```
> #ex 1:
> ecdif1:=diff(x(t),t)=-k*x(t)
```

$$ecdif1 := \frac{d}{dt} x(t) = -k\,x(t) \tag{1}$$

```
> cond_in:=x(0)=x__0
```

$$cond\_in := x(0) = x_0 \tag{2}$$

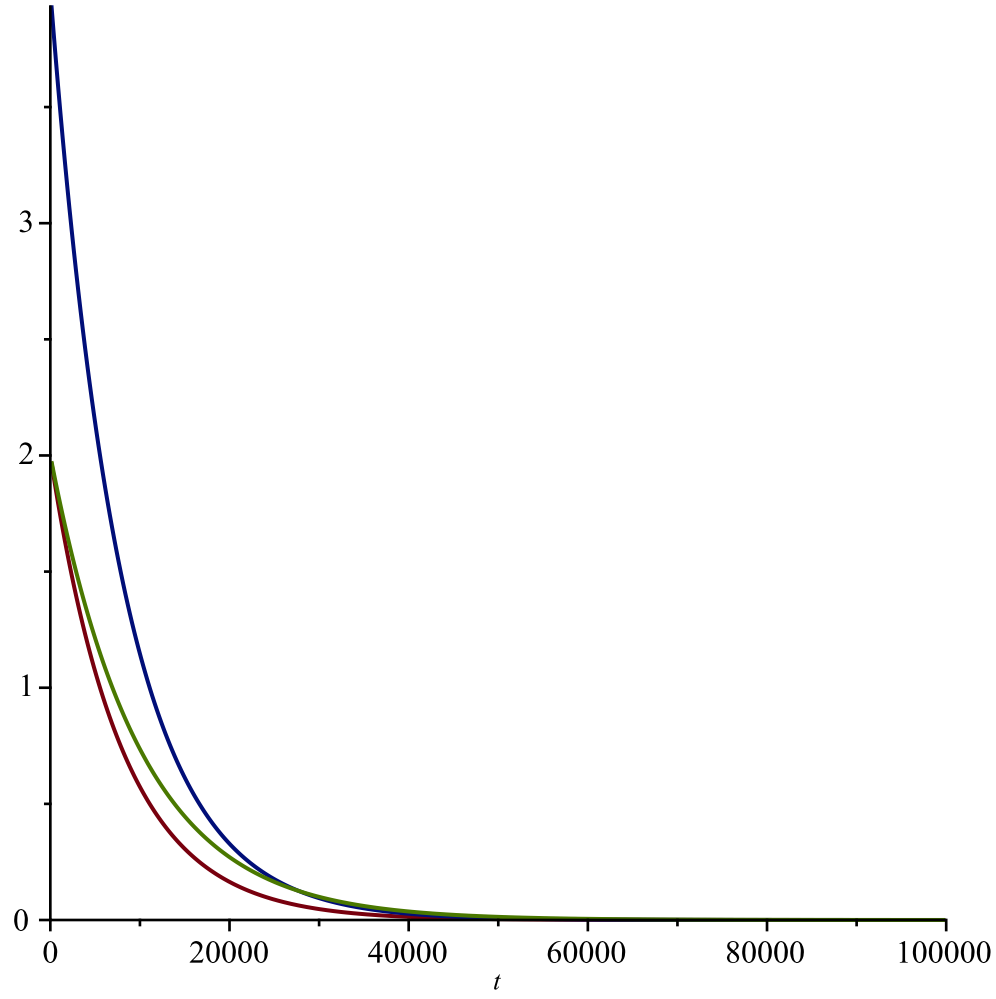
```
> sol:=dsolve({ecdif1,cond_in},x(t))
```

$$sol := x(t) = x_0\, e^{-k\,t} \tag{3}$$

```
> xx:=unapply(rhs(sol),t,x__0,k)
```

$$xx := (t, x_0, k) \mapsto x_0 \cdot e^{-k \cdot t} \tag{4}$$

```
> with(plots):
> plot([xx(t,2,1/8000),xx(t,4,1/8000),xx(t,2,1/10000)],t=0..100000)
```




```
> #xx(t,x__0,k)
> ec1:=xx(5730,x__0,k)=x__0/2
```

$$ec1 := x_0\, e^{-5730\,k} = \frac{x_0}{2} \tag{5}$$

```
> k__c14:=solve(ec1,k)
```

