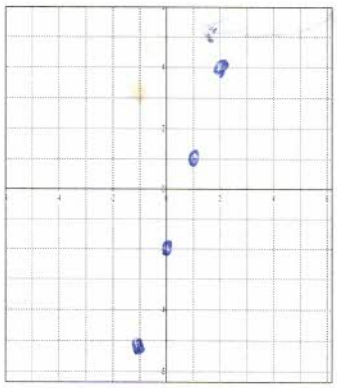
# Properties of Exponential Functions

**Part A – Linear Relationships**

Complete a table of values, and graph each relationship below.

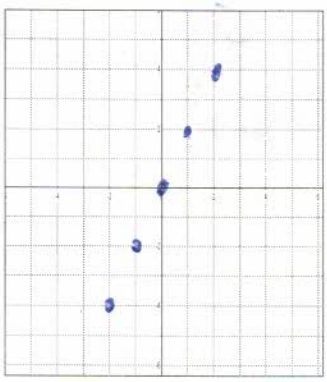
$y = 3x - 2$

| x | y | first differences |
|---|---|---|
| -2 | -8 | |
| -1 | -5 | 3 |
| 0 | -2 | 3 |
| 1 | 1 | 3 |
| 2 | 4 | 3 |



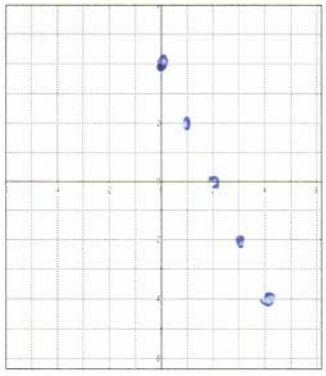
$y = 2x$

| x | y | first differences |
|---|---|---|
| -2 | -4 | |
| -1 | -2 | 2 |
| 0 | 0 | 2 |
| 1 | 2 | 2 |
| 2 | 4 | 2 |



$y = -2x + 4$

| x | y | first differences |
|---|---|---|
| -2 | 8 | |
| -1 | 6 | -2 |
| 0 | 4 | -2 |
| 1 | 2 | -2 |
| 2 | 0 | -2 |



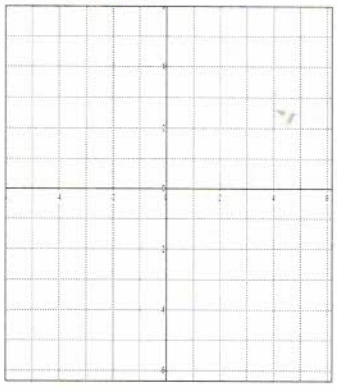
Do you notice a pattern in the table of values?

First differences are equal.

**Part B – Quadratic Functions**

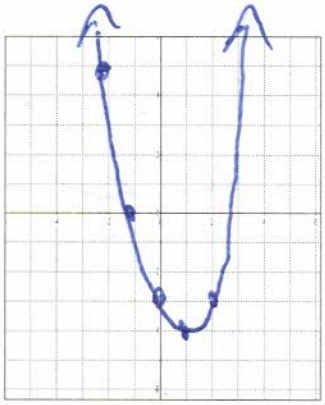
$y = 2x^2$

| x | y | first diff. | 2nd differences |
|---|---|---|---|
| -2 | 8 | | |
| -1 | 2 | -6 | -2-(-6)=4 |
| 0 | 0 | -2 | 4 |
| 1 | 2 | 2 | 4 |
| 2 | 8 | 6 | |



$y = x^2 - 2x - 3$

| x | y | 1st diff. | 2nd diff. |
|---|---|---|---|
| -2 | 5 | -5 | |
| -1 | 0 | -3 | 2 |
| 0 | -3 | -1 | 2 |
| 1 | -4 | 1 | 2 |
| 2 | -3 | | |



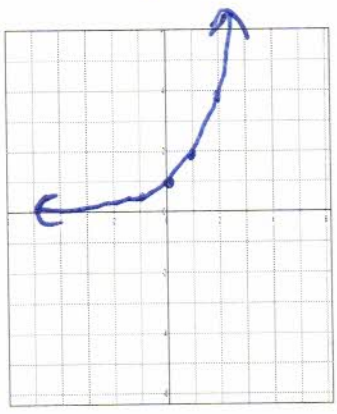
Do you notice a pattern in the table of values?

