Name : _____

| Geogebra Exploration | Cubics $y = ax^3 + c$ | 10 MAD |
|---|---|---|

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$y = ax^3 + c$ is the equation of a ***cubic*** *curve*. (where $a$ and $c$ are numbers)

Eg. $y = x^3$, $y = x^3 + 2, y = -2x^3 + 5$ are cubics.

Its ***inflection point***, i.e. a point where the graph goes from being concave up to being concave down or vice versa, is $(0, 0)$.

http://www.mathsisfun.com/calculus/inflection-points.html

**1)** Install Geogebra : https://www.geogebra.org/

## THERE ARE ONLY TWO POSSIBLE SHAPES FOR $y = ax^3 + c$

**2)** In Geogebra, on the same set of axes, sketch $y = x^3$, $y = 2x^3$ and $y = 0.1x^3$ .

- *Just type $y = x$^3 in the input bar at the bottom of the screen and press ENTER, then type $y = 2x$^3 in the input bar at the bottom of the screen and press ENTER...etc.*
- *If you want to change the colour of the graphs, right click on them and then chose "object properties" (at the bottom)*
- *In order to have the equation of the graph displayed on the diagram, right click on the graph, click on "object properties" then on "show label" then on "value".*

Copy and paste your diagram below (snipping tool)

***Ask the teacher to check your work ☐.***

**3)** *Fill in the blanks.*

The graphs of $y = ax^3$ all look alike but as the coefficient of $x^3$ increases, the graphs become _____ (*narrower /wider*).

**4)** Start a new diagram in Geogebra.
On the same set of axes, sketch $y = -x^3$, $y = -3x^3$ and $y = -0.1x^3$.

Copy and paste your diagram below (snipping tool)

***Ask the teacher to check your work ☐.***

**5)** *Fill in the blanks.*

| $y = ax^3$ is the equation of a ***cubic***.<br>**There are only two basic shapes for cubics with equation $y = ax^3$:** | |
|---|---|
| If the coefficient of $x^3$ is _____,<br>the cubic looks like $y = x^3$ (see below) | If the coefficient of $x^3$ is _____,<br>the cubic looks like $y = x^3$ (see below) |
| | |
| always **in**creasing (as $x$ increases)<br>becomes horizontal at the ***inflection point*** | always **de**creasing (as $x$ increases)<br>becomes horizontal at the ***inflection point*** |

An ***inflection point*** is a point where the graph goes from being concave up to being concave down or vice versa.

*http://www.mathsisfun.com/calculus/inflection-points.html*

**6)** *Let's get some practice on this* : Draw the general shape of the following curves showing the y intercept and one more point.

| **(a)** $y = -4x^3$ | **(b)** $y = 2x^3$ | **(c)** $y = \frac{x^3}{8}$ |
|---|---|---|
| | | |

## EFFECT OF THE CONSTANT TERM IN THE EQUATION OF A GRAPH

**7)** Start a new diagram in Geogebra.

On the same set of axes, sketch $y = x^3$, $y = x^3 + 3$ and $y = x^3 - 2$

- *If you want to change the colour of the graphs, right click on them and then chose "object properties" (at the bottom)*
- *In order to have the equation of the graph displayed on the diagram, right click on the graph, click on "object properties" then on then on "show label " then on "value".*

Copy and paste your diagram below (snipping tool)

**8)** *Fill in the blanks.*

The graph of $y = x^3 + 3$ is obtained by shifting the graph of $y = x^3$ _____.

The graph of $y = x^3 - 2$ is obtained by shifting the graph of $y = x^3$ _____.

*More generally, if c is any number*

The graph of $y = x^3 + c$ is obtained by shifting the graph of $y = x^3$ _____.

***Ask the teacher to check your work ☐.***

**9)** *Let's get some practice on this* : Draw the general shape of the following curves showing the y intercept and one more point.

| **(a)** $y = x^3 + 4$ | **(b)** $y = -2x^3 + 7$ | **(c)** $y = 5x^3 - 8$ |
|---|---|---|
| | | |

## EFFECT OF CHANGING $r$ IN $y = a(x - r)\text{^}3 + c$

**10)** Start a new diagram in Geogebra.

On the same set of axes, sketch $y = x^3$, $y = x^3 + 3$ and $y = x^3 - 2$

- *If you want to change the colour of the graphs, right click on them and then chose "object properties" (at the bottom)*
- *In order to have the equation of the graph displayed on the diagram, right click on the graph, click on "object properties" then on then on "show label " then on "value".*

Copy and paste your diagram below (snipping tool)

**11)** *Fill in the blanks.*

The graph of $y = (x + 1)^3$ is obtained by shifting the graph of $y = x^3$ _____.
The inflection point is (_____, _____ ).

The graph of $y = (x - 2)^3$ is obtained by shifting the graph of $y = x^3$ _____.
The inflection point is (_____, _____ )

*More generally, if $r$ is any number*

The graph of $y = (x - r)^3$ is obtained by shifting the graph of $y = x^3$ _____.
The inflection point is ( _____, _____ ). We get it by solving '$bracket = 0$'.

***Ask the teacher to check your work ☐.***

**12)** *Let's get some practice on this* : Draw the general shape of the following curves showing the y intercept and the inflection point.

| | | |
|---|---|---|
| **(a)** $y = (x-5)^3$ | **(b)** $y = (x+2)^3$ | **(c)** *Harder :* $(x+7)^3 + 4$ |
| **(d)** *Even harder :* $y = -2(x-5)^3 + 3$ | **(e)** *Even harder :* $y = 3(x+6)^3 + 4$ | **(f)** *Even harder :* $y = -\frac{x^3}{4} + 7$ |