1.2 Instruction, exécution et résultat

```
> 2 + 2;
```

$$4 \qquad (1.1)$$

```
> 2 + 2 :
> 2 + 2
```

$$4 \qquad (1.2)$$

```
> 2 + 3;
  3 + 5;
```

$$5$$
$$8 \qquad (1.3)$$

```
> sqrt(3 + 3·7/5);
```

$$\frac{6}{5}\sqrt{5} \qquad (1.4)$$

```
> evalf(sqrt(3 + 3·7/5));
```

$$2.683281572 \qquad (1.5)$$

```
> abs(1 − 2··5);
```

$$31 \qquad (1.6)$$

```
> cos(Pi/2); exp(1); ln(1);
```

$$0$$
$$e$$
$$0 \qquad (1.7)$$

```
> print(Coucou);
```

$$Coucou \qquad (1.8)$$

```
> ?plot
>
>
>
```

1.4 Les variables

```
> I^2;
```

$$-1 \qquad (2.1)$$

```
> Pi;
```

$$\pi \qquad (2.2)$$

```
> evalf(Pi);
```

$$3.141592654 \quad (2.3)$$

```
> Digits;
```

$$10 \quad (2.4)$$

```
> Digits := 50; evalf(Pi);
```

$$Digits := 50$$

$$3.1415926535897932384626433832795028841971693993751 \quad (2.5)$$

```
> Pi := 3.14;
Error, attempting to assign to `Pi` which is protected
> a;
```

$$a \quad (2.6)$$

```
> a := 1 : a;
```

$$1 \quad (2.7)$$

```
> b = 1;
```

$$b = 1 \quad (2.8)$$

```
> b;
```

$$b \quad (2.9)$$

```
> a := 1 : a; unassign('a'); a;
```

$$1$$

$$a \quad (2.10)$$

```
> a := 2 : b := 3;
```

$$b := 3 \quad (2.11)$$

```
> restart;
> a; b;
```

$$a$$

$$b \quad (2.12)$$

```
> a := 2;
```

$$a := 2 \quad (2.13)$$

```
> a := a·2;
```

$$a := 32 \quad (2.14)$$

```
> a;
```

$$32 \quad (2.15)$$

```
>
```

1.5 Boucles et instructions conditionnelles

1.5.1 Boucles

```
> montant := 0 :
  for i from 1 to 27 do
```

```
montant := montant + 10 :
od:
montant;
```

270 (3.1.1)

1.5.2 Test if/while

```
> x := 5;
```

$x := 5$ (3.2.1)

```
> if (x < 10) then a := 10 : fi: a;
```

10 (3.2.2)

```
> a := 1;if (a > 0) then b := 0 : else b := 1 : fi: b;
```

$a := 1$

0 (3.2.3)

```
> n := 0 :
  while(n^2 < 1000) do
  n := n + 1 :
  od:
  n;
```

32 (3.2.4)

```
> 32^2; 31^2;
```

1024

961 (3.2.5)

1.5.3 Opérateurs logiques

```
> a := 0; b := 3; c := 0 :
  if ((a = 1) or (b = 3)) then
  c := 10 :
  fi:
  c;
```

$a := 0$

$b := 3$

10 (3.3.1)

```
> a := 0; b := 4; c := 0 :
  if ((a = 1) or (b = 3)) then
  c := 10 :
  fi:
  c;
```

$a := 0$

$$b := 4$$

$$0 \qquad \textbf{(3.3.2)}$$

```
> a := 1; b := 3; c := 0 :
  if ((a = 1) and (b = 3)) then
  c := 10 :
  fi:
  c;
```

$$a := 1$$

$$b := 3$$

$$10 \qquad \textbf{(3.3.3)}$$

```
>
```

1.6 Les fonctions

1.6.1 Fonctions et expressions

```
> f := x→x^2 + 1;
```

$$f := x \to x^2 + 1 \qquad \textbf{(4.1.1)}$$

```
> f(12);
```

$$145 \qquad \textbf{(4.1.2)}$$

```
> x; restart;
```

$$5 \qquad \textbf{(4.1.3)}$$

```
> f := x^2 + 1;
```

$$f := x^2 + 1 \qquad \textbf{(4.1.4)}$$

```
> subs(x = 12, f);
```

$$145 \qquad \textbf{(4.1.5)}$$

```
> f(12);
```

$$x(12)^2 + 1 \qquad \textbf{(4.1.6)}$$

```
> f := x→x^2 + 2; f := f(x)
```

$$f := x \to x^2 + 2$$

$$f := x^2 + 2 \qquad \textbf{(4.1.7)}$$

```
> f := x^2 + 1; f := unapply(f, x);
```

$$f := x^2 + 1$$

$$f := x \to x^2 + 1 \qquad \textbf{(4.1.8)}$$

```
>
```

1.6.2 Procédures

```
> toto := proc(f, N)
  local i, tmp :
  tmp := 0 :
  for i from 1 to N do
  tmp := tmp + evalf(subs(x = i/N, f)) / N :
  od:
  tmp;
  end proc:
> f := x^2 + 1 : N := 100 : toto(f, N);
```

1.338350000 **(4.2.1)**

```
>
```

1.7 Les tableaux

1.7.1 La commande array

```
> N := 100 : c := array(1..N);
```

$c := array(1..100, [\,])$ **(5.1.1)**

```
> c[6] := 1;
```

$c_6 := 1$ **(5.1.2)**

```
> c[-10] := 12;
```

Error, 1st index, -10, smaller than lower array bound 1

```
> debut := -50 : fin := 75 : c := array(debut..fin);
```

$c := array(-50..75, [\,])$ **(5.1.3)**

```
> c[-10] := 12;
```

$c_{-10} := 12$ **(5.1.4)**

```
> N := 100; c := array(1..N);
```

$N := 100$

$c := array(1..100, [\,])$ **(5.1.5)**

```
> c[1] := 1/7;
  for k from 2 to N do
  T := add(j·c[j]·c[k-j], j = 1..k-1) :
  S := add(c[j], j = 1..k-1) :
  c[k] := 6/(5k+9) · (T + 1/3 - S) :
```

```
od:
evalf(c[100]);
```

$$c_1 := \frac{1}{7}$$

$$2.989229284\ 10^{-10} \quad \textbf{(5.1.6)}$$

```
> #eval(c);
```

$$c \quad \textbf{(5.1.7)}$$

```
>
```

1.7.2 Les listes

```
> L := [1, 4, 7];
```

$$L := [1, 4, 7] \quad \textbf{(5.2.1)}$$

```
> nops(L);
```

$$3 \quad \textbf{(5.2.2)}$$

```
> op(2, L);
```

$$4 \quad \textbf{(5.2.3)}$$

```
> L[3];
```

$$7 \quad \textbf{(5.2.4)}$$

```
> L := [seq(i·i, i = 1..5)];
```

$$L := [1, 4, 9, 16, 25] \quad \textbf{(5.2.5)}$$

```
> op(3, L);
```

$$9 \quad \textbf{(5.2.6)}$$

```
> N := 10 : L := [seq(k/N, k = 1..N)];
  f := x→exp(x);
  fL := map(f, L);
```

$$L := \left[\frac{1}{10}, \frac{1}{5}, \frac{3}{10}, \frac{2}{5}, \frac{1}{2}, \frac{3}{5}, \frac{7}{10}, \frac{4}{5}, \frac{9}{10}, 1\right]$$

