>

>

1. Plot the function f(x) = 2 sin x - x^3 - 1/5, for $x \in [-4, 4]$.
Find all the zeros of the function with an accuracy of 20 decimal digits. Hint: See Digits, fsolve

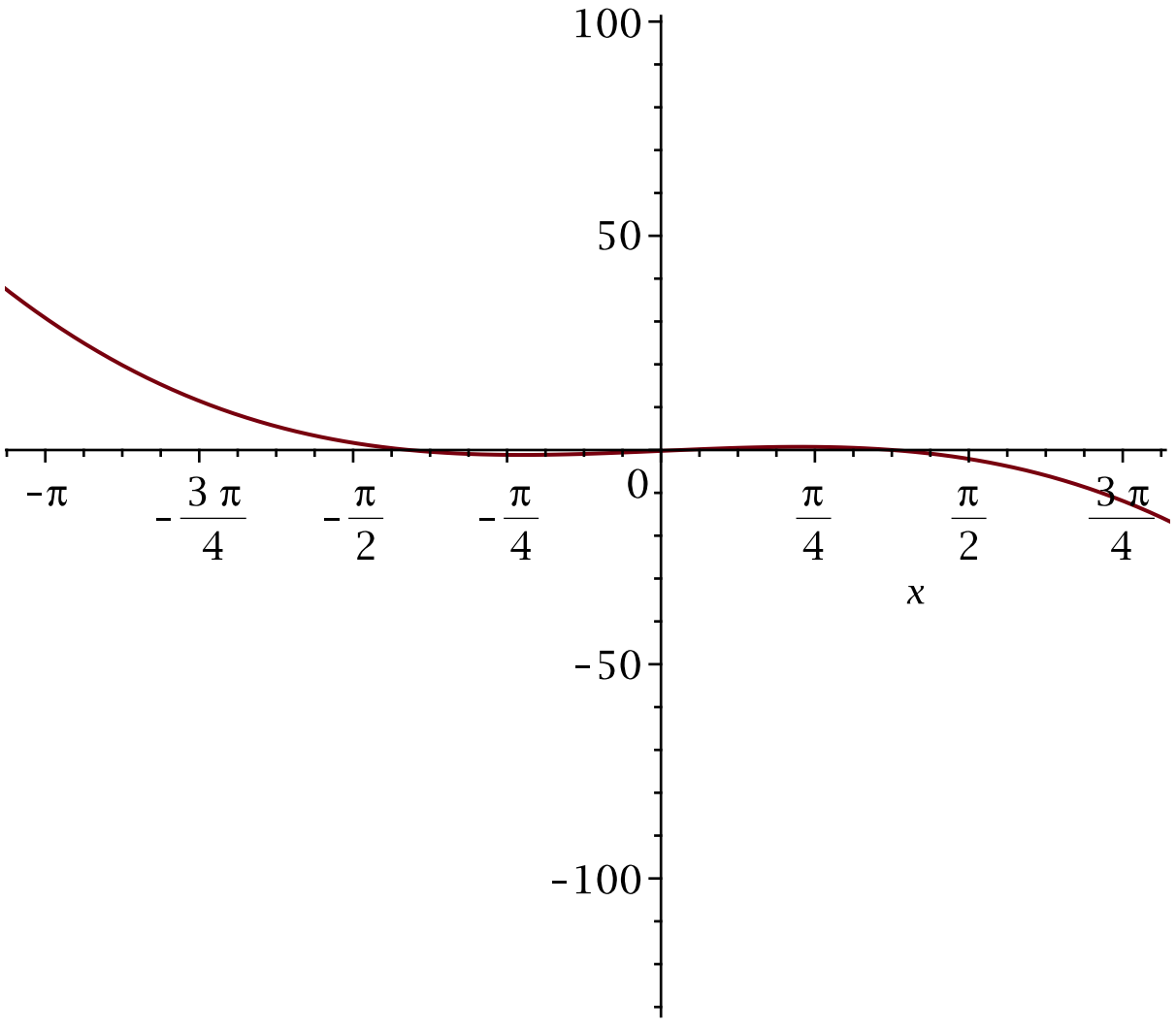
> $f := 2\sin(x) - x^3 - \frac{1}{5};$

