```
(%i28) kill(all);
```

(%o0) *done*

```
(%i1) E2: H_E = 1/2*m*(rdot^2+r^2*thdot^2*(1+r0/r))+U;
```

(%o1) $H\_E = U + \frac{m\left(r^2\left(\frac{r0}{r}+1\right)thdot^2+rdot^2\right)}{2}$

```
(%i2) E5: solve(E2, rdot);
```

(%o2) $[rdot = -\sqrt{-\frac{2\,U}{m}+\frac{2\,H\_E}{m}-r\,r0\,thdot^2-r^2\,thdot^2}, rdot = \sqrt{-\frac{2\,U}{m}+\frac{2\,H\_E}{m}-r\,r0\,thdot^2-r^2\,thdot^2}]$

```
(%i3) thdot: L0/(m*r^2);
```

(%o3) $\frac{L0}{m\,r^2}$

```
(%i4) E5a: ev(E5);
```

(%o4) $[rdot = -\sqrt{-\frac{2\,U}{m}-\frac{r0\,L0^2}{m^2\,r^3}-\frac{L0^2}{m^2\,r^2}+\frac{2\,H\_E}{m}}, rdot = \sqrt{-\frac{2\,U}{m}-\frac{r0\,L0^2}{m^2\,r^3}-\frac{L0^2}{m^2\,r^2}+\frac{2\,H\_E}{m}}]$

```
(%i5) dthdr: 1/rdot*L0/(m*r^2);
```

(%o5) $\frac{L0}{m\,r^2\,rdot}$

```
(%i6) rdot: rhs(second(E5a));
```

(%o6) $\sqrt{-\frac{2\,U}{m}-\frac{r0\,L0^2}{m^2\,r^3}-\frac{L0^2}{m^2\,r^2}+\frac{2\,H\_E}{m}}$

```
(%i7) ev(dthdr);
```

(%o7) $\frac{L0}{m\,r^2\sqrt{-\frac{2\,U}{m}-\frac{r0\,L0^2}{m^2\,r^3}-\frac{L0^2}{m^2\,r^2}+\frac{2\,H\_E}{m}}}$

0.1 Integral (19)

```
(%i8) f: u^3/(a+b*u+c*u^2)^(3/2);
```

(%o8) $\frac{u^3}{(c\,u^2+b\,u+a)^{3/2}}$

```
(%i9) integrate(f,u);
Is 4 a c-b^2 zero or nonzero?n;
Is c positive or negative?n;
Is b zero or nonzero?n;
```

(%o9) $$\frac{3\,b\,\mathrm{asin}\left(\frac{2\,c\,u+b}{\sqrt{b^2-4\,a\,c}}\right)}{2\,\sqrt{-c}\,c^2}+\frac{u^2}{c\,\sqrt{c\,u^2+b\,u+a}}+\frac{10\,a\,b\,u}{c\,(4\,a\,c-b^2)\,\sqrt{c\,u^2+b\,u+a}}-\frac{3\,b^3\,u}{c^2\,(4\,a\,c-b^2)\,\sqrt{c\,u^2+b\,u+a}}-\frac{a\,b^2}{c^2\,(4\,a\,c-b^2)\,\sqrt{c\,u^2+b\,u+a}}+\frac{2\,a}{c^2\,\sqrt{c\,u^2+b\,u+a}}$$

```
(%i10) fu: ratsimp(%);
```

(%o10) $$((12\,a\,b\,c-3\,b^3)\,\sqrt{c\,u^2+b\,u+a}\,\mathrm{asin}\left(\frac{2\,c\,u+b}{\sqrt{b^2-4\,a\,c}}\right)+\sqrt{-c}\,((8\,a\,c^2-2\,b^2\,c)\,u^2+(20\,a\,b\,c-6\,b^3)\,u+16\,a^2\,c-6\,a\,b^2))/(\sqrt{-c}\,(8\,a\,c^3-2\,b^2\,c^2)\,\sqrt{c\,u^2+b\,u+a})$$