$$f := x \to e^{x}$$

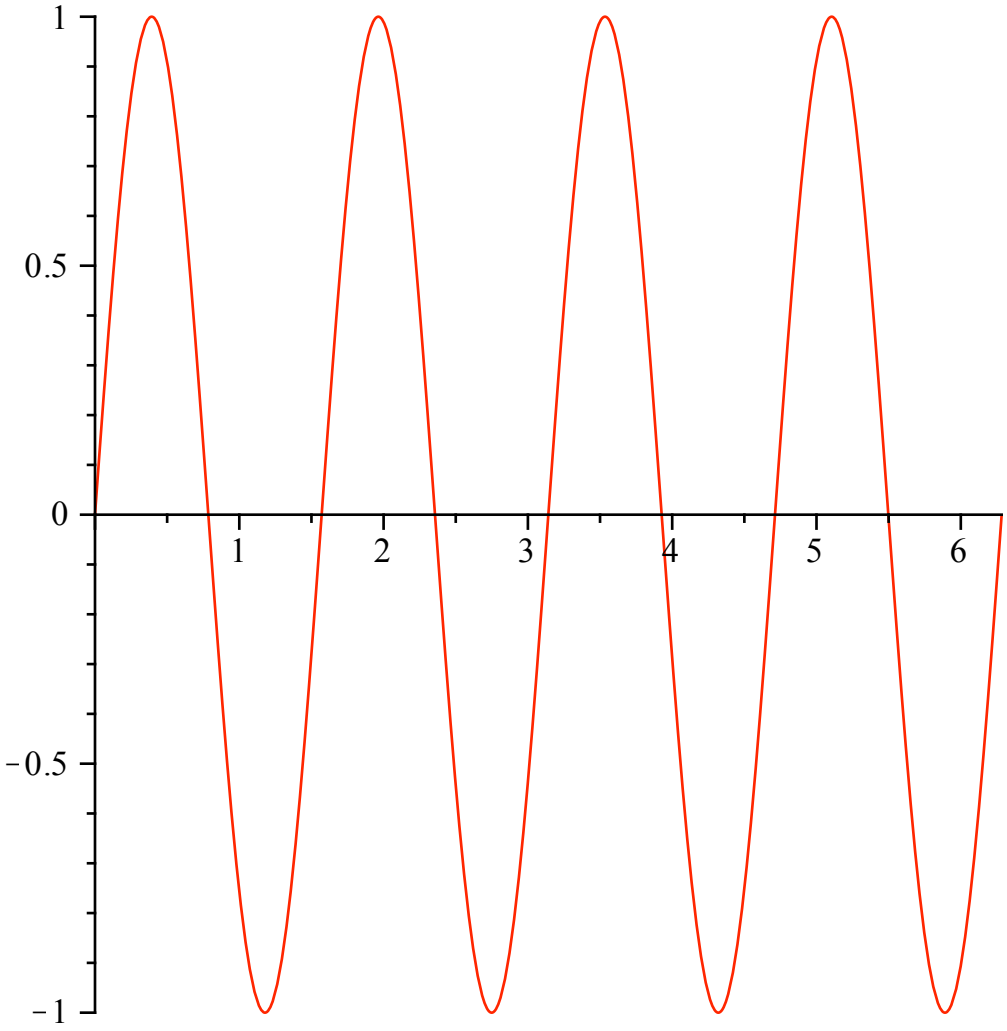
$$fL := \left[e^{\frac{1}{10}}, e^{\frac{1}{5}}, e^{\frac{3}{10}}, e^{\frac{2}{5}}, e^{\frac{1}{2}}, e^{\frac{3}{5}}, e^{\frac{7}{10}}, e^{\frac{4}{5}}, e^{\frac{9}{10}}, e\right] \quad \textbf{(5.2.7)}$$

```
>
```

