Question 1

A function is defined by $f(x) = 54x - 13, \quad -2 < x < 20$.

(a) Find the value of $f\left(\frac{5}{2}\right)$. [1]

(b) Write down the range of $f(x)$. [2]

(c) Find the value of $f^{-1}(122)$. [2]

(d) Write down the range of the inverse function. [1]

a) Sub $x = \frac{5}{2}$ into $f(x)$.

$f\left(\frac{5}{2}\right) = 54\left(\frac{5}{2}\right) - 13$

$\boxed{f\left(\frac{5}{2}\right) = 122}$

A function is defined by $f(x) = 54x - 13, \quad -2 < x < 20$.

(a) Find the value of $f\left(\frac{5}{2}\right)$. [1]

(b) Write down the range of $f(x)$. [2]

(c) Find the value of $f^{-1}(122)$. [2]

(d) Write down the range of the inverse function. [1]

b) Use the domain of $f(x)$ to find its range.

$f(-2) = 54(-2) - 13$

$f(-2) = -121$

$f(20) = 54(20) - 13$

$f(20) = 1067$

$\boxed{\text{Range is } \{y \mid -121 < y < 1067\}}$

A function is defined by $f(x) = 54x - 13, \quad -2 < x < 20$.

(a) Find the value of $f\left(\frac{5}{2}\right)$. $\boxed{f\left(\frac{5}{2}\right) = 122}$ [1]

(b) Write down the range of $f(x)$. [2]

(c) Find the value of $f^{-1}(122)$. [2]

(d) Write down the range of the inverse function. [1]

c) The inverse of a function reverses the effect of the function.

$\therefore$ if $f\left(\frac{5}{2}\right) = 122$

$\boxed{f^{-1}(122) = \frac{5}{2}}$

A function is defined by $f(x) = 54x - 13$, $-2 < x < 20$.

(a) Find the value of $f\left(\frac{5}{2}\right)$. [1]

(b) Write down the range of $f(x)$. [2]

(c) Find the value of $f^{-1}(122)$. [2]

(d) Write down the range of the inverse function. [1]

d) The domain of $f(x)$ is the range of $f^{-1}(x)$.

$\boxed{\text{Range is } \{y \mid -2 < y < 20\}}$

Question 2

Consider the function $f(x) = -6x - 3$. The domain of $f(x)$ is $-5 \leq x \leq 3$.

(a) Find

(i) $f(2)$

(ii) x when $f(x) = 15$. [2]

(b) Find the range of $f(x)$. [3]

(c) Write down the domain of the inverse function. [1]

a) i) Sub $x = 2$ into $f(x)$.

$f(2) = -6(2) - 3$

$\boxed{f(2) = -15}$

ii) Set $f(x) = 15$ and rearrange for x.

$f(x) = 15$

$-6x - 3 = 15$ $\quad +3$

$-6x = 18$ $\quad \div(-6)$

$\boxed{x = -3}$

Consider the function $f(x) = -6x - 3$. The domain of $f(x)$ is $-5 \leq x \leq 3$.

(a) Find

(i) $f(2)$

(ii) x when $f(x) = 15$. [2]

(b) Find the range of $f(x)$. [3]

(c) Write down the domain of the inverse function. [1]

b) Use the domain of $f(x)$ to find its range.

$f(-5) = -6(-5) - 3$

$f(-5) = 27$

$f(3) = -6(3) - 3$

$f(3) = -21$

$\boxed{\text{Range is } \{y \mid -21 \leq y \leq 27\}}$

Consider the function $f(x) = -6x - 3$. The domain of $f(x)$ is $-5 \le x \le 3$.

(a) Find

(i) $f(2)$

(ii) x when $f(x) = 15$.

[2]

(b) Find the range of $f(x)$.

Range is $\{y \mid -21 \le y \le 27\}$

[3]

(c) Write down the domain of the inverse function.

[1]

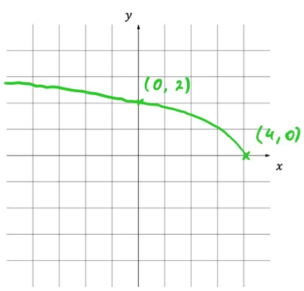
c) The range of $f(x)$ is the domain of $f^{-1}(x)$.

