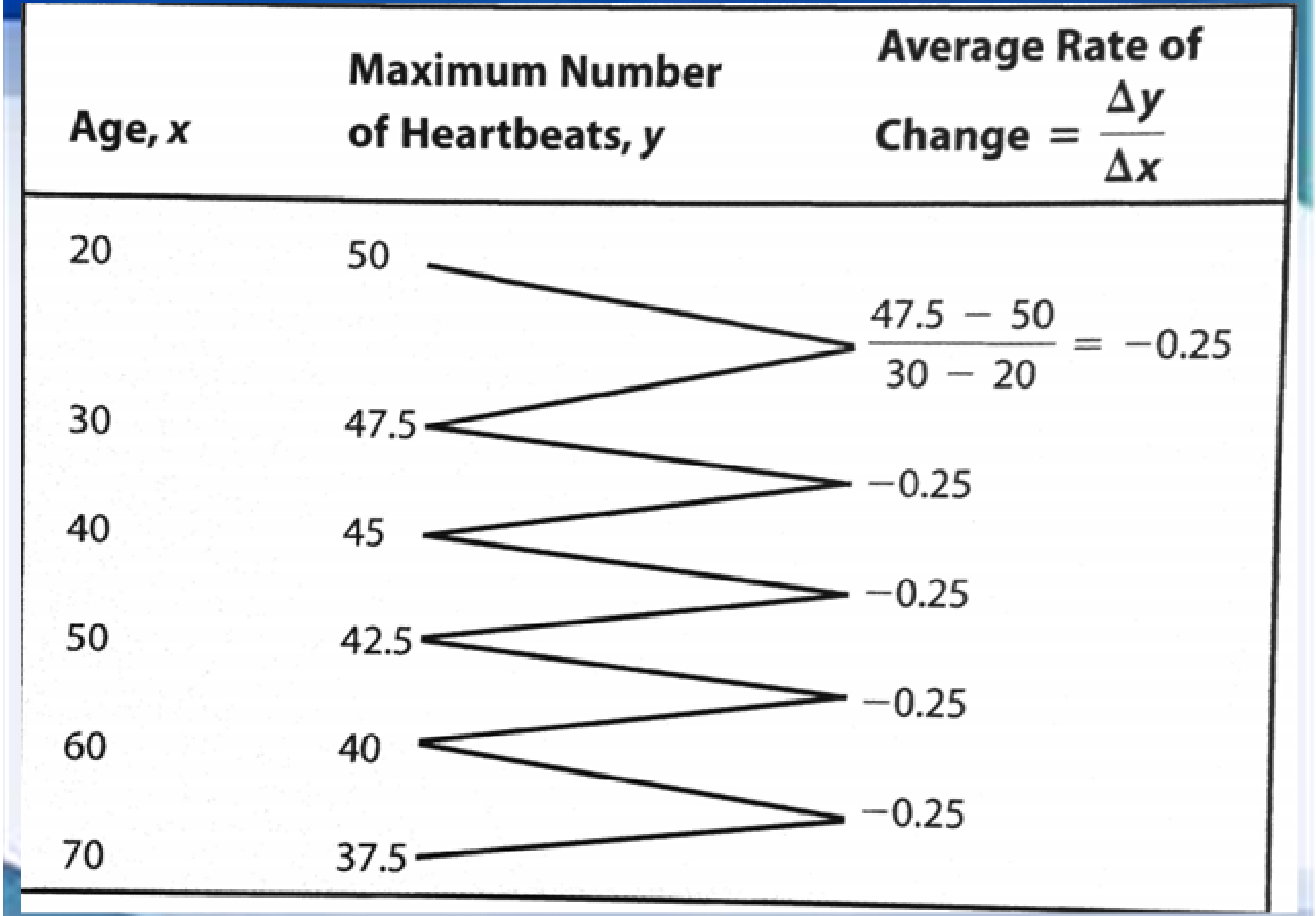
**The table below represents the maximum number of heartbeats that a healthy individual should have during a 15 second interval of time while exercising for different ages. Use the avg. rate of change to determine whether the function is linear.**



| Age, *x* | Maximum Number of Heart Beats, *y* | (*x*, *y*) |
|---|---|---|
| 20 | 50 | (20, 50) |
| 30 | 47.5 | (30, 47.5) |
| 40 | 45 | (40, 45) |
| 50 | 42.5 | (50, 42.5) |
| 60 | 40 | (60, 40) |
| 70 | 37.5 | (70, 37.5) |

$$\frac{45-47.5}{40-30} = \frac{-2.5}{10} = -.25$$

$$\frac{y-y}{x-x} = \frac{47.5-50}{30-20} = \frac{-2.5}{10} = -.25$$



| Age, $x$ | Maximum Number of Heartbeats, $y$ | Average Rate of Change $= \frac{\Delta y}{\Delta x}$ |
|---|---|---|
| 20 | 50 | |
| | | $\frac{47.5 - 50}{30 - 20} = -0.25$ |
| 30 | 47.5 | |
| | | $-0.25$ |
| 40 | 45 | |
| | | $-0.25$ |
| 50 | 42.5 | |
| | | $-0.25$ |
| 60 | 40 | |
| | | $-0.25$ |
| 70 | 37.5 | |

# OBJECTIVE 3

## DETERMINE WHETHER A FUNCTION IS INCREASING, DECREASING, OR CONSTANT

A function $f(x)$ is increasing is its slope is positive

it is decreasing if its slope is negative

it is constant if $m = 0$

Graphing Linear Functions...

# DETERMINE WHETHER A FUNCTION IS INCREASING, DECREASING, OR CONSTANT

$g(x) = 0x - 1$

(a) $f(x) = \frac{-1}{2}x+5$ dec.

(b) $g(x)= -1$ constant.

