## Modelling Quadratic Relations

## ACTIVITY

Plot the points and draw the graph for each of the relations below.


|  | $\mathbf{x}$ | $\mathbf{y}$ |
| :---: | :---: | :---: |
| $\boldsymbol{K}$ | -1 | -3 |
| $\mathbf{L}$ | 0 | -4 |
| $M$ | 1 | -3 |
| $N$ | 2 | 0 |
| 0 | 3 | 5 |



## LINEAR VS QUADRATIC

The graph of a Linear Equation $y=m x+b$ is a straight line The graph of a Quadratic Equation $y=A x^{2}+B x+C$ is a parabolic curve

## $1^{\text {st }} \& 2^{\text {nd }}$ DIFFERENCES

$1^{\text {st }}$ differences: for evenly spaced $X$ values, find the difference between consecutive $\underline{Y}$
$\qquad$ values $2^{\text {nd }}$ differences: determine the difference between consecutive $\qquad$


All $1^{\text {st }}$ diff. are the some; therefore, it's linear


All $2^{\text {nd }}$ diff are the same; therefore, it's quadratic

## DEFINITIONS

Parabola: symmetrical "U" shaped curve that opens up/down;
Vertex: lowest or heighest point on a parabola
Minimum: lowest paint on a parabola that opens up iv
Maximum: highest point on a parabola that opens down
$\qquad$

Maxi nu:

## LINEAR OR QUADRATIC? HOW TO TELL

If the graph is a parabola $\rightarrow$ quadratic
If $1^{\text {st }}$ differences are constant $\rightarrow$ linear
If $2^{\text {nd }}$ differences are constant $\rightarrow$ quadratic
If the degree of the polynomial is 1 (has $x$ term only) $\rightarrow$ linear $y=2 x+1$
If the degree of the polynomial is 2 (has $x^{2}$ term) $\rightarrow$ quadratic $y=2 x^{2}+1$

## ACTIVITY

For each example, evaluate or estimate for $\mathrm{x}=2$ and identify whether it is linear or quadratic.
a) $y=-3(x+1)^{2}+1$
$=-3(2+1)^{2}+1$
$=-3(3)^{2}+1$
$=-27+1=-26 / 1$
b) $2 x-y+7=0$
c)

d)


## APPLICATION PROBLEM

A football was thrown in the air. Its path can be modelled by the relation $h=-5 t^{2}+20 t+1.5$ where $h$ is the height of the football in metres and $t$ is the time in seconds.
a) Complete the table of values and graph the relation.

| $\boldsymbol{t}$ | $\boldsymbol{h}$ |
| :--- | :---: |
| 0 | 1.5 |
| 1 | 16.5 |
| 2 | 21.5 |
|  | $=-5(0)^{2}+20(0)+1.5=1.5$ |
|  | $=-5(2)^{2}+20(2)+1.5=-20+40+1.5$ |
| 3 | 16.5 |
| 4 | 1.5 |
| 5 |  |
|  | $=-5(3)^{2}+20(3)+1.5=-45+60+1.5$ |
|  | $=-5(4)^{2}+20(4)+1.5=-80+80+1.5$ |
| $=-5(5)^{2}+20(5)+1.5=-125+100+1.5$ |  |


b) Use your graph to estimate how long the ball was in the air. about 4.1 sec .
c) Use your graph to estimate the coordinates of the vertex of the relation. Explain the meaning of the coordinates of the vertex in this context. $\mathrm{V}(2,21,5)$ when the ball is in $\cdot 1 / \mathrm{l}$ air for 2 see, its
d) Explain the meaning of the data in the first row of the table. max height is 21.5 m . It's time spent for the duration of the ball travelled in the pis.

## Modelling Quadratic Relations Practice

1. Graph each relation. Use the graph to determine if the relation is linear, quadratic, or nequher.
a)


c)

d)




Page $\mathbf{3}$ of 5
2. In question 1, complete the first and second differences to check if your diagram is correct. Are these expressions linear or non-linear.
3. Which of these relations are quadratic? How do you know?
a) $y=x^{(3)}+4$ Cubic
b) $y=2 x^{(2)}+5 x-6 \quad Q$
c) $y=3 x+1 \quad($
d) $y=6+\sqrt{2} \quad Q$
e) $y=(\hat{x})+7 \quad L$
f) $y=-4 x^{2}+4$
4. Estimate the vertex value for each relation, and state if it is a maximum or a minimum.
a)

b)

5. A box of food supplies is parachuted from a cargo plane over a remote village in Africa. The height, $h$, of the box, in metres, $t$ seconds after being dropped from the plane is given by the relation:

$$
h=-0.5 t^{2}+1000
$$

a) Complete the table of values.

| Time <br> $(\mathrm{s})$ | Height <br> $(\mathrm{m})$ |
| :---: | :---: |
| 0 | $-0.5(0)^{2}+1000$ <br> $=1000 \mathrm{~m}$ |
| 10 | $=-0.5(10)^{2}+1000$ |
| $=950$ |  |$|$| $=-0.5(20)^{2}+1000$ |
| :---: |
|  |
| 20800 |
| 30 | | $=-0.5(30)^{2}+1000$ |
| :--- |
| $=550$ |
| 40 |

b) Graph the relation.
c) Is the relation quadratic? Explain.


Quadratic b/c the shape is acurve.
6. A daycare owner wants to use 160 m of fencing to build a small rectangular playground. She wants the playground to have the greatest possible area.
a) Complete the table of values.

| Length <br> $(\mathrm{m})$ | Width <br> $(\mathrm{m})$ | Perimeter <br> $(\mathrm{m})$ | Area <br> $\left(\mathrm{m}^{2}\right)$ |
| :---: | :---: | :---: | :---: |
| 70 | 10 | 160 | 700 |
| 60 | 20 | 160 | 1200 |
| 50 | 30 | 160 | 1500 |
| 40 | 40 | 160 | 1600 |
| 20 | 50 | 160 | 1500 |
| 10 | 70 | 160 | 700 |


b) In the fourth column of the table, calculate the area for each pair of dimensions.
c) Draw a graph to compare the length and the area.
d) Use the graph to determine the dimensions of the playground with the greatest possible area.

It'd be a square with the dimensions $l: 40$ and w:40
7. A golf warehouse sold 200 sleeves of golf balls for $\$ 3$ each. A survey suggests that for every $\$ 1$ increase in price, sales will drop by 40 sleeves.
a) Complete the table of values.

| Price <br> $(\$)$ | Number <br> Sold | Revenue <br> $(\$)$ |
| :---: | :---: | :---: |
| 3 | 200 | 600 |
| 4 | 160 | 640 |
| 5 | 120 | 600 |
| 6 | 80 | 480 |
| 7 | 40 | 280 |

b) Draw a graph to compare price and revenue.
c) Which price will result in a maximum revenue? $\$ 4$
d) What is the maximum revenue?

$$
\text { max rev is } \$ 640
$$