Domain is $\{x \mid -21 \le x \le 27\}$

Question 3

Consider the function $g(x) = \sqrt{4-x}$.

(a) Sketch the graph of the function $g(x)$, labelling the x and y intercepts.



[3]

a) x-intercept is when $g(x) = 0$.

x-intercept is at $(4, 0)$

y-intercept is when $x = 0$.

y-intercept is at $(0, 2)$

Graph $g(x)$ on your GDC to find its shape.

(b) Find

(i) $g(-5)$

(ii) x when $g(x) = \frac{1}{2}$.

[2]

(c) Find

(i) the maximum possible domain of the function $g(x)$

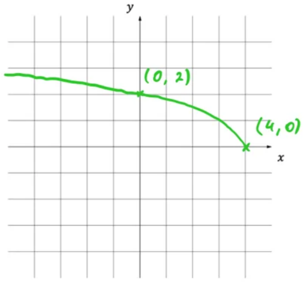
(ii) the range of the function $g(x)$ that corresponds to the domain found in part (c) (i).

[2]

EXAM PAPERS PRACTICE

Consider the function $g(x) = \sqrt{4 - x}$.

(a) Sketch the graph of the function $g(x)$, labelling the x and y intercepts.



[3]

(b) Find

(i) $g(-5)$

(ii) x when $g(x) = \frac{1}{2}$.

[2]

(c) Find

(i) the maximum possible domain of the function $g(x)$

(ii) the range of the function $g(x)$ that corresponds to the domain found in part (c) (i).

[2]

b) i) Sub $x = -5$ into $g(x)$.

$g(-5) = \sqrt{4-(-5)}$

$g(-5) = \sqrt{9}$

$\boxed{g(-5) = 3}$

ii) Set $g(x) = \frac{1}{2}$ and rearrange for x.

$g(x) = \frac{1}{2}$

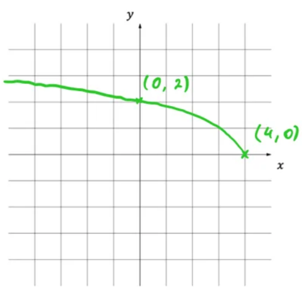
$\sqrt{4-x} = \frac{1}{2}$

$4 - x = \frac{1}{4}$

$\boxed{x = 3.75}$

Consider the function $g(x) = \sqrt{4 - x}$.

(a) Sketch the graph of the function $g(x)$, labelling the x and y intercepts.



[3]

(b) Find

(i) $g(-5)$

(ii) x when $g(x) = \frac{1}{2}$.

[2]

(c) Find

(i) the maximum possible domain of the function $g(x)$

(ii) the range of the function $g(x)$ that corresponds to the domain found in part (c) (i).

[2]

c) i) $g(x)$ is undefined for $x > 4$.

$\boxed{\text{Domain is } \{x \mid x \leq 4\}}$

ii) $g(x) = 0$ when $x = 4$.

$\boxed{\text{Range is } \{y \mid y \geq 0\}}$

EXAM PAPERS PRACTICE

Question 4

Consider the functions $f(x) = -x^5 + 2020$ and $g(x) = \frac{1}{\sqrt{(1-x)^3}} - 2$.

(a) Find the coordinates of the y-intercepts for the graph of

(i) f

(ii) g. [2]

(b) Find the coordinates of the x-intercepts for the graph of

(i) f

(ii) g. [2]

(c) For the graph of g, find the equation of

(i) the vertical asymptote

(ii) the horizontal asymptote. [3]

a) i) y-intercepts occur when $x = 0$.

Sub $x = 0$ into $f(x)$.

$f(0) = -(0)^5 + 2020$

$f(0) = 2020$

Hence the y-intercept for f is $(0, 2020)$.

ii) Sub $x = 0$ into $g(x)$.