(c) $h(x)=\frac{1}{4}\ x-3$ inc.

(d) $s(t)= -x+2$ dec.

# OBJECTIVE 4

## BUILD LINEAR MODELS WITH VERBAL DESCRIPTIONS

**If the average rate of change of a function is constant (m), a linear function f can be used to model the relationship between the two varables.**

$$f(x) = mx + b$$

Some companies depreciate their assets using straight-line depreciation so that the value of the asset declines by a fixed amount each year. The amount of the decline depends on the useful life that the company places on the asset.

Suppose that a company just purchased a fleet of new cars at the cost of \$28,000 per car. The company chooses to depreciate each vehicle using the straight line method over 7 years. This means that each car will depreciate by $\frac{28,000}{7} = \$4000$ per year.

(a) Build a linear model that expresses the book value v of each car as a function of its age, x.

$y = mx + b \longrightarrow V(x) = {}^{-}4000x + 28000$

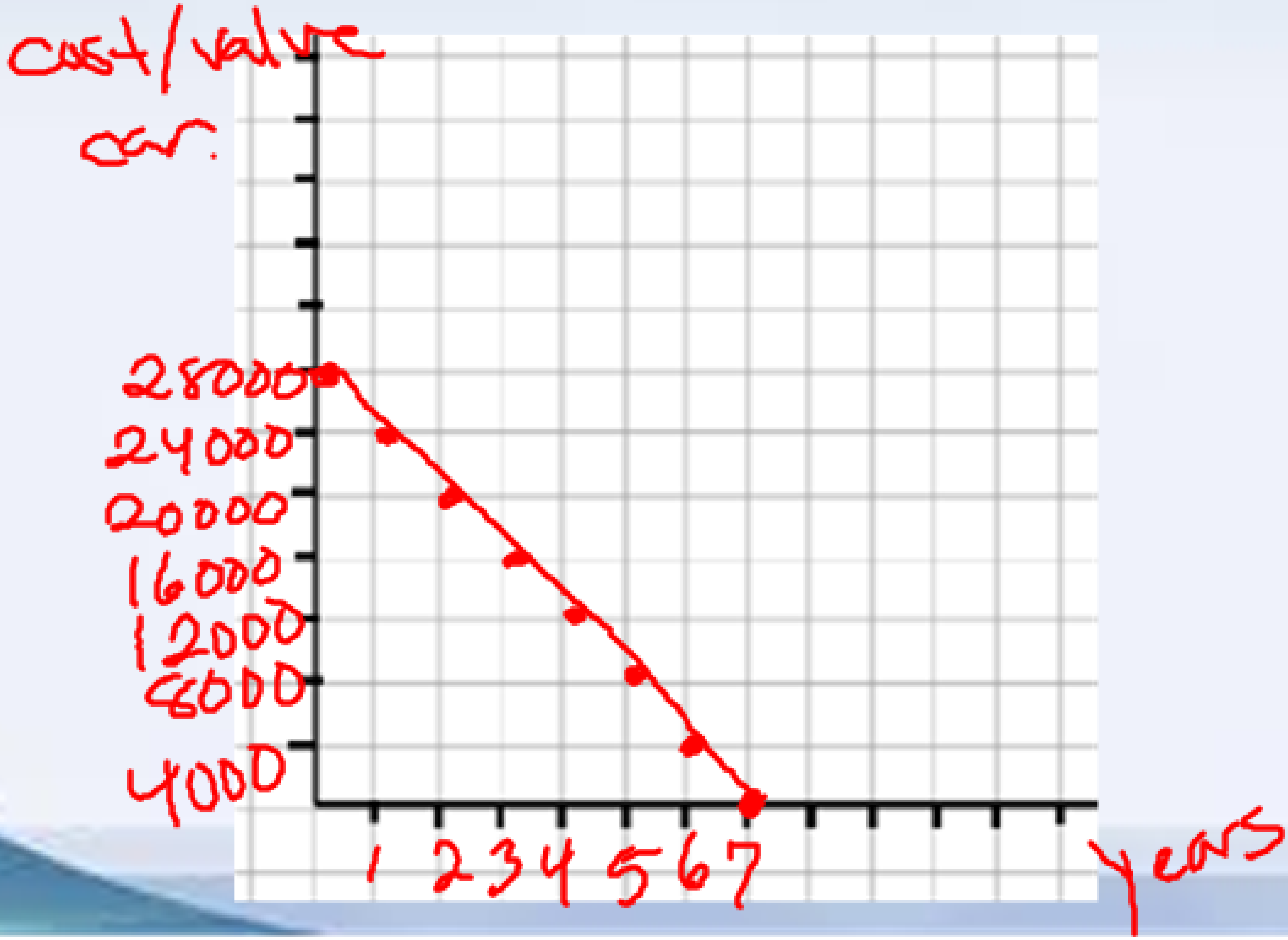
(a) Build a linear model that expresses the book value v of each car as a function of its age, x.

$$V(x) = -4000x + 28000$$

(b) What is the implied domain of the function found in part (a)?

$$\{x \mid [0, 7]\}$$

# (c) Graph the Linear Function...



$V(x) = {}^{-}4000x + 28000$

**(d) What is the book value of each car after 3 years?**

$V(3) = {}^{-}4000(3) + 28000$

$\boxed{= 16000}$

**(e) Interpret the slope.**

The value of the car is dec. $4000 every year.

**(f) When will the book value of each car reach $8000?**

$$\begin{aligned} 8000 &= {}^{-}4000x + 28000 \\ -28000 & \qquad\qquad\quad -28000 \\ \hline -20000 &= -4000x \end{aligned}$$

$\boxed{x = 5\text{yrs}}$

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p.132
#14, 16, 20, 22,
24, 29, 31