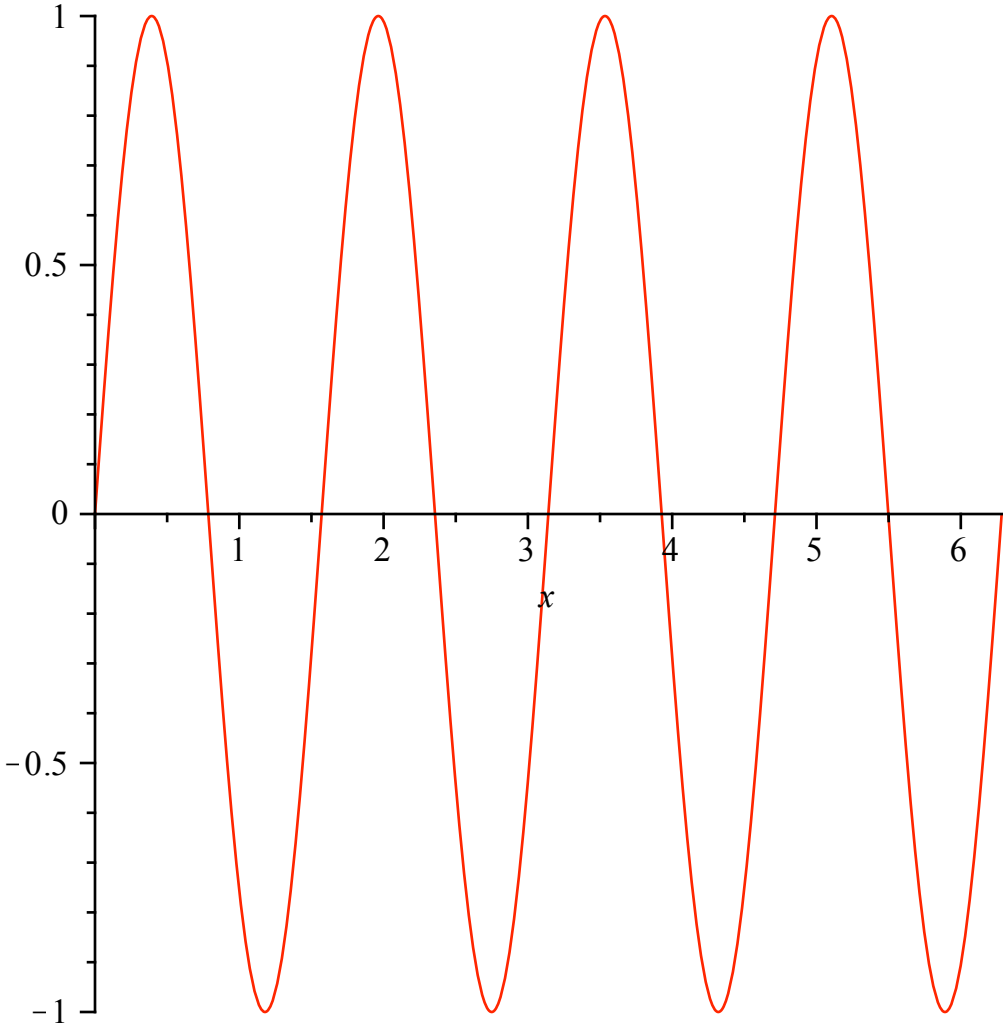
1.8 Graphiques

1.8.1 Des fonctions

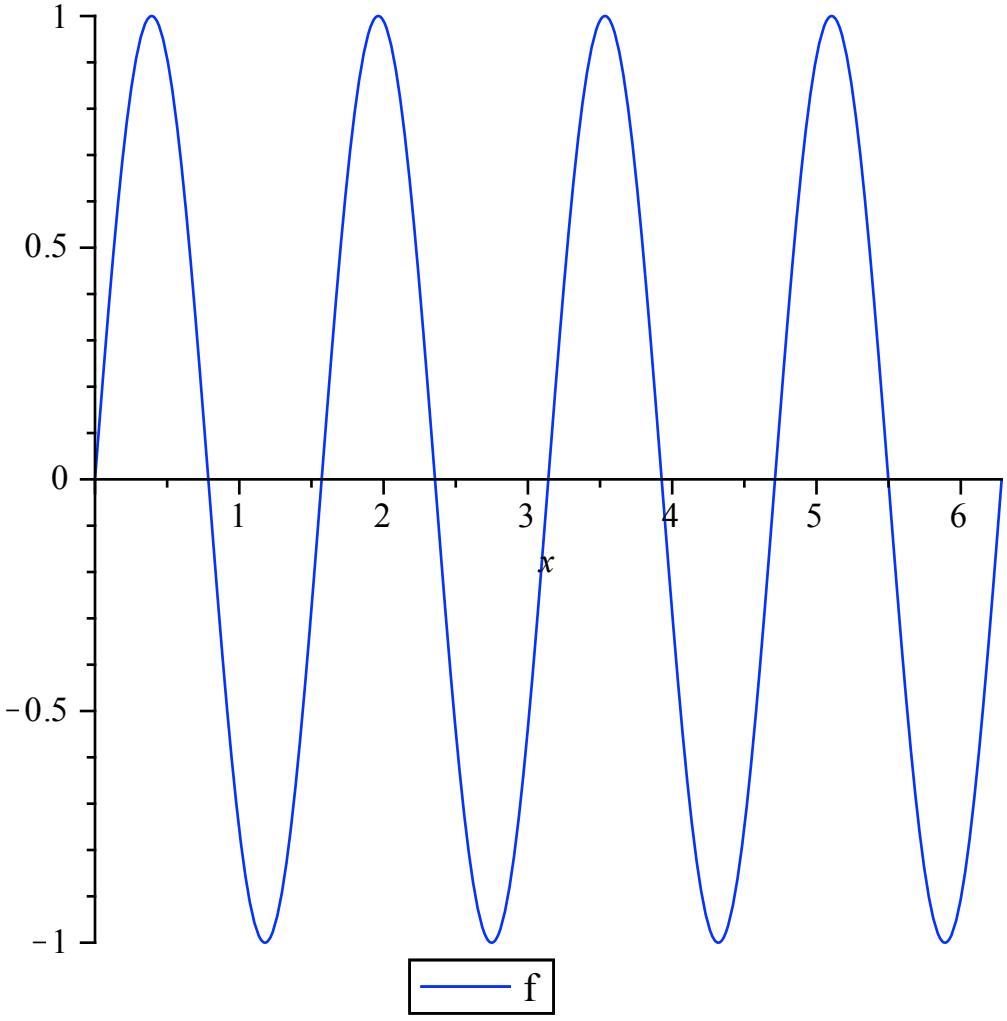
```
> f := x→sin(4·x) :
  plot( f, 0..2·Pi );
```



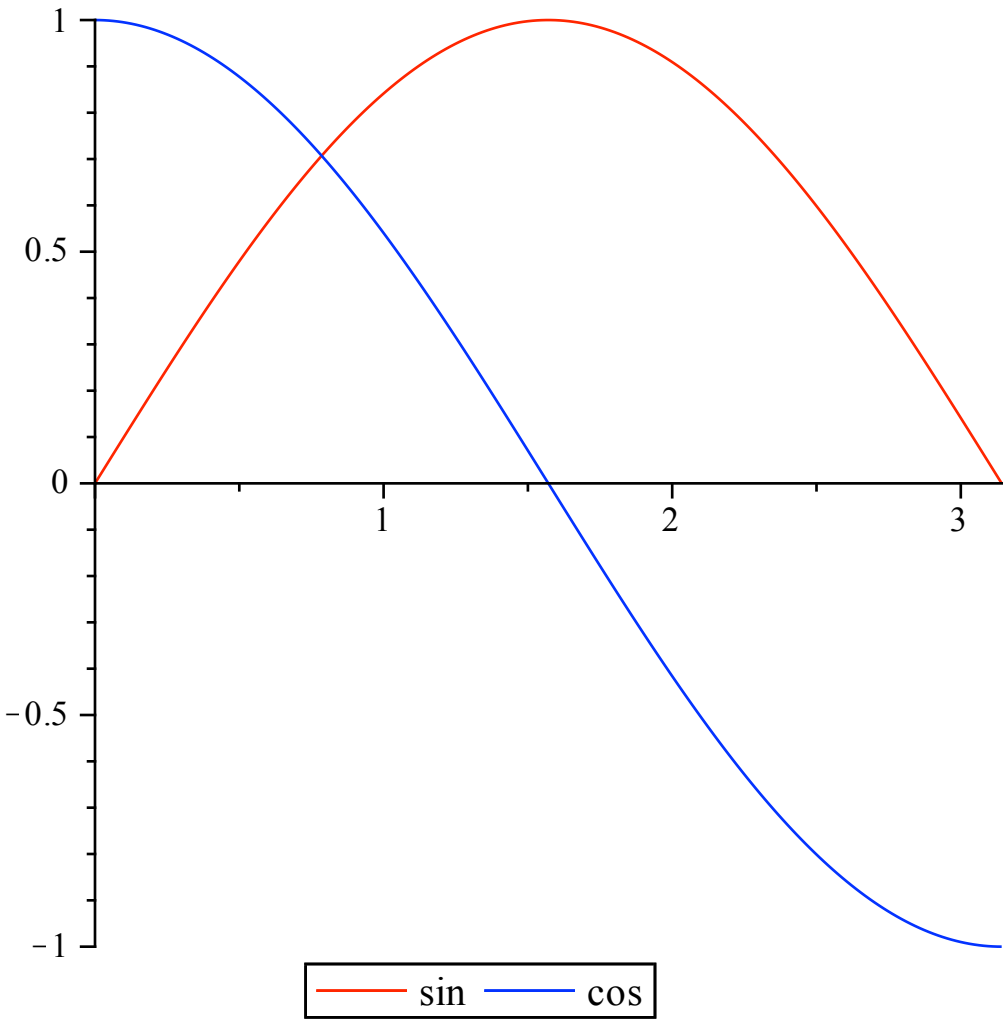

```
> f := sin(4·x) :
  plot( f, x = 0..2·Pi );
```