$g(0) = \frac{1}{\sqrt{(1-(0))^3}} - 2$

$g(0) = -1$

Hence the y-intercept for g is $(0, -1)$.

Consider the functions $f(x) = -x^5 + 2020$ and $g(x) = \frac{1}{\sqrt{(1-x)^3}} - 2$.

(a) Find the coordinates of the y-intercepts for the graph of

(i) f

(ii) g. [2]

(b) Find the coordinates of the x-intercepts for the graph of

(i) f

(ii) g. [2]

(c) For the graph of g, find the equation of

(i) the vertical asymptote

(ii) the horizontal asymptote. [3]

b) i) x-intercepts occur when the function equals zero.

Set $f(x) = 0$ and solve for x on your GDC.

$-x^5 + 2020 = 0$

$x \approx 4.58$

Hence the x-intercept for f is $(4.58, 0)$.

ii) Set $g(x) = 0$ and solve for x on your GDC.

$\frac{1}{\sqrt{(1-x)^3}} - 2 = 0$

$x \approx 0.370$

Hence the x-intercept for g is $(0.37, 0)$.

Consider the functions $f(x) = -x^5 + 2020$ and $g(x) = \frac{1}{\sqrt{(1-x)^3}} - 2$.

(a) Find the coordinates of the y-intercepts for the graph of

(i) f

(ii) g.

[2]

(b) Find the coordinates of the x-intercepts for the graph of

(i) f

(ii) g.

[2]

(c) For the graph of g, find the equation of

(i) the vertical asymptote

(ii) the horizontal asymptote.

[3]

c) i) The vertical asymptote is when the denominator of $g(x)$ equals zero.

[denominator of g] = 0

$\sqrt{(1-x)^3} = 0$

$x = 1$

$\boxed{\text{Hence the equation of the vertical asymptote is } x = 1}$

ii) As x tends towards negative infinity $(-\infty)$, $\frac{1}{\sqrt{(1-x)^3}}$ tends towards zero.

$g(x) = \frac{1}{\sqrt{(1-x)^3}} - 2$

$\lim_{x \to -\infty} g(x) = 0 - 2$
$= -2$

$\boxed{\text{Hence the equation of the horizontal asymptote is } y = -2.}$

Question 5

Consider the functions $f(x) = x^{-4} - 2021$ and $g(x) = 2 - \sqrt{x-1}$.

(a) Find the maximum possible domain and range of g.

[2]

(b) For the graph of f, find the equation of

(i) the vertical asymptote

(ii) the horizontal asymptote.

[3]

(c) Find the coordinates of the x-intercepts for the graph of

(i) f

(ii) g.

[2]

a) For $g(x)$ to be defined $x - 1 \geq 0$.

$\boxed{\text{Domain is } \{x \mid x \geq 1\}}$

Sub $x = 1$ into $g(x)$.

$g(1) = 2 - \sqrt{(1) - 1}$

$g(1) = 2$

$\boxed{\text{Range is } \{y \mid y \leq 2\}}$

EXAM PAPERS PRACTICE

Consider the functions $f(x) = x^{-4} - 2021$ and $g(x) = 2 - \sqrt{x-1}$.

(a) Find the maximum possible domain and range of g. [2]

(b) For the graph of f, find the equation of

(i) the vertical asymptote

(ii) the horizontal asymptote. [3]

(c) Find the coordinates of the x-intercepts for the graph of

(i) f

(ii) g. [2]

b) i) $f(x)$ is undefined when $x = 0$.

Hence the equation of the vertical asymptote is $x = 0$.

ii) As x tends towards $\pm\infty$,

x^{-4} tends towards zero.

$f(x) = x^{-4} - 2021$

$\lim_{x \to \pm\infty} f(x) = 0 - 2021$

Hence the equation of the horizontal asymptote is $y = -2021$.

Consider the functions $f(x) = x^{-4} - 2021$ and $g(x) = 2 - \sqrt{x-1}$.

(a) Find the maximum possible domain and range of g. [2]

(b) For the graph of f, find the equation of

(i) the vertical asymptote

(ii) the horizontal asymptote. [3]

(c) Find the coordinates of the x-intercepts for the graph of

(i) f

(ii) g. [2]

c) i) x-intercepts occur when the function equals zero.

