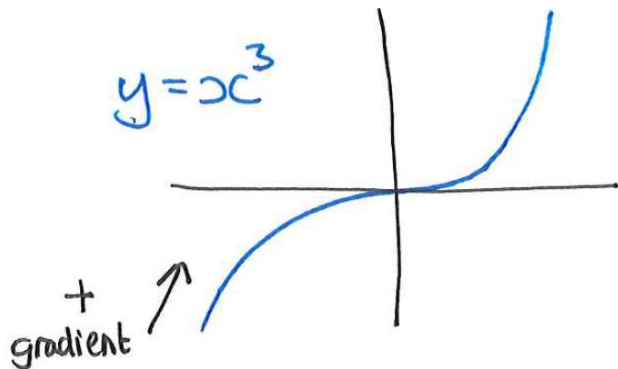
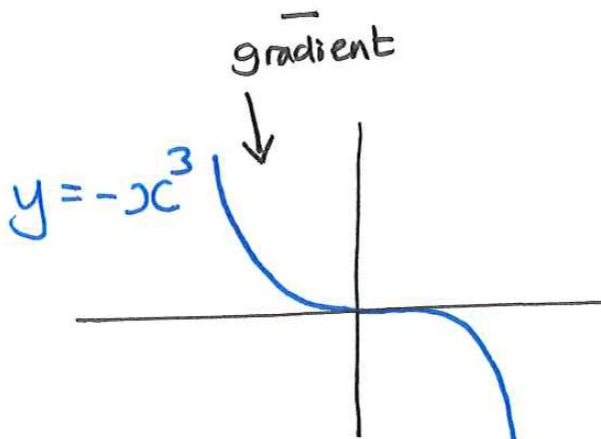


Cubic Graphs

Positive Gradient



Negative Gradient



y Intercept

$$y = ax^2 + bx + c$$

y Intercept = constant c

$$y = (x + 3)^2(x - 1)$$

$$y = (x + 3)(x + 3)(x - 1)$$

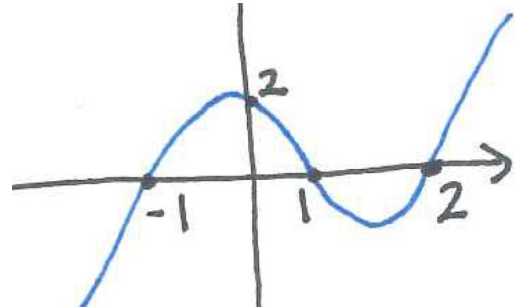
$$\text{Constant} = 3 \times 3 \times -1 = -9$$

$$\text{y Intercept} = (0, -9)$$

3 Roots

$$y = (x - 2)(x + 1)(x - 1)$$

Roots 2, -1, 1



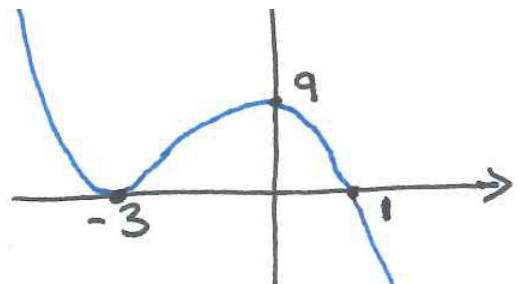
2 Roots

$$y = (x + 3)^2(1 - x)$$

$$y = (x + 3)(x + 3)(1 - x)$$

Roots -3, -3, 1

Double root = bounce



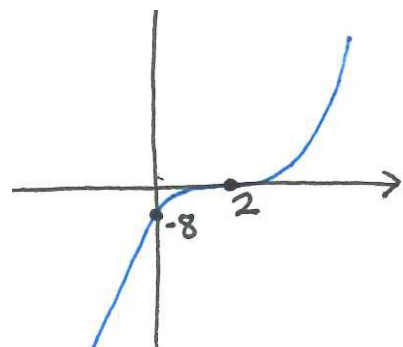
1 Root

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

$$y = (x - 2)(x - 2)(x - 2)$$

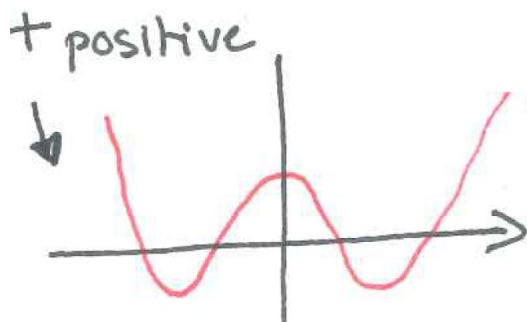
Roots 2, 2, 2

Treble root = inflection point

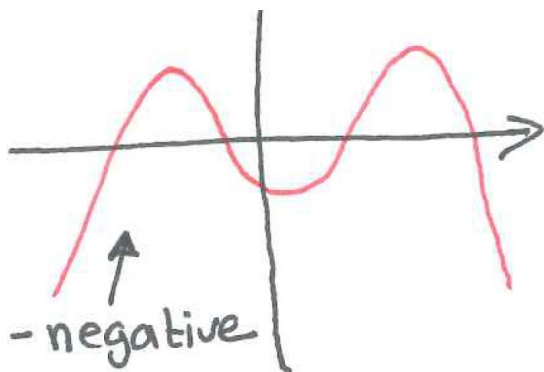


Quartic Graphs

Positive Gradient



Negative Gradient



y Intercept

$$y = ax^3 + bx^2 + cx + d$$

y Intercept = constant d

$$y = (x + 3)^2(x - 1)(x - 2)$$

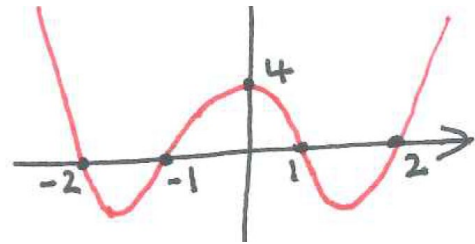
$$\text{Constant} = 3 \times 3 \times -1 \times -2 = 18$$