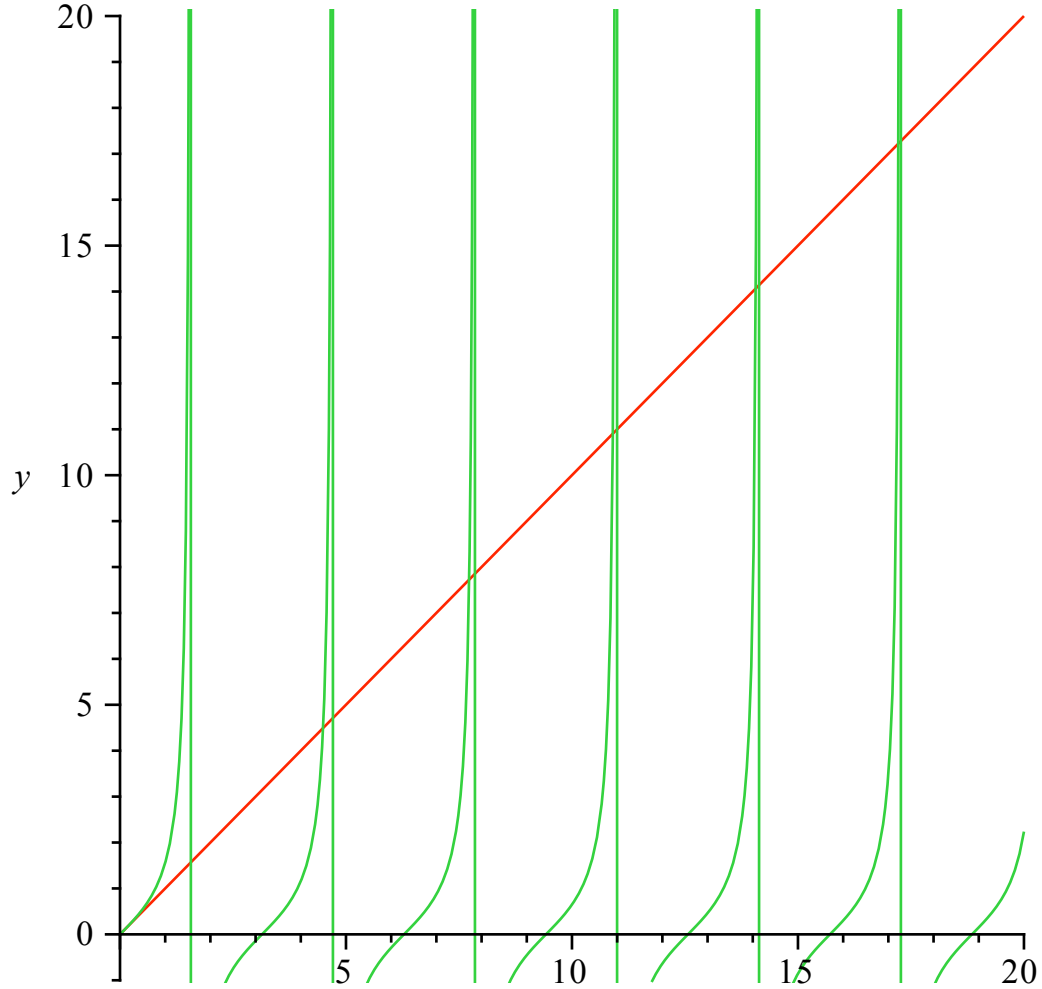

```
> f := sin(4·x) :
  plot( f, x = 0 ..2·Pi, color = blue, legend = "f" );
```



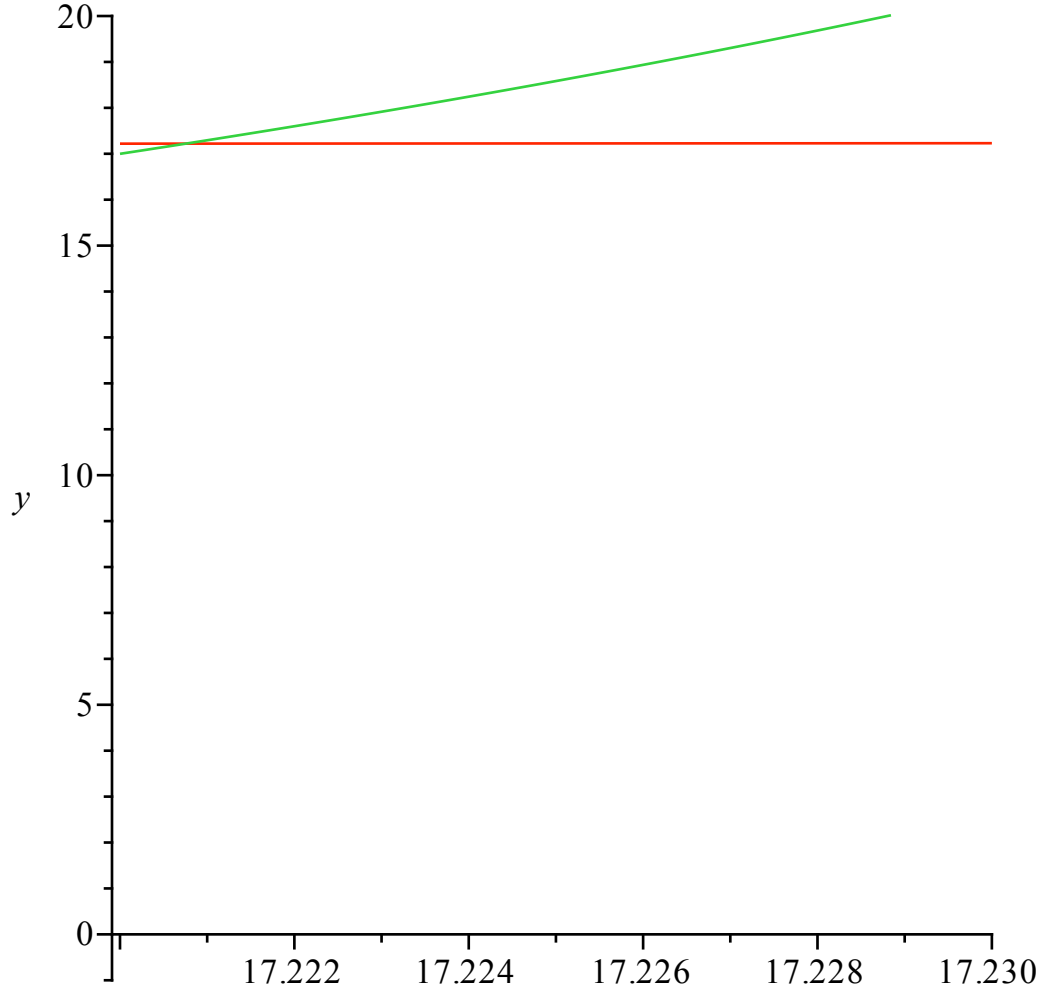

```
> plot([sin, cos], 0..Pi, color = [red, blue], legend = ["sin", "cos"]);
```




```
> #Exercice
> f := x→x :
  plot([f, tan], 0..20, y = -1..20);
```




```
> plot([f, tan], 17.22..17.23, y=-1..20);
```




```
> ?fsolvr
> h := tan(x) = x;
  fsolve(h, x = 17.2 ..17.23);
```