$$f := 2\sin(x) - x^3 - \frac{1}{5} \quad \textbf{(1)}$$

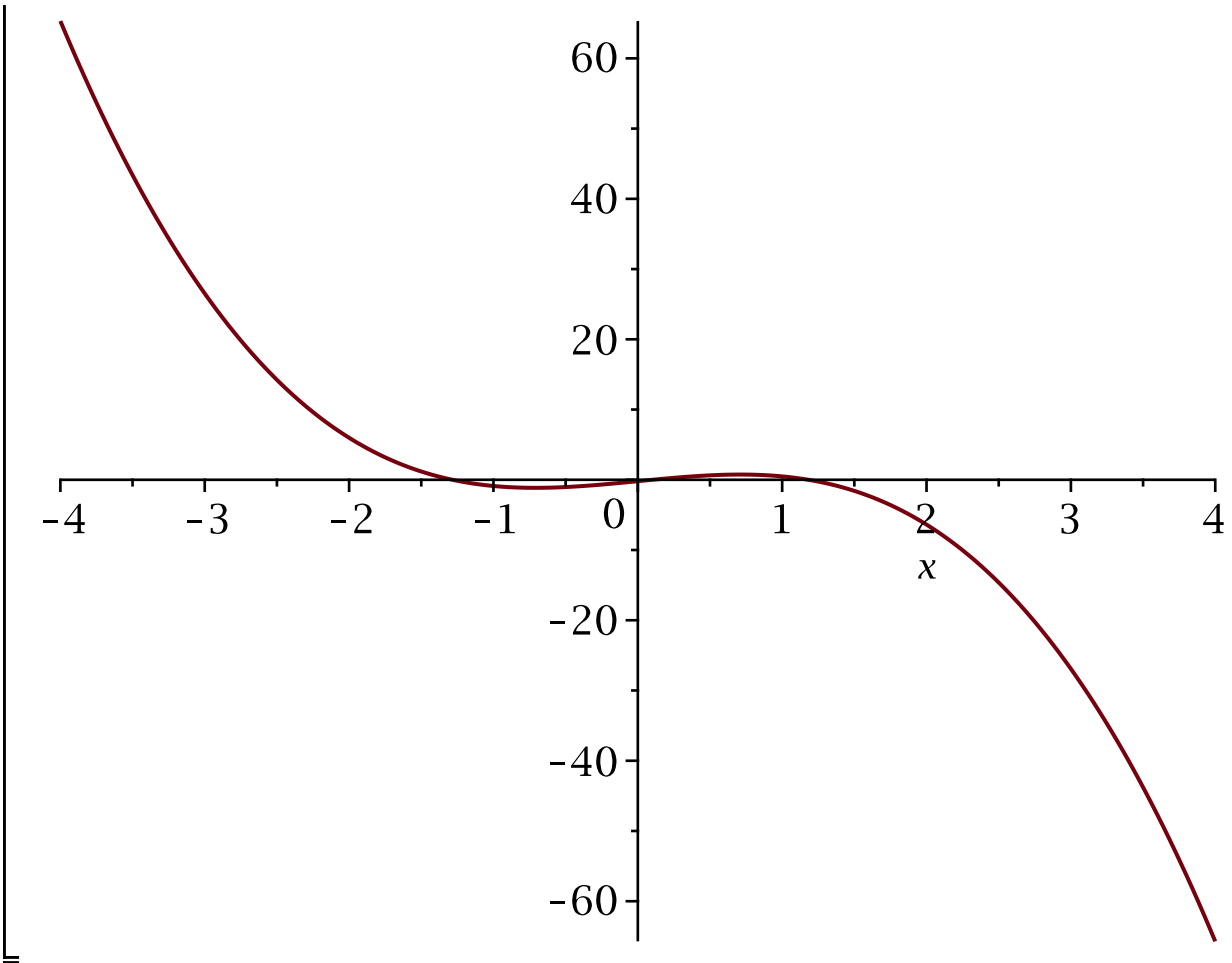
> f

$$2\sin(x) - x^3 - \frac{1}{5} \quad \textbf{(2)}$$

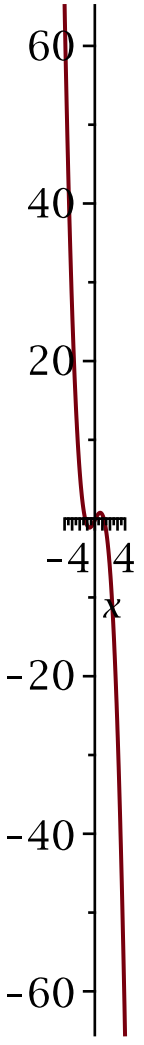
> $plot(f);$



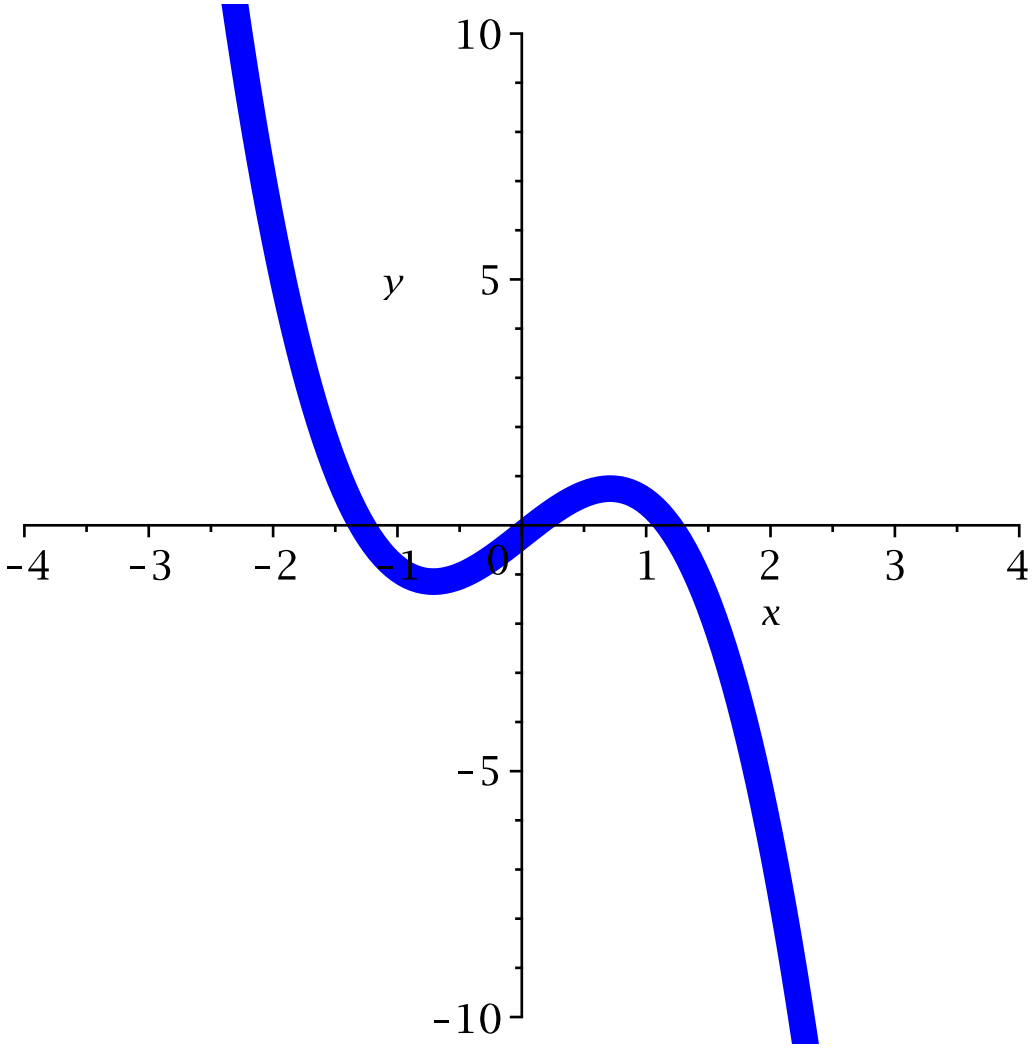
> $plot(f, x = -4..4);$




```
> plot( f, x = -4 .. 4, scaling = constrained );
```




```
> plot(f, x = -4..4, y = -10..10, color = blue, thickness = 10)
```



>

Here I cut and pasted stuff to answer part of the first exercise.