$$k_{c14} := \frac{\ln(2)}{5730} \tag{6}$$

```
> ec2:=xx(t,x__0,k__c14)=0.2*x__0
```

$$ec2 := x_0\, e^{-k_{c14}\, t} = 0.2\, x_0 \tag{7}$$

```
> timp:=solve(ec2,t)
```

$$timp := 13304.64798 \tag{8}$$

```
> ec3:=xx(t,x__0,k__c14)=0.9157*x__0
```

$$ec3 := x_0\, e^{-\frac{\ln(2)\, t}{5730}} = 0.9157\, x_0 \tag{9}$$

```
> t1:=solve(ec3,t)
```

$$t1 := 728.0141045 \tag{10}$$

```
> ec4:=xx(t,x__0,k__c14)=0.93021*x__0
```

$$ec4 := x_0\, e^{-\frac{\ln(2)\, t}{5730}} = 0.93021\, x_0 \tag{11}$$

```
> t2:=solve(ec4,t)
```

$$t2 := 598.0495293 \tag{12}$$

```
> T1:=1988-t1
```

$$T1 := 1259.985896 \tag{13}$$

```
> T2:=1988-t2
```

$$T2 := 1389.950471 \tag{14}$$

```
> #ex2:
> restart
> ecdif:=diff(T(t),t)=-k*(T(t)-T__m)
```

$$ecdif := \frac{d}{dt} T(t) = -k\,(T(t) - T_m) \tag{15}$$

```
> cond_in:=T(0)=T__0
```

$$cond\_in := T(0) = T_0 \tag{16}$$

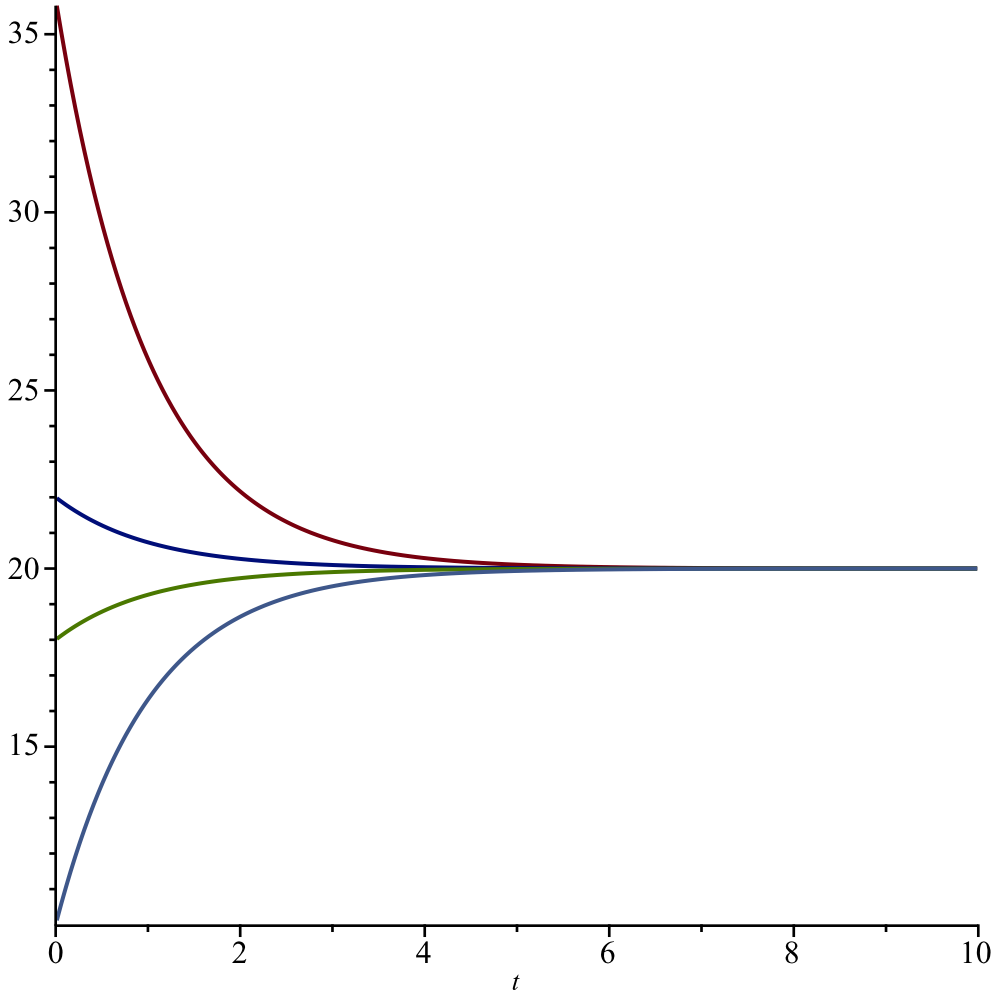
```
> sol:=dsolve({ecdif,cond_in},T(t))
```