Set $f(x) = 0$ and solve for x on your GDC.

$x^{-4} - 2021 = 0$

$x = \pm 2021^{-\frac{1}{4}}$

$x \approx \pm 0.149$

x-intercepts at $(0.149, 0)$ and $(-0.149, 0)$.

ii) Set $g(x) = 0$ and solve for x on your GDC.

$2 - \sqrt{x-1} = 0$

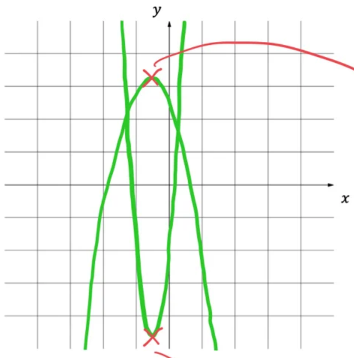
$x = 5$

x-intercept at $(5, 0)$.

Question 6

Consider the functions $f(x) = -x^2 - x + 6$ and $g(x) = (2x + 1)^2 - 9$.

(a) Sketch the graphs of the functions $f(x)$ and $g(x)$ and label the coordinates of the vertices for both functions.



[4]

(b) Find the coordinates for the points of intersection of $f(x)$ and $g(x)$.

[2]

(c) Find the x-intercepts of $f(x)$ and $g(x)$.

[2]

a) Graph $f(x)$ and $g(x)$ on your GDC.

$f(x)$ is a negative quadratic.

$\therefore$ the vertex of $f(x)$ is a maximum.

$g(x)$ is a positive quadratic.

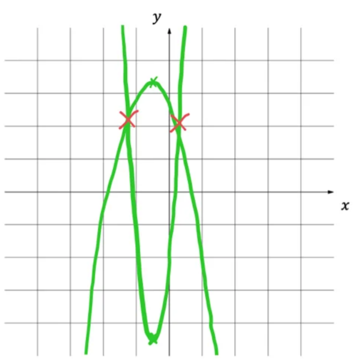
$\therefore$ the vertex of $g(x)$ is a minimum.

$\boxed{\text{Vertex of } f(x) \text{ at } (-0.5, 6.25)}$

$\boxed{\text{Vertex of } g(x) \text{ at } (-0.5, -9)}$

Consider the functions $f(x) = -x^2 - x + 6$ and $g(x) = (2x + 1)^2 - 9$.

(a) Sketch the graphs of the functions $f(x)$ and $g(x)$ and label the coordinates of the vertices for both functions.



[4]

(b) Find the coordinates for the points of intersection of $f(x)$ and $g(x)$.

[2]

(c) Find the x-intercepts of $f(x)$ and $g(x)$.

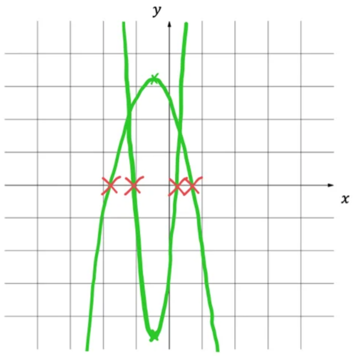
[2]

b) Graph $f(x)$ and $g(x)$ on your GDC and find their intersection.

$\boxed{\text{Intersection points are } (-2.25, 3.2) \text{ and } (1.25, 3.2)}$

Consider the functions $f(x) = -x^2 - x + 6$ and $g(x) = (2x+1)^2 - 9$.

(a) Sketch the graphs of the functions $f(x)$ and $g(x)$ and label the coordinates of the vertices for both functions.



[4]

(b) Find the coordinates for the points of intersection of $f(x)$ and $g(x)$.

[2]

(c) Find the x-intercepts of $f(x)$ and $g(x)$.