Second differences are all equal.

**Part C – Exponential Relationships**

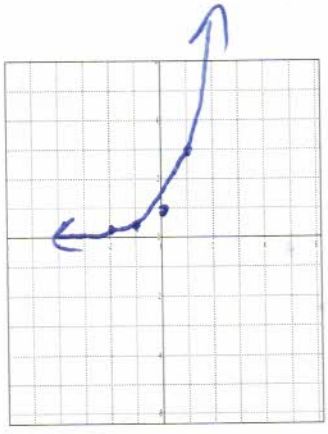
$y = 2^x$

| x | y |
|---|---|
| -2 | 1/4 |
| -1 | 1/2 |
| 0 | 1 |
| 1 | 2 |
| 2 | 4 |



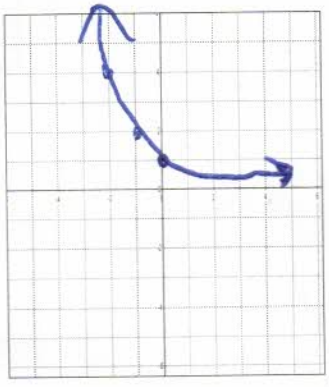
$y = 3^x$

| x | y |
|---|---|
| -2 | 1/9 |
| -1 | 1/3 |
| 0 | 1 |
| 1 | 3 |
| 2 | 9 |



$y = 0.5^x$

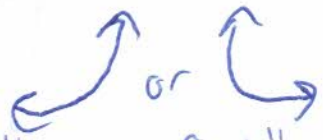
| x | y |
|---|---|
| -2 | 4 |
| -1 | 2 |
| 0 | 1 |
| 1 | 0.5 |
| 2 | 0.25 |



Do you notice a pattern in the table of values?

constant multiplier or constant ratio.

**Summarize your findings below...**

| Type of Relationship | What does the equation look like? | What does the graph look like? | Pattern found in the table of values. |
|---|---|---|---|
| **Linear** | $y = mx + b$. | straight line | First differences are all equal. |
| **Quadratic** | "$x^2$" in it | parabola | second differences are all equal. |
| **Exponential** | x is in the exponent place |  "grows fast" | constant "multiplier". |

**Sample Problems**

1. Suppose the population of a town is shown below. Does this represent a linear, quadratic or exponential relationship?

| Year | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Population | 1200 | 1320 | 1452 | 1597 |

$\frac{1320}{1200} = 1.1$

$\frac{1452}{1320} = 1.1$

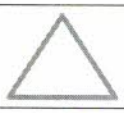
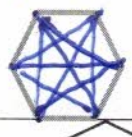
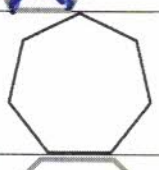
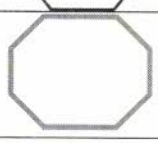
×1.1 ×1.1 ×1.1

Find the equation for the town's population.

$P = 1200(1.1)^n$

2. A polygon is any 2-dimensional closed shape. Several polygons are drawn and the number of diagonals are found and recorded. Is this a linear, exponential or quadratic relationship?

quadratic → 2nd differences are equal.

| Number of Side in Polygon | Sketch | Number of Diagonals |
|---|---|---|
| 3 |  | 0 |
| 4 |  | 2 |
| 5 |  | 5 |
| 6 |  | 9 |
| 7 |  | 14 |
| 8 |  | 20 |

>2 >1 >3 >1 >4 >1 >5 >6

3. The population of a school is currently 850 students. The school grows by 25 students each year. Is the growth of the school linear, exponential or quadratic? Find an equation if possible.

linear goes up same amount.

$P = 850 + 25n$.