$$sol := T(t) = T_m + e^{-k\, t}\,(T_0 - T_m) \tag{17}$$

```
> with(plots):
> TT:=unapply(rhs(sol),t,k,T__0,T__m)
```

$$TT := (t, k, T_0, T_m) \mapsto T_m + e^{-k\cdot t}\cdot (T_0 - T_m) \tag{18}$$

```
> plot([TT(t,1,36,20),TT(t,1,22,20),TT(t,1,18,20),TT(t,1,10,20)],t=
  0..10)
```




```
> T__0:=36;T__m:=21;T__1:=34.22;T__2:=34.11
```

$$T_0 := 36$$

$$T_m := 21$$

$$T_1 := 34.22$$

$$T_2 := 34.11 \quad \textbf{(19)}$$

```
> ec1:=TT(t,k,T__0,T__m)=T__1
```

$$ec1 := 21 + 15\,e^{-k\,t} = 34.22 \quad \textbf{(20)}$$

```
> ec2:=TT(t+1,k,T__0,T__m)=T__2
```

$$ec2 := 21 + 15\,e^{-k\,(t+1)} = 34.11 \quad \textbf{(21)}$$

```
> sist:=ec1,ec2
```

$$sist := 21 + 15\,e^{-k\,t} = 34.22,\ 21 + 15\,e^{-k\,(t+1)} = 34.11 \quad \textbf{(22)}$$

```
> sols:=solve({sist},{t,k})
```

$$sols := \{k = 0.008355536648,\ t = 15.11804352\} \quad \textbf{(23)}$$

```
> timp:=sols[2]
```

$$timp := t = 15.11804352 \quad \textbf{(24)}$$

```
> ora:=11.30-timp+24
```

$$ora := -t + 35.30 = 20.18195648 \quad \textbf{(25)}$$

```
> #ex3
> restart
> ecdif1:=diff(x(t),t)=r*x(t)
```

$$ecdif1 := \frac{d}{dt} x(t) = r\,x(t) \tag{26}$$

```
> cond_in1:=x(0)=x__0
```

$$cond\_in1 := x(0) = x_0 \tag{27}$$

```
> ecdif2:=diff(x(t),t)=r__0*x(t)*(1-x(t)/K)
```

$$ecdif2 := \frac{d}{dt} x(t) = r_0\,x(t)\left(1 - \frac{x(t)}{K}\right) \tag{28}$$

```
> cond_in2:=x(0)=x__0
```

$$cond\_in2 := x(0) = x_0 \tag{29}$$

```
> sol1:=dsolve({ecdif1,cond_in1},x(t))
```