[2]

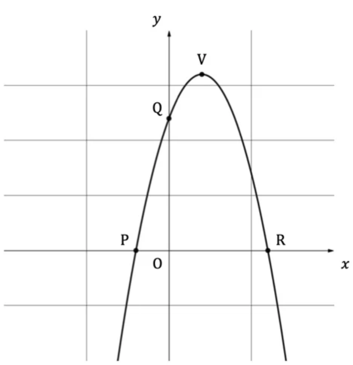
c) Graph $f(x)$ and $g(x)$ on your GDC and find the x-intercepts.*

$f(x)$ x-intercepts at $(-3, 0)$ and $(2, 0)$
$g(x)$ x-intercepts at $(-2, 0)$ and $(1, 0)$.

* N.B x-intercepts are also known as "zeros".

Question 7

The diagram below shows part of the graph of the function $f(x) = -x^2 + bx + c$, where b and c are both integers. Points P(-2, 0) and R(6, 0) represent the x-intercepts, point Q(0, 12) represents the y-intercept, point V represents the vertex of the graph of f and O represents the origin (0, 0).



(a) Write down the value of c.

[1]

(b) Find the value of b and write down $f(x)$.

[3]

(c) Write down the coordinates of V.

[2]

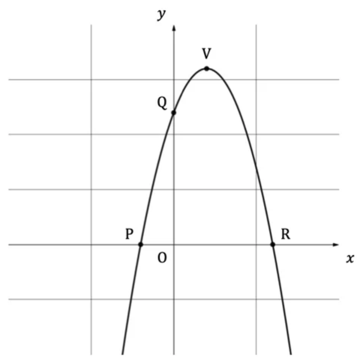
a) Point $Q(0, 12)$ is the y-intercept.

$g(0) = 12$

$-(0)^2 + b(0) + c = 12$

$\boxed{c = 12}$

The diagram below shows part of the graph of the function $f(x) = -x^2 + bx + c$, where b and c are both integers. Points P(-2, 0) and R(6, 0) represent the x-intercepts, point Q(0, 12) represents the y-intercept, point V represents the vertex of the graph of f and O represents the origin (0, 0).



(a) Write down the value of c.

$\boxed{c = 12}$

[1]

(b) Find the value of b and write down $f(x)$.

[3]

(c) Write down the coordinates of V.

[2]

b) Sub *P(-2, 0) into $f(x)$.

$f(-2) = 0$

$-(-2)^2 + b(-2) + 12 = 0$

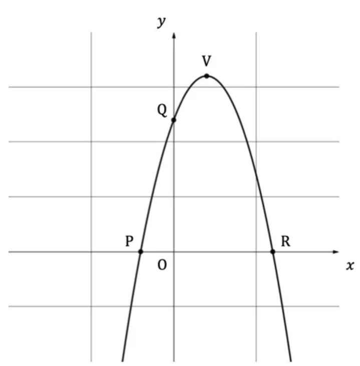
$-4 - 2b + 12 = 0$

$2b = 8$

$$\boxed{\begin{array}{l} b = 4 \\ \therefore f(x) = -x^2 + 4x + 12 \end{array}}$$

*N.B you can also use point R.

The diagram below shows part of the graph of the function $f(x) = -x^2 + bx + c$, where b and c are both integers. Points P(-2, 0) and R(6, 0) represent the x-intercepts, point Q(0, 12) represents the y-intercept, point V represents the vertex of the graph of f and O represents the origin (0, 0).



(a) Write down the value of c.

[1]

(b) Find the value of b and write down $f(x)$.

$\boxed{f(x) = -x^2 + 4x + 12}$

[3]

(c) Write down the coordinates of V.

[2]

c) $f(x)$ is a negative quadratic.

$\therefore$ the vertex of $f(x)$ is a maximum.

Graph $f(x)$ on your GDC and find its maximum.

$\boxed{V(2, 16)}$

EXAM PAPERS PRACTICE

Question 8

The function $g(x) = ax^2 + bx + c$ intercepts the y-axis at -16, has an x-intercept when $x = -4$ and can be obtained by an appropriate translation of the graph $y = 2x^2$.

(a) (i) Find the values of a, b and c.

(ii) Write down $g(x)$.

[4]

(b) Find the other x-intercept of $g(x)$.

