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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 .

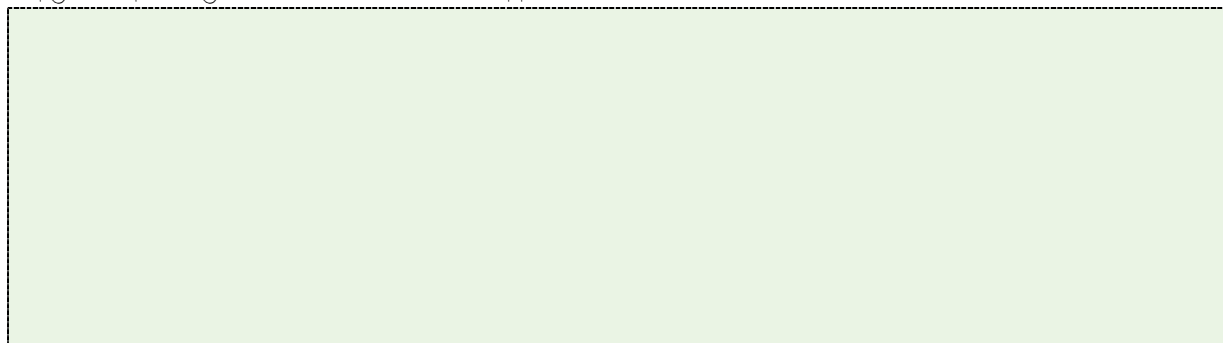
3) Fill in the blanks.

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 <i>cubic</i> . There are only two basic shapes for cubics with equation $y = ax^3$:	
If the coefficient of x^3 is _____, the cubic looks like $y = x^3$ (see below)	If the coefficient of x^3 is _____, the cubic looks like $y = -x^3$ (see below)
always increasing (as x increases) becomes horizontal at the inflection point	always decreasing (as x increases) 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) $y = \frac{x^3}{8}$
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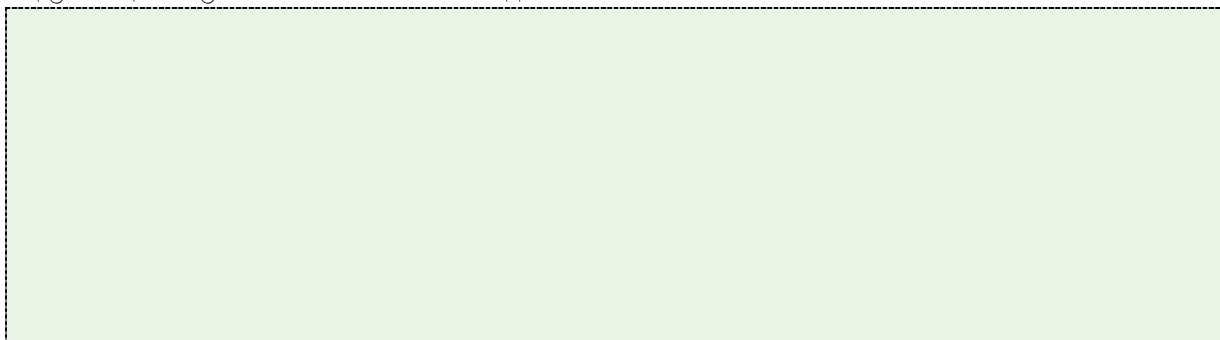
EFFECT OF THE CONSTANT TERM IN THE EQUATION OF A GRAPH

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) $y = 5x^3 - 8$

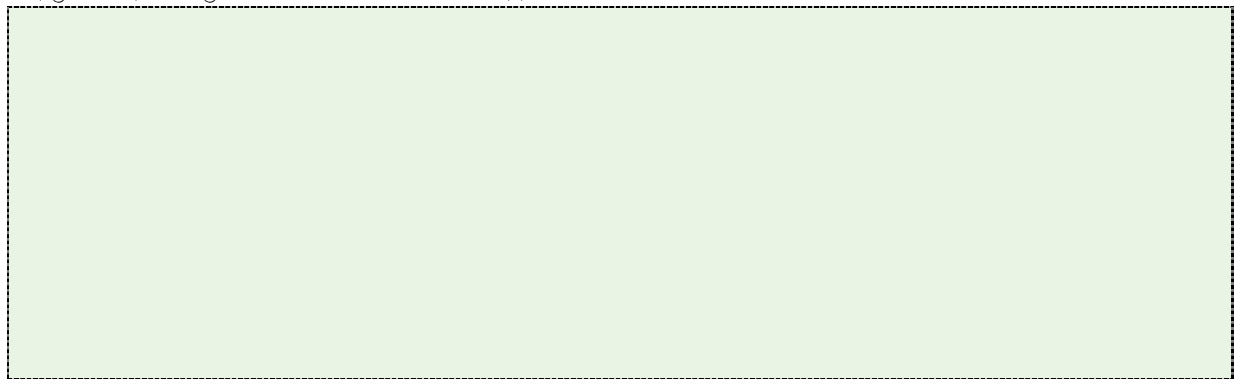
EFFECT OF CHANGING r IN $y = a(x - r)^3 + c$

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) <i>Harder</i> : $(x + 7)^3 + 4$
(d) <i>Even harder</i> : $y = -2(x - 5)^3 + 3$	(e) <i>Even harder</i> : $y = 3(x + 6)^3 + 4$	(f) <i>Even harder</i> : $y = -\frac{x^3}{4} + 7$