$$sol1 := x(t) = x_0\,e^{r\,t} \tag{30}$$

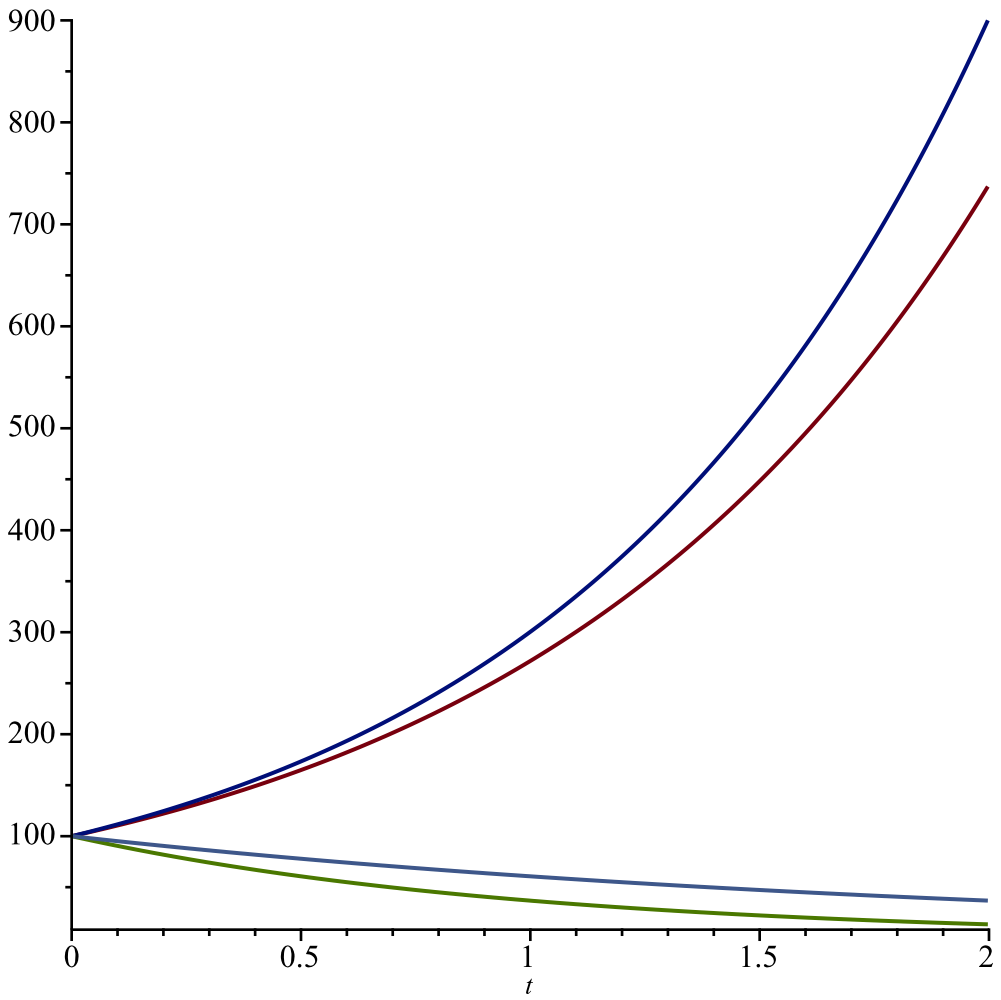
```
> sol2:=dsolve({ecdif2,cond_in2},x(t))
```

$$sol2 := x(t) = \frac{K\,x_0}{(K - x_0)\,e^{-r_0\,t} + x_0} \tag{31}$$

```
> xM:=unapply(rhs(sol1),t,x__0,r)
```