$$y \text{ Intercept} = (0, 18)$$

4 Roots

$$y = (x - 2)(1 - x)(x + 1)(x + 2)$$

Roots 2, 1, -1, -2

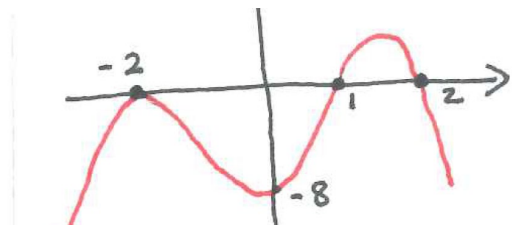


3 Roots

$$y = (x + 3)^2(1 - x)(x - 2)$$

Roots -2, -2, 1, 2

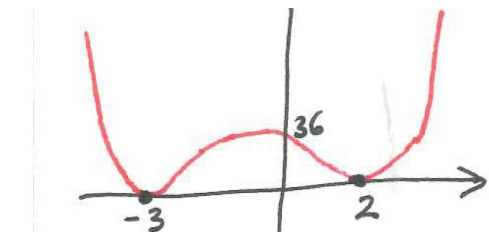
Double root = bounce



2 Root

$$y = (x - 2)^2(x + 3)^2$$

Roots 2, 2, -3, -3



1 Root

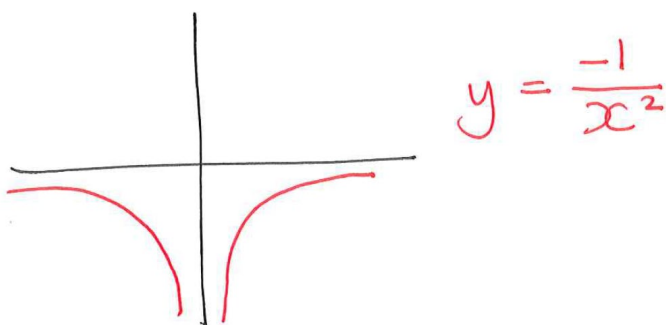
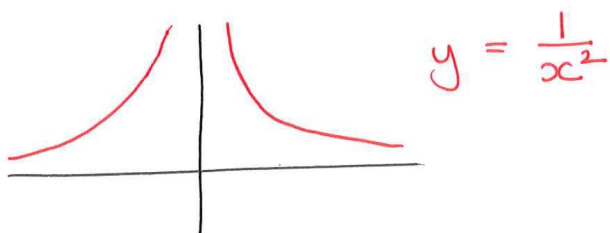
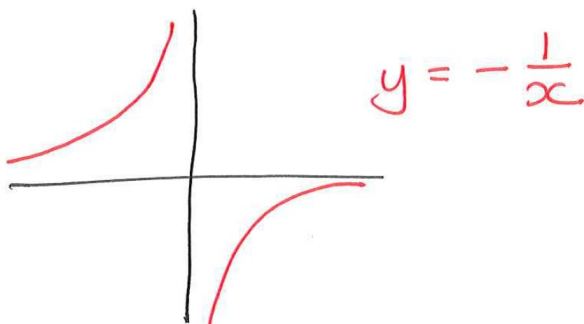
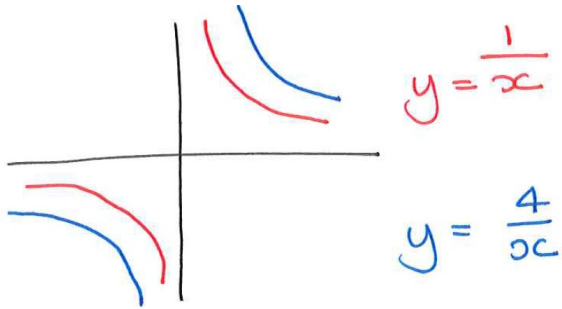
$$y = (x + 3)^4$$

Roots -3, -3, -3, -3

Quadruple root = inflection point



Reciprocal Graphs



Points of Intersection

$g(x)$ intersects $f(x)$
when

$$g(x) = f(x)$$

Example

$$g(x) = 2x^2$$

$$f(x) = 4x$$

$$2x^2 = 4x$$

$$2x^2 - 4x = 0$$

$$2x(x - 2) = 0$$

$$x = 0 \text{ or } x = 2$$

Don't forget to find the y value

$$f(x) = 4(0) = 0$$

$$f(x) = 4(2) = 8$$

Points of intersection

$(0, 0)$ and $(2, 8)$

Transformations

$y = f(x)$ starting position

Shift up

$$y = f(x) + 3 \quad (x, y + 3)$$

Shift down

$$y = f(x) - 3 \quad (x, y - 3)$$

Shift left

$$y = f(x + 2) \quad (x - 2, y)$$

Shift right

$$y = f(x - 2) \quad (x + 2, y)$$

Horizontal Stretch

$$y = f(4x) \quad \left(\frac{x}{4}, y\right)$$

Vertical Stretch

$$y = 4f(x) \quad (x, 4y)$$

Reflection in the x axis

$$y = f(-x) \quad (x, -y)$$

Reflection in the y axis

$$y = -f(x) \quad (-x, y)$$