$$h := \tan(x) = x$$

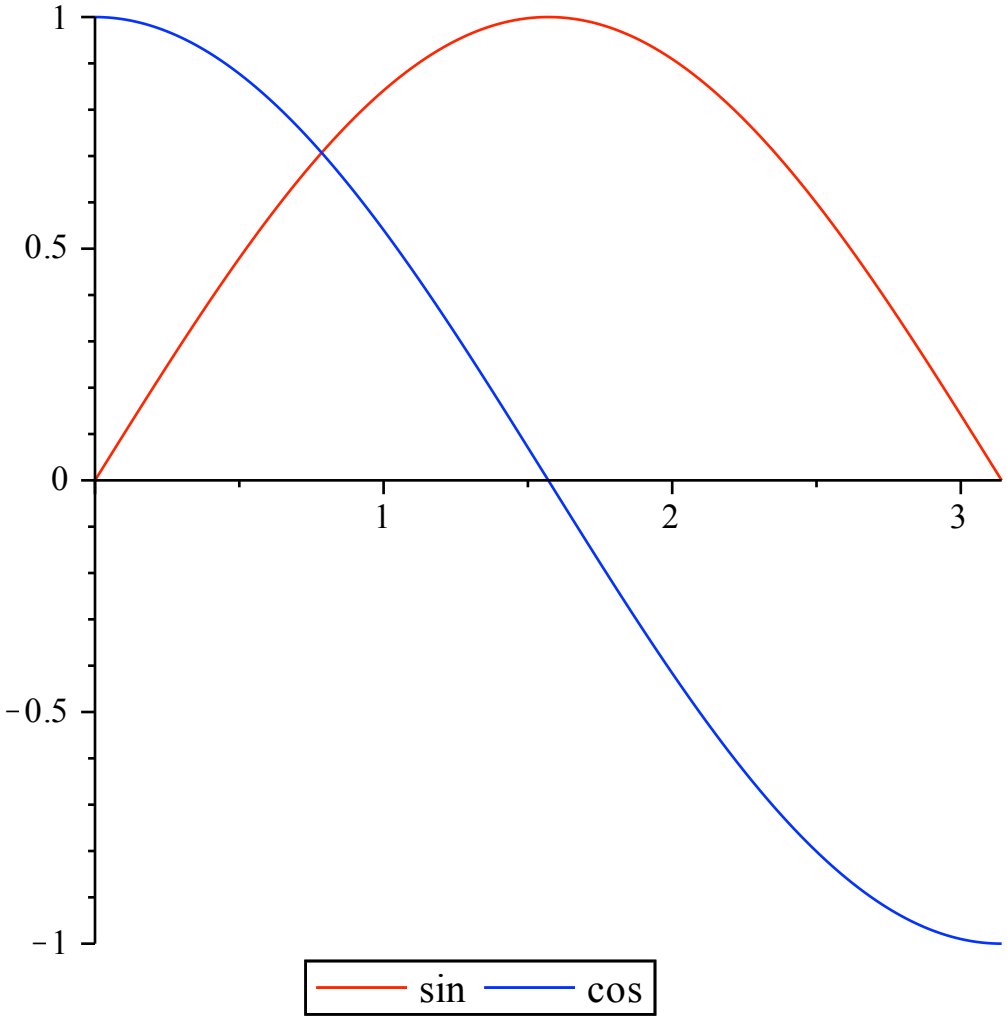
$$17.22075527 \qquad \textbf{(6.1.1)}$$

```
> #Fin exo
> with(plots);
```

[*animate*, *animate3d*, *animatecurve*, *arrow*, *changecoords*, *complexplot*, *complexplot3d*, *conformal*, *conformal3d*, *contourplot*, *contourplot3d*, *coordplot*, *coordplot3d*, *densityplot*, *display*, *dualaxisplot*, *fieldplot*, *fieldplot3d*, *gradplot*, *gradplot3d*, *implicitplot*, *implicitplot3d*, *inequal*, *interactive*, *interactiveparams*, *intersectplot*, *listcontplot*, *listcontplot3d*, *listdensityplot*, *listplot*, *listplot3d*, *loglogplot*, *logplot*, *matrixplot*, *multiple*, *odeplot*, *pareto*, *plotcompare*, *pointplot*, *pointplot3d*, *polarplot*, *polygonplot*, *polygonplot3d*, *polyhedra_supported*, *polyhedraplot*, *rootlocus*, *semilogplot*, *setcolors*, *setoptions*, *setoptions3d*, *spacecurve*, *sparsematrixplot*, *surfdata*, *textplot*, *textplot3d*, *tubeplot*] **(6.1.2)**

```
> G1 := plot(sin, 0..Pi, color = red, legend = "sin");
  G2 := plot(cos, 0..Pi, color = blue, legend = "cos"):
  display(G1, G2);
```