[1]

(c) Write down the coordinates of the vertex of $g(x)$.

[2]

a) i) $g(x)$ can be obtained by an appropriate translation of the graph $y = 2x^2$

$\boxed{\therefore a = 2}$

$g(x)$ intersects the y-axis at $(0, -16)$

$g(0) = -16$

$2(0)^2 + b(0) + c = -16$

$\boxed{\therefore c = -16}$

$g(x)$ intersects the x-axis at $(-4, 0)$

$g(-4) = 0$

$2(-4)^2 + b(-4) - 16 = 0$

algebraic solver on GDC

$\boxed{\therefore b = 4}$

ii) $\boxed{\therefore g(x) = 2x^2 + 4x - 16}$

The function $g(x) = ax^2 + bx + c$ intercepts the y-axis at -16, has an x-intercept when $x = -4$ and can be obtained by an appropriate translation of the graph $y = 2x^2$.

(a) (i) Find the values of a, b and c.

(ii) Write down $g(x)$.

$\boxed{g(x) = 2x^2 + 4x - 16}$

[4]

(b) Find the other x-intercept of $g(x)$.

[1]

(c) Write down the coordinates of the vertex of $g(x)$.

[2]

b) x-intercepts occur when the function equals zero.

$g(x) = 0$

$2x^2 + 4x - 16 = 0$

factorise

$(2x - 4)(x + 4) = 0$

null factor law

$\therefore x = \underline{2}$ and -4

$\boxed{x\text{-intercept at } (2, 0)}$

Alternatively you could graph $g(x)$ and find its x-intercepts ("zeros").

The function $g(x) = ax^2 + bx + c$ intercepts the y-axis at -16, has an x-intercept when $x = -4$ and can be obtained by an appropriate translation of the graph $y = 2x^2$.

(a) (i) Find the values of a, b and c.

(ii) Write down $g(x)$.

$\boxed{g(x) = 2x^2 + 4x - 16}$

[4]

(b) Find the other x-intercept of $g(x)$.

$\boxed{x\text{-intercept at } (2,0)}$

[1]

(c) Write down the coordinates of the vertex of $g(x)$.

[2]

c) x-coordinate of the vertex is between the x-intercepts.

$x = \frac{(-4)+2}{2}$

$x = -1$

Sub $x = -1$ into $g(x)$.

$g(-1) = 2(-1)^2 + 4(-1) - 16$

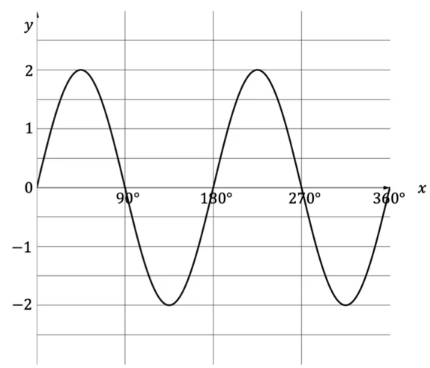
$g(-1) = -18$

$\boxed{\text{Vertex at } (-1, -18)}$

Alternatively you could graph $g(x)$ and find its vertex.

Question 9

The diagram below shows the graph of the function $f(x) = 2\sin(2x)$ for $0° \leq x \leq 360°$.



(a) State the amplitude of $f(x)$.

[1]

a) Amplitude formula

$\text{Amplitude} = \frac{f_{max} - f_{min}}{2}$ (not in formula booklet)

$\text{Amplitude} = \frac{2 - (-2)}{2}$

$\boxed{\text{Amplitude} = 2}$

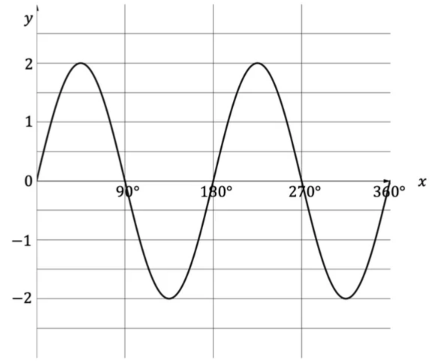
(b) Calculate the period of $f(x)$.