$$xM := (t, x_0, r) \mapsto x_0 \cdot e^{r \cdot t} \tag{32}$$

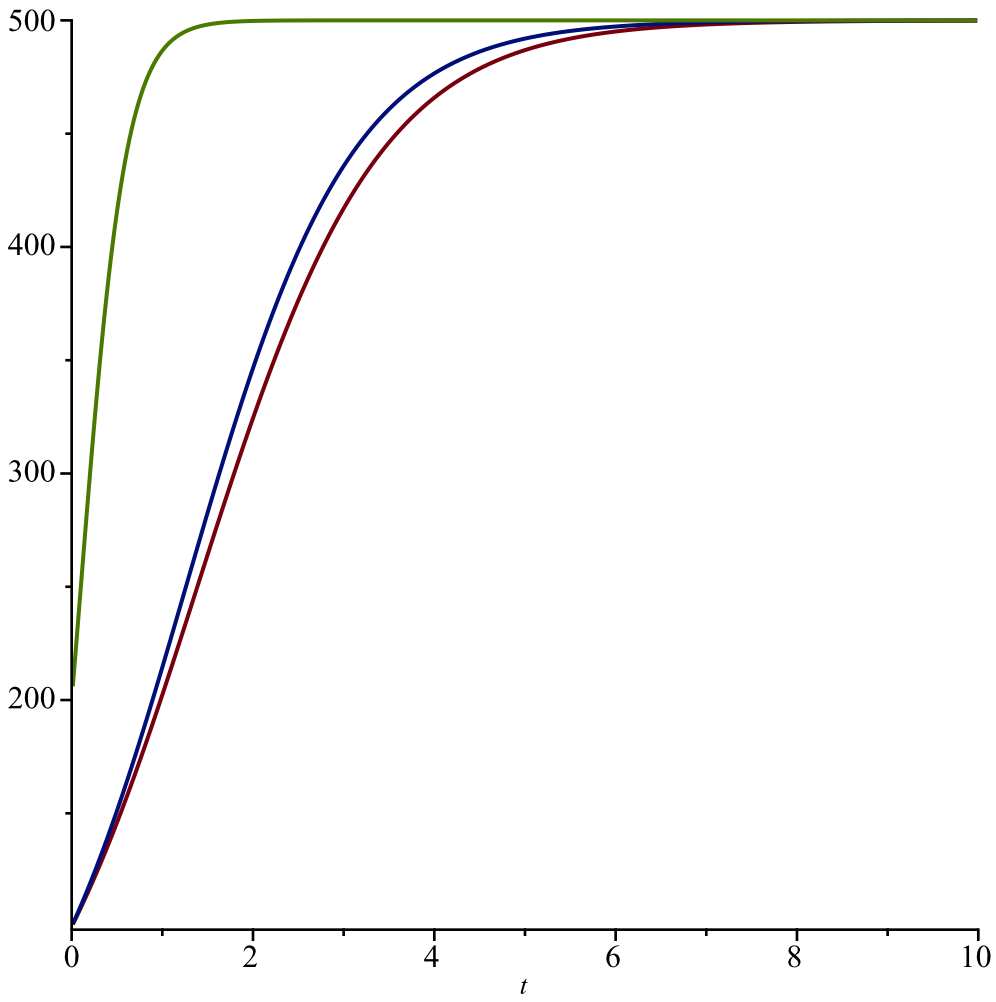
```
> with(plots):
> plot([xM(t,100,1),xM(t,100,1.1),xM(t,100,-1),xM(t,100,-0.5)],t=0.
  .2)
```



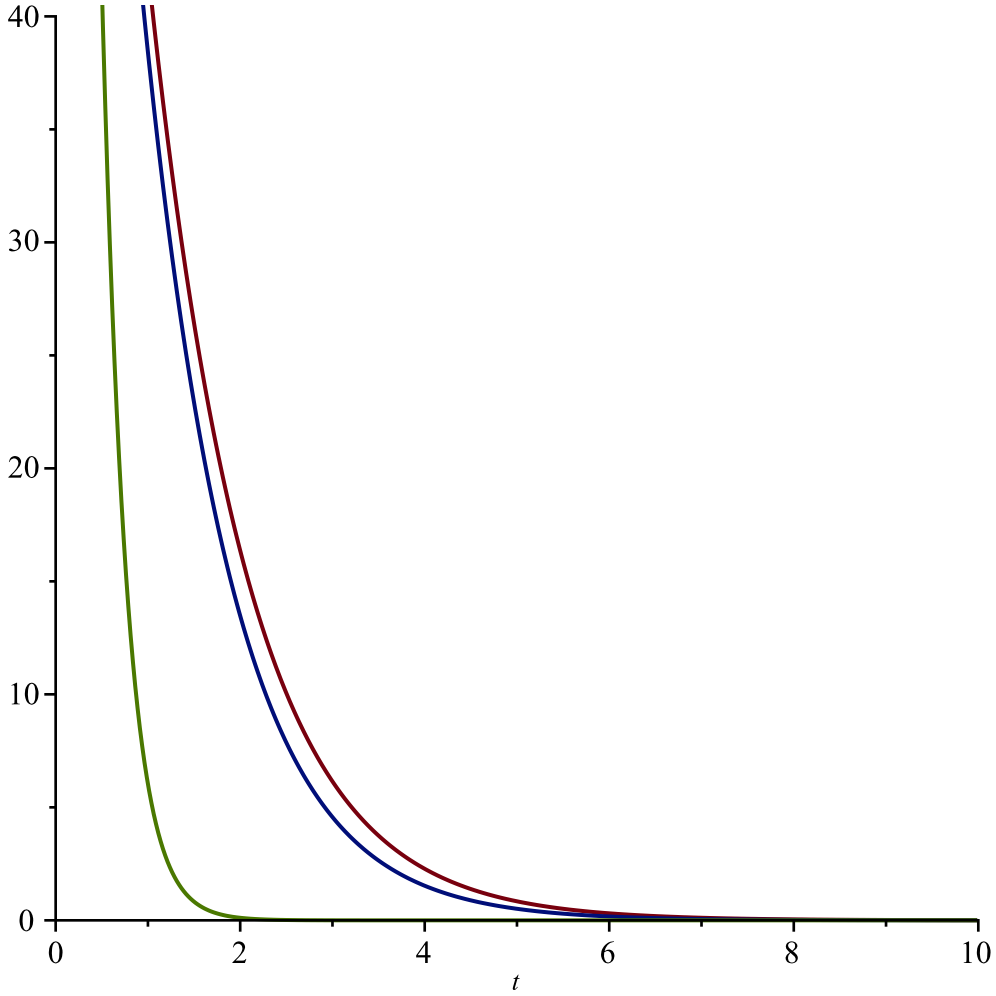

```
> xV:=unapply(rhs(sol2),t,x__0,r__0,K)
```