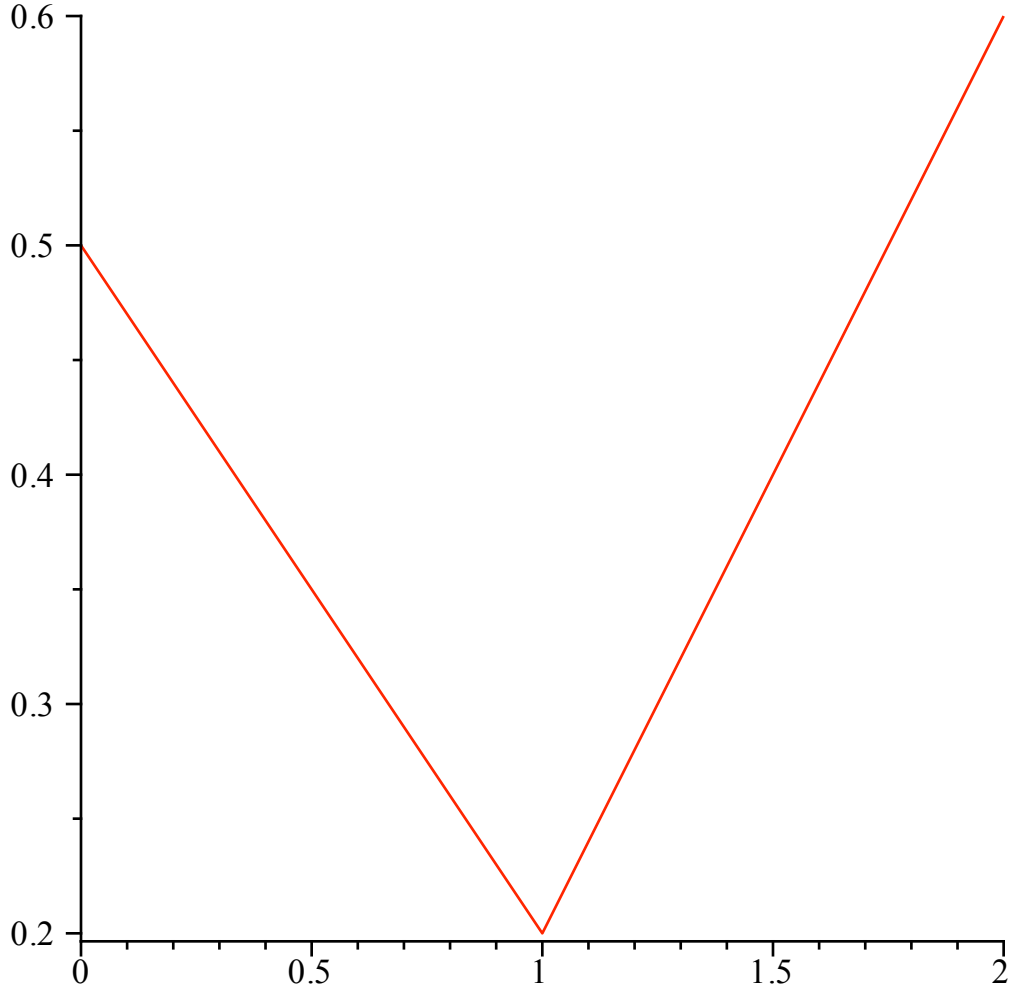
$$G1 := PLOT(\ldots)$$



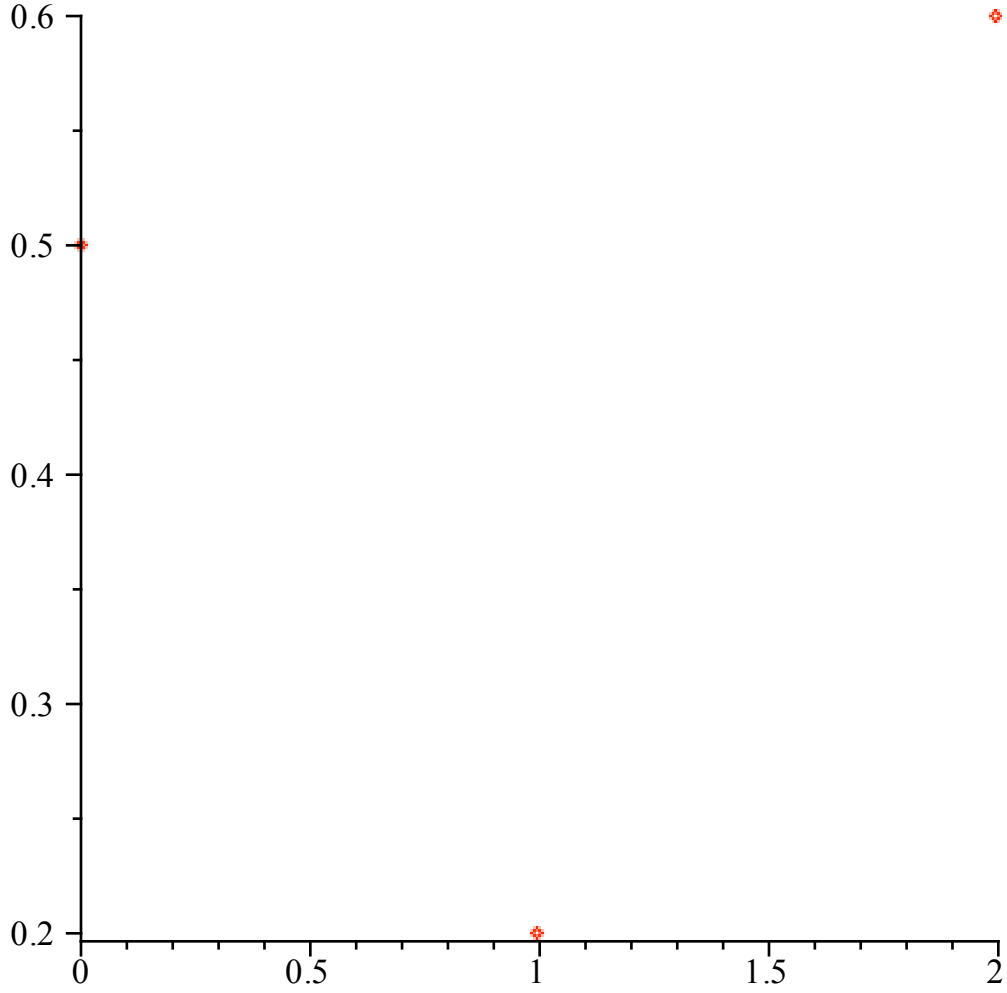

```
>
```

1.8.2 Un ensemble de points

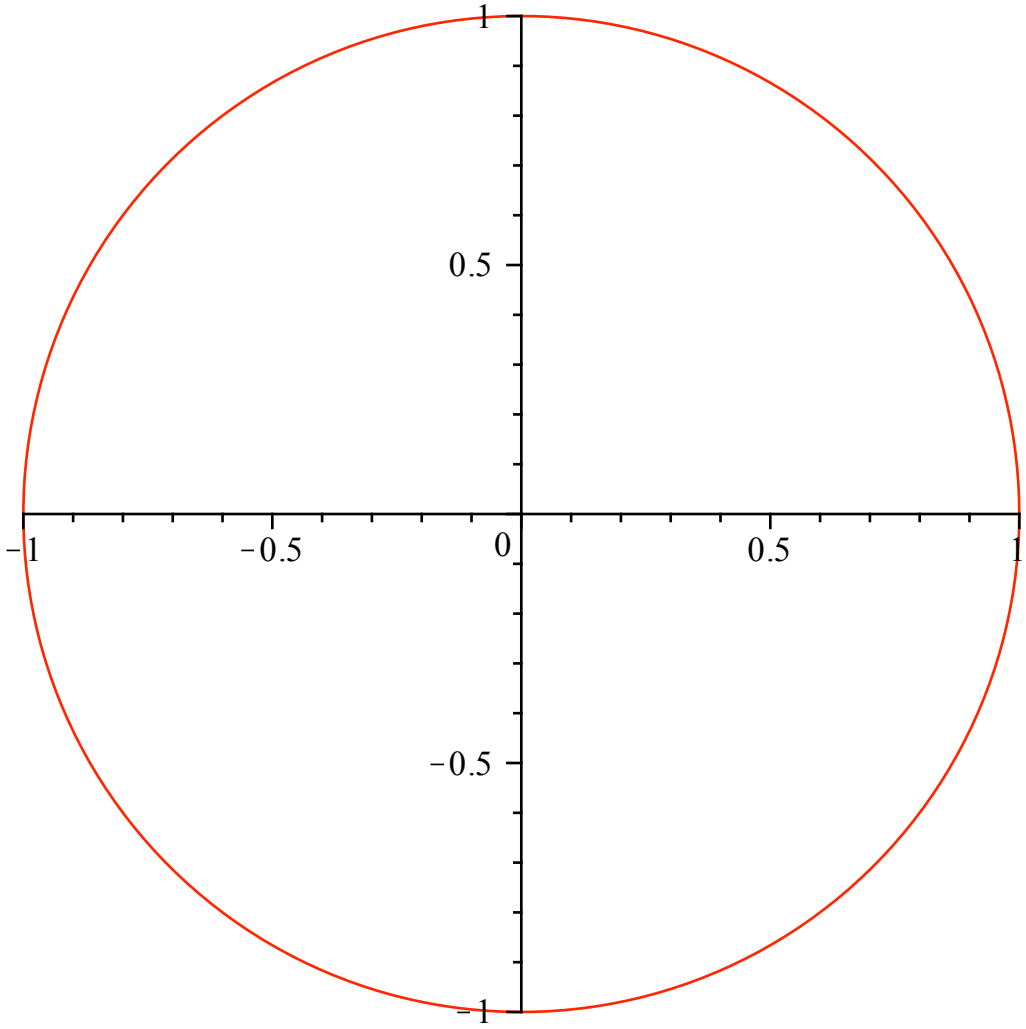
```
> plot([[0, 0.5], [1, 0.2], [2, 0.6]]);
```



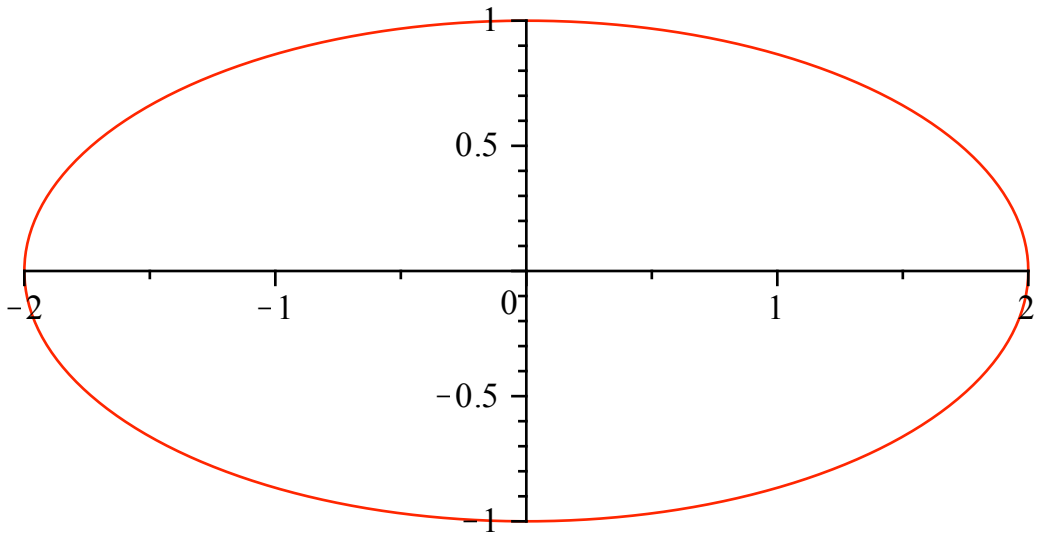

```
> plot([[0, 0.5], [1, 0.2], [2, 0.6]], style = point);
```




```
> plot([cos(t), sin(t), t = 0..2·Pi], scaling = constrained);
```




```
> plot([2·cos(t), sin(t), t = 0..2·Pi], scaling = constrained);
```