>

>

>

> f

$$2\sin(x) - x^3 - \frac{1}{5} \quad \textbf{(3)}$$

> $f(1.2)$

$$2\sin(x)(1.2) - x(1.2)^3 - \frac{1}{5} \quad \textbf{(4)}$$

> $g := x^2$

$$g := x^2 \quad \textbf{(5)}$$

> $g(-1)$

$$x(-1)^2 \quad \textbf{(6)}$$

also wrong, but maple is being nice.

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

$$g := x \mapsto x^2 \quad (7)$$

here I typed g:=x->x^2

> $g := x \to x^2$

$$g := x \mapsto x^2 \quad (8)$$

> $g(3);$

$$9 \quad (9)$$

> $g(2.6);$

$$6.76 \quad (10)$$

I might try this, but it fails.

>

> $newf := x \to f;$

$$newf := x \mapsto f \quad (11)$$

> $newf(3)$

$$2\sin(x) - x^3 - \frac{1}{5} \quad (12)$$

> $anotherTry := x \to 2\sin(x) - x^3 - \frac{1}{5}$

$$anotherTry := x \mapsto 2\sin(x) - x^3 - \frac{1}{5} \quad (13)$$

> $anotherTry(2.1);$

$$-7.734581267 \quad (14)$$

>

I don't want to copy/paste or retype. So.....

spoze I just want to plug 1.2 into the expression f

> $eval(f, x = 1.3)$

$$-0.4698836290 \quad (15)$$

> $subs(x = 1.3, f)$

$$2\sin(1.3) - 2.397000000 \quad (16)$$

> $subs(x = y^2, f);$

$$2\sin(y^2) - y^6 - \frac{1}{5} \quad (17)$$

> $eval(f, x = 1);$

$$2\sin(1) - \frac{6}{5} \quad (18)$$

> $evalf(\%)$

$$0.482941970 \quad (19)$$

> f

$$2\sin(x) - x^3 - \frac{1}{5} \quad (20)$$

```
> fAsAFunc := unapply(f, x)
```

$$fAsAFunc := x \mapsto 2\sin(x) - x^3 - \frac{1}{5} \tag{21}$$

```
>
```

fAsAFunc(x) is way too long, let's just turn f into a function.

```
> f := unapply(f, x)
```

$$f := x \mapsto 2\sin(x) - x^3 - \frac{1}{5} \tag{22}$$

```
> f(1.02);
```

$$0.4430080440 \tag{23}$$

```
> solve(f(x) = 0, x)
```

$$RootOf(5\_Z^3 - 10\sin(\_Z) + 1) \tag{24}$$

```
> solve(y = x^3 - 1, x)
```

$$(y+1)^{1/3},\ -\frac{(y+1)^{1/3}}{2} + \frac{I\sqrt{3}\,(y+1)^{1/3}}{2},\ -\frac{(y+1)^{1/3}}{2} - \frac{I\sqrt{3}\,(y+1)^{1/3}}{2} \tag{25}$$

```
> solve(3 = x^3 - 1, x)
```

$$2^{2/3},\ -\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2},\ -\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2} \tag{26}$$

```
> evalf(%);
```

$$1.587401052,\ -0.7937005260 + 1.374729638\,I,\ -0.7937005260 - 1.374729638\,I \tag{27}$$

```
> argument(%[2]);
```

$$2.094395102 \tag{28}$$

```
> sols := (solve(3 = x^3 - 1, x))
```

$$sols := 2^{2/3},\ -\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2},\ -\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2} \tag{29}$$

```
> argument(sols[2]);
```

$$\frac{2\pi}{3} \tag{30}$$

```
> abs(sols[2]);
```

$$2^{2/3} \tag{31}$$

```
> evalf(%);
```

$$1.587401052 \tag{32}$$

```
> argument(sols);
Error, (in argument) expecting 1 argument, got 3
> map(argument, [sols])
```

$$\left[0,\ \frac{2\pi}{3},\ -\frac{2\pi}{3}\right] \tag{33}$$

```
> map(abs, [sols])
```