$$xV := \left(t, x_0, r_0, K\right) \mapsto \frac{K \cdot x_0}{\left(K - x_0\right) \cdot \mathrm{e}^{-r_0 \cdot t} + x_0} \tag{33}$$

```
> plot([xV(t,100,1,500),xV(t,100,1.1,500),xV(t,200,4,500)],t=0..10)
```




```
> plot([xV(t,100,-1,500),xV(t,100,-1.1,500),xV(t,200,-4,500)],t=0.
  .10)
```




```
> x__0:=25*10^3;final:=30*10^3;timp:=2
```

$$x_0 := 25000$$

$$final := 30000$$

$$timp := 2 \quad \textbf{(34)}$$

```
> ec:=xM(timp,x__0,r)=final
```

$$ec := 25000\, e^{2\,r} = 30000 \quad \textbf{(35)}$$

```
> rM:=solve(ec,r)
```

$$rM := \frac{\ln\left(\frac{6}{5}\right)}{2} \quad \textbf{(36)}$$

```
> est:=xM(5,x__0,rM);evalf(%)
```

$$est := 7200\sqrt{30}$$

$$39436.02414 \quad \textbf{(37)}$$

```
> x__0:=20*10^3;f1:=40*10^3;t1:=2;f2:=50*10^3;t2:=3
```

$$x_0 := 20000$$

$$f1 := 40000$$

$$t1 := 2$$

$$f2 := 50000$$

$$t2 := 3 \quad (38)$$

```
> ec1:=xV(t1,x__0,r__0,K)=f1
```

$$ec1 := \frac{20000\,K}{(K-20000)\,e^{-2\,r_0}+20000} = 40000 \quad (39)$$

```
> ec2:=xV(t2,x__0,r__0,K)=f2
```

$$ec2 := \frac{20000\,K}{(K-20000)\,e^{-3\,r_0}+20000} = 50000 \quad (40)$$

```
> sist:=ec1,ec2
```

$$sist := \frac{20000\,K}{(K-20000)\,e^{-2\,r_0}+20000} = 40000,\ \frac{20000\,K}{(K-20000)\,e^{-3\,r_0}+20000} = 50000 \quad (41)$$

```
> s:=solve({sist},{r__0,K})
```

$$s := \left\{K = \frac{200000\,RootOf(5\_Z^2 - \_Z - 1)}{7} + \frac{400000}{7},\ r_0 = -\ln(RootOf(5\_Z^2 - \_Z - 1))\right\} \quad (42)$$

```
> r00:=evalf(rhs(s[2]))
```