[2]

(c) Find the possible values of x when $f(x) = -1$.

[4]

The diagram below shows the graph of the function $f(x) = 2\sin(2x)$ for $0° \leq x \leq 360°$.



(a) State the amplitude of $f(x)$.

[1]

(b) Calculate the period of $f(x)$.

[2]

(c) Find the possible values of x when $f(x) = -1$.

[4]

b) $f(x)$ is in the form $a \sin bx$

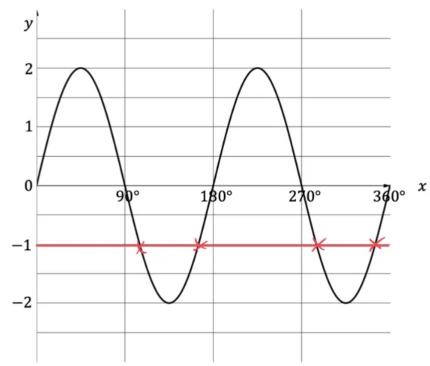
Period formula

Period $= \dfrac{360°}{b}$ (not in formula booklet)

Period $= \dfrac{360°}{2}$

$\boxed{\text{Period} = 180°}$

The diagram below shows the graph of the function $f(x) = 2\sin(2x)$ for $0° \leq x \leq 360°$.



(a) State the amplitude of $f(x)$.

[1]

(b) Calculate the period of $f(x)$.

[2]

(c) Find the possible values of x when $f(x) = -1$.

[4]

c) Set $f(x) = -1$ and rearrange for x.

Tip: Draw $y = -1$ on the graph to see the number of solutions and what they are approximately.

$2\sin(2x) = -1$) $\div 2$

$\sin 2x = -\dfrac{1}{2}$) inverse sin

$2x = \sin^{-1}\left(-\dfrac{1}{2}\right)$) $\div 2$

$x = \dfrac{\sin^{-1}\left(-\frac{1}{2}\right)}{2}$

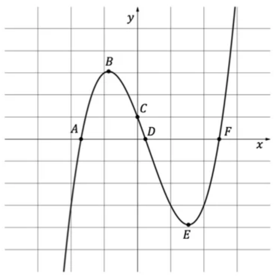
$\boxed{x = 105°, 165°, 285°, 345°}$

Alternative GDC method

· Graph $f(x)$ and $y = -1$ and find intersections.

Question 10

The diagram below shows part of the graph of the function $f(x) = x^3 - x^2 - 4x + 1$.



(a) Points A, C, D and F represent where the graph of f intersects the coordinate axes, write down the coordinates for

(i) A

(ii) C

(iii) D

(iv) F.

[4]

(b) Points B and E represent the local maximum and minimum respectively of $f(x)$, write down the coordinates for

(i) B

(ii) E.

[2]

a) Graph $f(x)$ on your GDC and find the axes intercepts.

A, D and F are the x-intercepts ("zeros")

C is the y-intercept, which is when $x=0$.

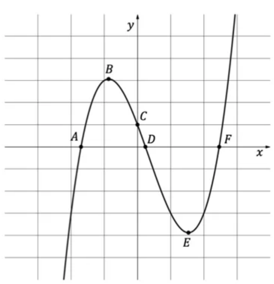
i) $\boxed{A(-1.7, 0)}$

ii) $\boxed{C(0, 1)}$

iii) $\boxed{D(0.234, 0)}$

iv) $\boxed{F(2.46, 0)}$

The diagram below shows part of the graph of the function $f(x) = x^3 - x^2 - 4x + 1$.



(a) Points A, C, D and F represent where the graph of f intersects the coordinate axes, write down the coordinates for

(i) A

(ii) C

(iii) D

(iv) F.

[4]

(b) Points B and E represent the local maximum and minimum respectively of $f(x)$, write down the coordinates for

(i) B

(ii) E.