(34)

$$[2^{2/3}, 2^{2/3}, 2^{2/3}] \tag{34}$$

> $map(x \to [\mathrm{abs}(x), \mathrm{argument}(x)], \{sols\});$

$$\left\{[2^{2/3}, 0], \left[2^{2/3}, -\frac{2\pi}{3}\right], \left[2^{2/3}, \frac{2\pi}{3}\right]\right\} \tag{35}$$

> $fsolve(f(x) = 0, x)$

$$0.1006802788 \tag{36}$$

> $Digits := 20;$

$$Digits := 20 \tag{37}$$

> $fsolve(f(x) = 0, x)$

$$0.10068027882300758308 \tag{38}$$

> $fsolve(f(x) = 0, x) :$

> $\mathrm{argument}(1 + I);$

$$\frac{\pi}{4} \tag{39}$$

> $\mathrm{argument}(-1 + I)$

$$\frac{3\pi}{4} \tag{40}$$

> $sols;$

$$2^{2/3}, -\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2}, -\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2} \tag{41}$$

> $[sols]$

$$\left[2^{2/3}, -\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2}, -\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2}\right] \tag{42}$$

> $map(x \to x^3, \%);$

$$\left[4, \left(-\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2}\right)^3, \left(-\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2}\right)^3\right] \tag{43}$$

> $g := x \to x^3$

$$g := x \mapsto x^3 \tag{44}$$

> $map(g, [sols])$

$$\left[4, \left(-\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2}\right)^3, \left(-\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2}\right)^3\right] \tag{45}$$

> $map(f, [sols]);$

$$\left[2\sin(2^{2/3}) - \frac{21}{5}, -2\sin\left(\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2}\right) - \left(-\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2}\right)^3 - \frac{1}{5},\right.$$
$$\left. -2\sin\left(\frac{2^{2/3}}{2} + \frac{I\sqrt{3}\,2^{2/3}}{2}\right) - \left(-\frac{2^{2/3}}{2} - \frac{I\sqrt{3}\,2^{2/3}}{2}\right)^3 - \frac{1}{5}\right] \tag{46}$$

> $fsolve(f(x) = 0, x)$

$$0.10068027882300758308 \tag{47}$$

```
> f(%)
```

$$0. \tag{48}$$

```
> Digits := 10
```

$$Digits := 10 \tag{49}$$

```
> fsolve(f(x) = 0, x);
```

$$0.1006802788 \tag{50}$$

```
> f(%);
```

$$-1.\,10^{-10} \tag{51}$$

```
> Digits := 30
```

$$Digits := 30 \tag{52}$$

```
> f(0.10068027882300758308)
```

$$-8.221234418\,10^{-21} \tag{53}$$

```
> ?Digits
> f(y)
```

$$2\sin(y) - y^3 - \frac{1}{5} \tag{54}$$

```
> fex := 2 sin(x) - x^3 - 1/5
```

$$fex := 2\sin(x) - x^3 - \frac{1}{5} \tag{55}$$

```
> s := fsolve(fex = 0, x)
```

$$s := 0.100680278823007583084195657982 \tag{56}$$

```
> f := x->2 sin(x) - x^3 - 1/5
```

$$f := x \mapsto 2\sin(x) - x^3 - \frac{1}{5} \tag{57}$$

```
> f(s)
```

$$-1.\,10^{-30} \tag{58}$$

```
> fex(s)
```

$$2\sin(x)(0.100680278823007583084195657982) - x(0.100680278823007583084195657982)^3 - \frac{1}{5} \tag{59}$$

```
> eval(fex, x = s)
```

$$-1.\,10^{-30} \tag{60}$$

```
>
```