$$r00 := 0.5829348290 \quad (43)$$

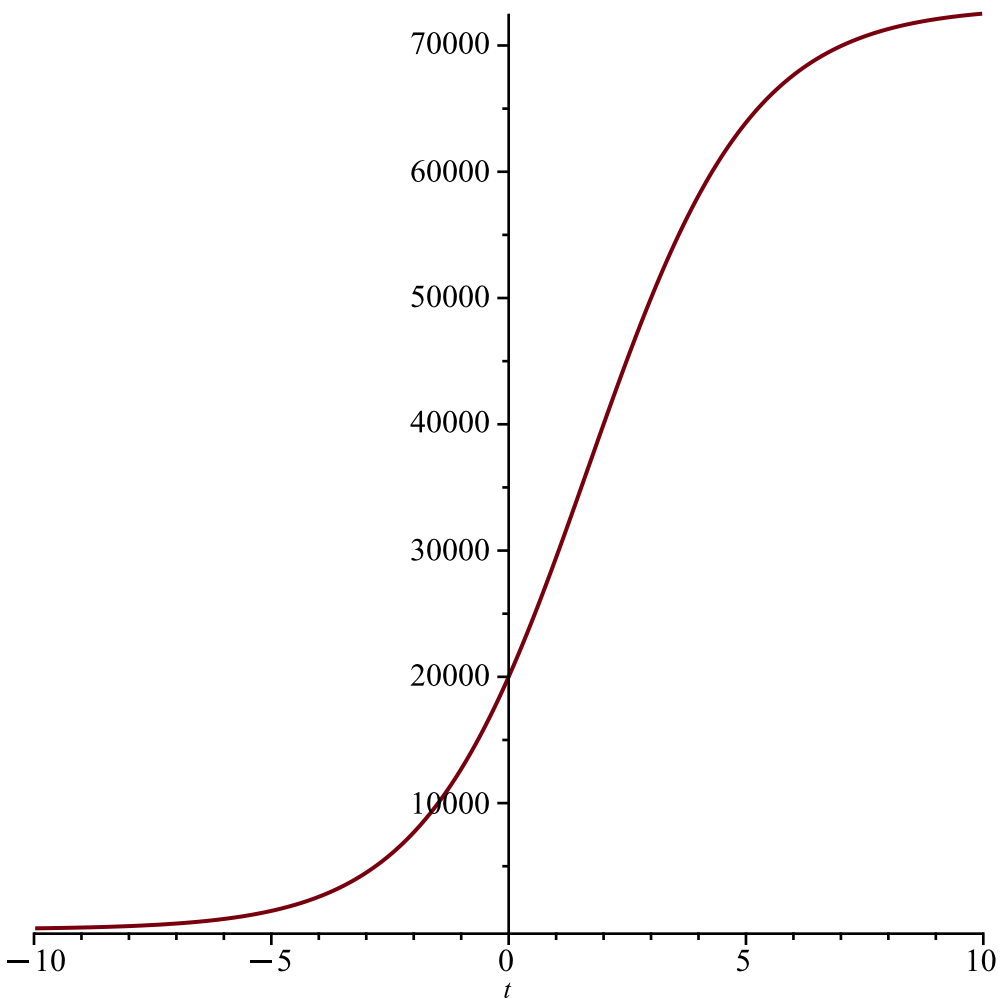
```
> K1:=evalf(rhs(s[1]))
```

$$K1 := 73093.07341 \quad (44)$$

```
> est1:=xV(7,x__0,r00,K1)
```

$$est1 := 69954.95937 \quad (45)$$

```
> plot(xV(t,x__0,r00,K1,t=0..30))
```




```
> #ex:
> restart
> ecdif:=diff(v(x),x)*v(x)=-g*R^2/(x+R)^2
```

$$ecdif := \left(\frac{\mathrm{d}}{\mathrm{d}x}\, v(x)\right) v(x) = -\frac{g\,R^2}{(x+R)^2} \tag{46}$$

```
> cond_in:=v(0)=v__0
```

$$cond\_in := v(0) = v_0 \tag{47}$$

```
> sol:=dsolve({ecdif,cond_in},v(x),implicit)
```

$$sol := v(x)^2 - \frac{2\,g\,R^2}{x+R} + 2\,g\,R - v_0{}^2 = 0 \tag{48}$$

```
> ec:=lhs(sol)=0
```

$$ec := v(x)^2 - \frac{2\,g\,R^2}{x+R} + 2\,g\,R - v_0{}^2 = 0 \tag{49}$$

```
> vs:=solve(ec,v(x))
```

$$vs := \frac{\sqrt{-(x+R)\left(2\,g\,R\,x - v_0{}^2\,R - v_0{}^2\,x\right)}}{x+R},\ -\frac{\sqrt{-(x+R)\left(2\,g\,R\,x - v_0{}^2\,R - v_0{}^2\,x\right)}}{x+R} \tag{50}$$

```
> vv:=unapply(vs[1],x,v__0,g,R)
```

$$vv := \left(x, v_0, g, R\right) \mapsto \frac{\sqrt{-(x+R)\cdot\left(2\cdot R\cdot g\cdot x - R\cdot {v_0}^2 - {v_0}^2\cdot x\right)}}{x+R} \tag{51}$$

```
> #de terminat b,c,d,e :))
```