[2]

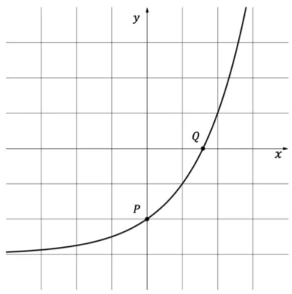
b) Find the local maximum and minimum of $f(x)$ on your GDC.

i) $\boxed{B(-0.869, 3.06)}$

ii) $\boxed{E(1.54, -3.88)}$

Question 11

The diagram below shows part of the graph of the function $f(x) = 2^x - 3$.



(a) Find

(i) $f(2)$

(ii) x when $f(x) = -1$.

[2]

(b) The point P represents the y-intercept of $f(x)$. Write down the coordinates of P.

[1]

(c) The point Q represents the x-intercept of $f(x)$. Write down the coordinates of Q.

[1]

(d) Write down the number of solutions to the equation $f(x) = -3$.

[2]

a) i) Sub $x = 2$ into $f(x)$.

$f(2) = 2^{(2)} - 3$

$\boxed{f(2) = 1}$

ii) Set $f(x) = -1$ and rearrange for x.

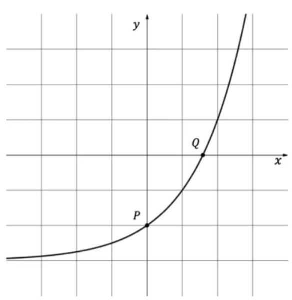
$f(x) = -1$

$2^x - 3 = -1$

$2^x = 2$

$\boxed{x = 1}$

The diagram below shows part of the graph of the function $f(x) = 2^x - 3$.



(a) Find

(i) $f(2)$

(ii) x when $f(x) = -1$.

[2]

(b) The point P represents the y-intercept of $f(x)$. Write down the coordinates of P.

[1]

(c) The point Q represents the x-intercept of $f(x)$. Write down the coordinates of Q.

[1]

(d) Write down the number of solutions to the equation $f(x) = -3$.

[2]

b) y-intercept is when $x = 0$.

Sub $x = 0$ into $f(x)$.

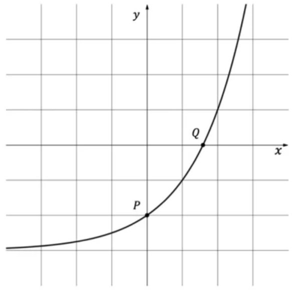
$f(0) = 2^{(0)} - 3$

$f(0) = 1 - 3$

$f(0) = -2$

$\boxed{P(0, -2)}$

The diagram below shows part of the graph of the function $f(x) = 2^x - 3$.



(a) Find

(i) $f(2)$

(ii) x when $f(x) = -1$.

[2]

(b) The point P represents the y-intercept of $f(x)$. Write down the coordinates of P.

[1]

(c) The point Q represents the x-intercept of $f(x)$. Write down the coordinates of Q.

[1]

(d) Write down the number of solutions to the equation $f(x) = -3$.

[2]

c) x-intercept is when $f(x) = 0$.

Set $f(x) = 0$ and rearrange for x.

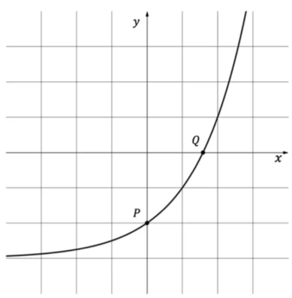
$2^x - 3 = 0$

algebraic solver on GDC

$x \approx 1.58$

$\boxed{Q(1.58, 0)}$

The diagram below shows part of the graph of the function $f(x) = 2^x - 3$.



(a) Find

(i) $f(2)$

(ii) x when $f(x) = -1$.

[2]

(b) The point P represents the y-intercept of $f(x)$. Write down the coordinates of P.

[1]

(c) The point Q represents the x-intercept of $f(x)$. Write down the coordinates of Q.

[1]

(d) Write down the number of solutions to the equation $f(x) = -3$.

[2]

c) $f(x) = 2^x - 3$ and $2^x > 0$.

$\boxed{\therefore f(x) = -3 \text{ has no solutions}}$

N.B the line $y = -3$ is the horizontal asymptote of $f(x)$.