>

1.9 Résolution d'équations différentielles

> $f := x \to x^3;$
> $diff(f(x), x);$

$$f := x \to x^3$$

$$3x^2 \quad \textbf{(7.1)}$$

> $D(f);$
> $D(f)(0);$

$$x \to 3x^2$$

$$0 \quad \textbf{(7.2)}$$

> $f := x^3;$
> $diff(f, x);$

```
subs(x = 0, diff(f, x));
```

$$f := x^3$$

$$3x^2$$

$$0 \tag{7.3}$$

```
> f := x→x^3;
  diff(f(x), x, x);
```

$$f := x \to x^3$$

$$6x \tag{7.4}$$

```
> #Eq diff
```

```
> m := 2; alpha := 0.5; k := 5;
```

$$m := 2$$

$$\alpha := 0.5$$

$$k := 5 \tag{7.5}$$

```
> ressort := {m·diff(x(t), t, t) + alpha·diff(x(t), t) + k·x(t) = 0};
```

$$ressort := \left\{2\left(\frac{d^2}{dt^2}x(t)\right) + 0.5\left(\frac{d}{dt}x(t)\right) + 5x(t) = 0\right\} \tag{7.6}$$

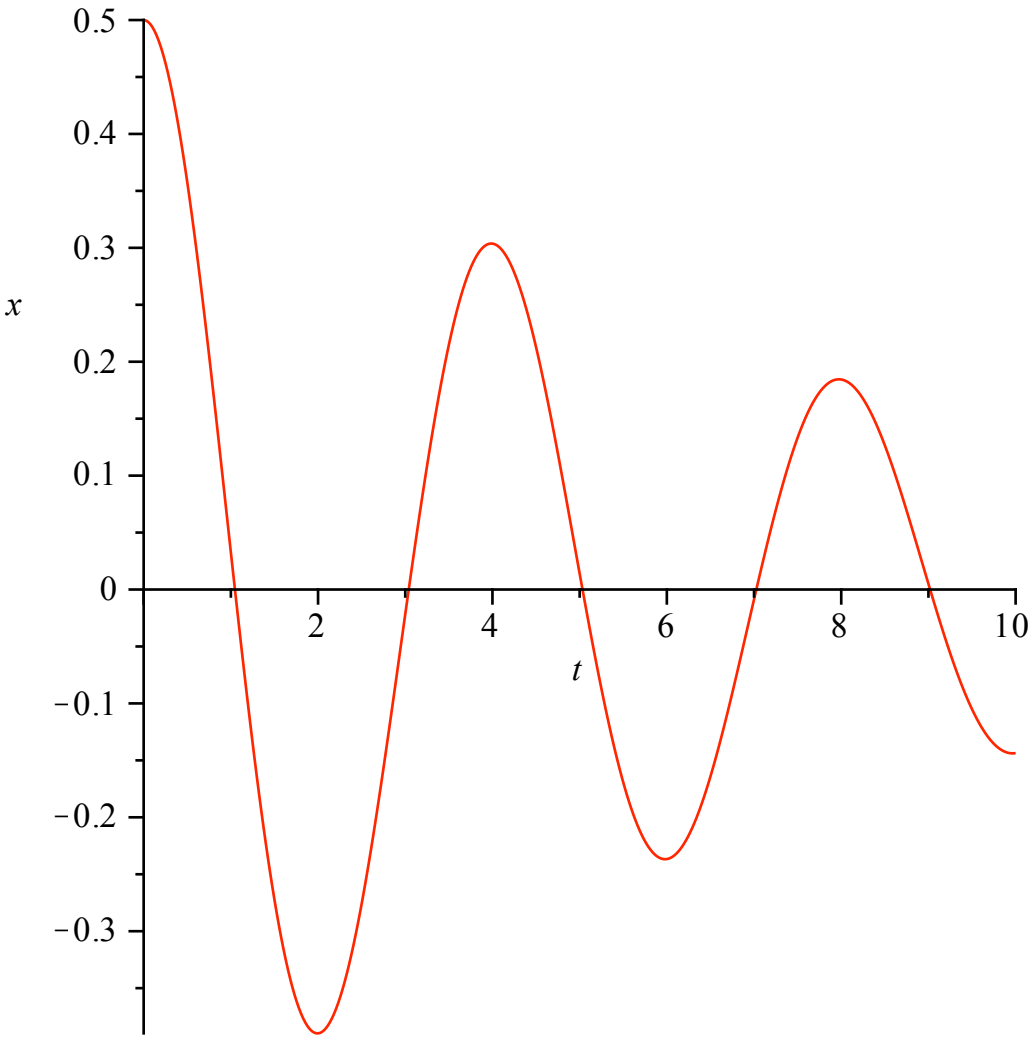
```
> CI := (a, b)→{x(0) = a, D(x)(0) = b};
```

$$CI := (a, b) \to \{x(0) = a, D(x)(0) = b\} \tag{7.7}$$

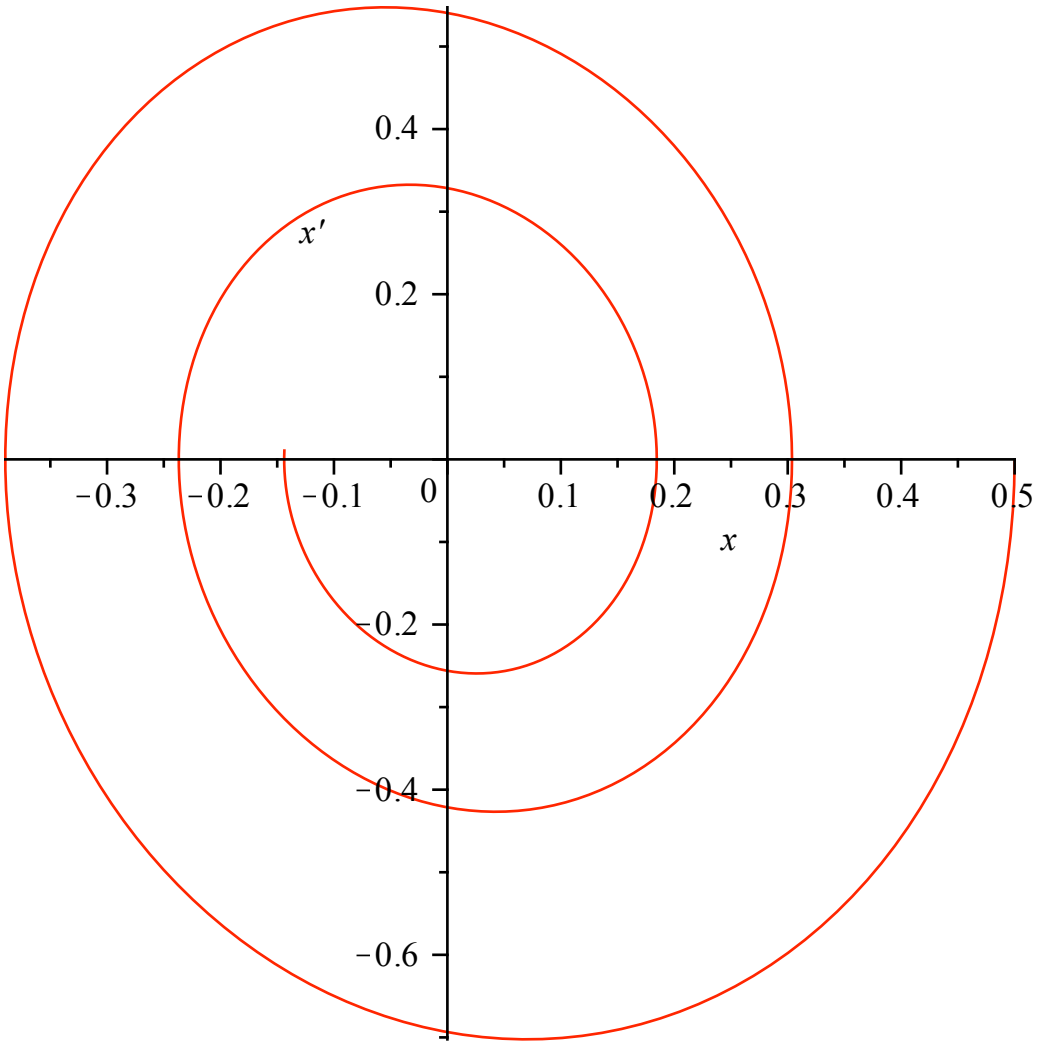
```
> sol := dsolve(ressort union CI(0.5, 0), x(t), numeric);
```

$$sol := \mathbf{proc}(x\_rkf45) \ \ldots \ \mathbf{end\ proc} \tag{7.8}$$

```
> odeplot(sol, [t, x(t)], 0..10, numpoints = 400);
```




```
> odeplot(sol, [x(t), diff(x(t), t)], 0..10, numpoints = 400);
```



>

1.10 Pour s'évaluer

> #2)

> $Digits := 20; evalf(\mathrm{Pi});$

$$Digits := 20$$

$$3.1415926535897932385 \quad \textbf{(8.1)}$$

> #3)

> $a := 2; b = 2;$

$$a := 2$$

$$b = 2 \quad \textbf{(8.2)}$$

> $a; b;$

$$2$$

$$b \quad \textbf{(8.3)}$$

> $unassign('a');$

```
> a;
```

$$a \tag{8.4}$$

```
> #4)
> restart;
> f:x→sin(2·x);
```

$$x \to \sin(2\,x) \tag{8.5}$$

```
> f(2);
```

$$f(2) \tag{8.6}$$

```
> f:= x→sin(2·x);
```

$$f := x \to \sin(2\,x) \tag{8.7}$$

```
> f(0.3);f(0.5);
```

$$0.5646424734$$

$$0.8414709848 \tag{8.8}$$

```
> f:= sin(2·x);
```

$$f := \sin(2\,x) \tag{8.9}$$

```
> subs(x=0.3,f); evalf(subs(x=0.3,f));
```

$$\sin(0.6)$$

$$0.5646424734 \tag{8.10}$$

```
> subs(x=0.5,f); evalf(subs(x=0.5,f));
```

$$\sin(1.0)$$

$$0.8414709848 \tag{8.11}$$

```
> #5)
> somme:=proc(x,y)
  x+y:
  end proc:
> somme(2,8);
```

$$10 \tag{8.12}$$

```
> #6)
> harmonique:=proc(N)
  local k:
  add(1/k, k=1..N):
  end proc:
> harmonique(10);
```

$$\frac{7381}{2520} \tag{8.13}$$

```
> evalf(harmonique(10));
```

$$2.928968254 \tag{8.14}$$

```
> #7)
> a:=15:b:=20:N:=50; L:=[seq(a+k·(b-a)/N, k=0..N)];
```

$$N := 50$$

$$L := \left[15, \frac{151}{10}, \frac{76}{5}, \frac{153}{10}, \frac{77}{5}, \frac{31}{2}, \frac{78}{5}, \frac{157}{10}, \frac{79}{5}, \frac{159}{10}, 16, \frac{161}{10}, \frac{81}{5}, \frac{163}{10}, \frac{82}{5}, \frac{33}{2}, \frac{83}{5}, \frac{167}{10}, \frac{84}{5}, \frac{169}{10}, 17, \frac{171}{10}, \frac{86}{5}, \frac{173}{10}, \frac{87}{5}, \frac{35}{2}, \frac{88}{5}, \frac{177}{10}, \frac{89}{5}, \frac{179}{10}, 18, \frac{181}{10}, \frac{91}{5}, \frac{183}{10}, \frac{92}{5}, \frac{37}{2}, \frac{93}{5}, \frac{187}{10}, \frac{94}{5}, \frac{189}{10}, 19, \frac{191}{10}, \frac{96}{5}, \frac{193}{10}, \frac{97}{5}, \frac{39}{2}, \frac{98}{5}, \frac{197}{10}, \frac{99}{5}, \frac{199}{10}, 20\right] \tag{8.15}$$

```
> #8)
```

```
> f := x→cos(Pi·x) :
  map(f, L);
```

$$\left[-1, -\cos\left(\frac{1}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{2}{5}\pi\right), 0, \cos\left(\frac{2}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{1}{10}\pi\right), 1, \cos\left(\frac{1}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{2}{5}\pi\right), 0, -\cos\left(\frac{2}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{1}{10}\pi\right), -1, -\cos\left(\frac{1}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{2}{5}\pi\right), 0, \cos\left(\frac{2}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{1}{10}\pi\right), 1, \cos\left(\frac{1}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{2}{5}\pi\right), 0, -\cos\left(\frac{2}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{1}{10}\pi\right), -1, -\cos\left(\frac{1}{10}\pi\right), -\cos\left(\frac{1}{5}\pi\right), -\cos\left(\frac{3}{10}\pi\right), -\cos\left(\frac{2}{5}\pi\right), 0, \cos\left(\frac{2}{5}\pi\right), \cos\left(\frac{3}{10}\pi\right), \cos\left(\frac{1}{5}\pi\right), \cos\left(\frac{1}{10}\pi\right), 1\right] \tag{8.16}$$

```
> evalf( map(f, L));
```

$$[-1., -0.9510565163, -0.8090169943, -0.5877852522, -0.3090169938, 0., 0.3090169938, 0.5877852522, 0.8090169943, 0.9510565163, 1., 0.9510565163, 0.8090169943, 0.5877852522, 0.3090169938, 0., -0.3090169938, -0.5877852522, -0.8090169943, -0.9510565163, -1., -0.9510565163, -0.8090169943, -0.5877852522, -0.3090169938, 0., 0.3090169938, 0.5877852522, 0.8090169943, 0.9510565163, 1., 0.9510565163, 0.8090169943, 0.5877852522, 0.3090169938, 0., -0.3090169938, -0.5877852522, -0.8090169943, -0.9510565163, -1., -0.9510565163, -0.8090169943, -0.5877852522, -0.3090169938, 0., 0.3090169938, 0.5877852522, 0.8090169943, 0.9510565163, 1.] \tag{8.17}$$

```
> #9)
```

```
> N := 100 :
  c := array(0..N) :
```

```
> c[0] := 1;
```

$$c_0 := 1 \tag{8.18}$$

```
> for n from 0 to N - 1 do
    c[n + 1] := add((k + 1)·c[k], k = 0..n):
  od:
  c[100];
```

$$47129738799191797104258115622414683747811563973512718841639446767084887996\backslash$$
$$58110738251543930795904173455811745001774799791684853151301632000000000\backslash \tag{8.19}$$
$$000000000000000$$

```
> nbpositif := proc(L)
  local nbpos, N, i:
  nbpos := 0:
  N := nops(L):
  for i from 1 to N do
  if (op(i, L) > 0) then
  nbpos := nbpos + 1:
  fi:
  od:
  nbpos:
  end proc:
> L := [4, 7, -6, -9, 9]:
  nbpositif(L);
```

$$3 \tag{8.20}$$

```
>
```