0.2 Definition of parameters

```
(%i11) a: 2*m*H;
```

(%o11) $2\,m\,H$

```
(%i12) b: k: L0^2/(m*alpha);
```

(%o12) $\frac{L0^2}{\alpha\,m}$

```
(%i13) c: -L0^2/(2*m);
```

(%o13) $-\frac{L0^2}{2\,m}$

```
(%i14) assume(L0>0, m>0, alpha>0);
```

(%o14) $[L0>0,\,m>0,\,\alpha>0]$

```
(%i15) ev(fu);
```

(%o15) $$(\sqrt{2}\,\sqrt{m}\,(\sqrt{-\frac{u^2\,L0^2}{2\,m}+\frac{u\,L0^2}{\alpha\,m}+2\,m\,H}\,\left(-\frac{3\,L0^6}{\alpha^3\,m^3}-\frac{12\,H\,L0^4}{\alpha\,m}\right)\mathrm{asin}\left(\frac{\frac{L0^2}{\alpha\,m}-\frac{u\,L0^2}{m}}{\sqrt{\frac{L0^4}{\alpha^2\,m^2}+4\,H\,L0^2}}\right)+\frac{L0\left(u^2\left(\frac{L0^6}{\alpha^2\,m^3}+\frac{4\,H\,L0^4}{m}\right)+u\left(-\frac{6\,L0^6}{\alpha^3\,m^3}-\frac{20\,H\,L0^4}{\alpha\,m}\right)-\frac{12\,H\,L0^4}{\alpha^2\,m}-32\,m\,H^2\,L0^2\right)}{\sqrt{2}\,\sqrt{m}}))/(L0\,\sqrt{-\frac{u^2\,L0^2}{2\,m}+\frac{u\,L0^2}{\alpha\,m}+2\,m\,H}\,\left(-\frac{L0^8}{2\,\alpha^2\,m^4}-\frac{2\,H\,L0^6}{m^2}\right))$$

```
(%i16) theta0: acos(1/epsilon*(alpha/r-1));
```

(%o16) $\operatorname{acos}\left(\frac{\frac{\alpha}{r}-1}{\varepsilon}\right)$

```
(%i17) fr: ev(fu, u=1/r);
```

(%o17) $$\left(\sqrt{2}\sqrt{m}\left(\sqrt{\frac{L0^2}{\alpha\, m\, r}-\frac{L0^2}{2\, m\, r^2}+2\, m\, H}\left(-\frac{3\, L0^6}{\alpha^3\, m^3}-\frac{12\, H\, L0^4}{\alpha\, m}\right)\operatorname{asin}\left(\frac{\frac{L0^2}{\alpha\, m}-\frac{L0^2}{m\, r}}{\sqrt{\frac{L0^4}{\alpha^2\, m^2}+4\, H\, L0^2}}\right)+\frac{L0\left(\frac{\frac{L0^6}{\alpha^2\, m^3}+\frac{4\, H\, L0^4}{m}}{r^2}+\frac{-\frac{6\, L0^6}{\alpha^3\, m^3}-\frac{20\, H\, L0^4}{\alpha\, m}}{r}-\frac{12\, H\, L0^4}{\alpha^2\, m}-32\, m\, H^2\, L0^2\right)}{\sqrt{2}\sqrt{m}}\right)\right)\Big/\left(L0\sqrt{\frac{L0^2}{\alpha\, m\, r}-\frac{L0^2}{2\, m\, r^2}+2\, m\, H}\left(-\frac{L0^8}{2\,\alpha^2\, m^4}-\frac{2\, H\, L0^6}{m^2}\right)\right)$$

```
(%i18) str: [L0=1.5, H=-1., alpha=1, epsilon=0.3, m=1];
```

(%o18) $[L0=1.5, H=-1, \alpha=1, \varepsilon=0.3, m=1]$

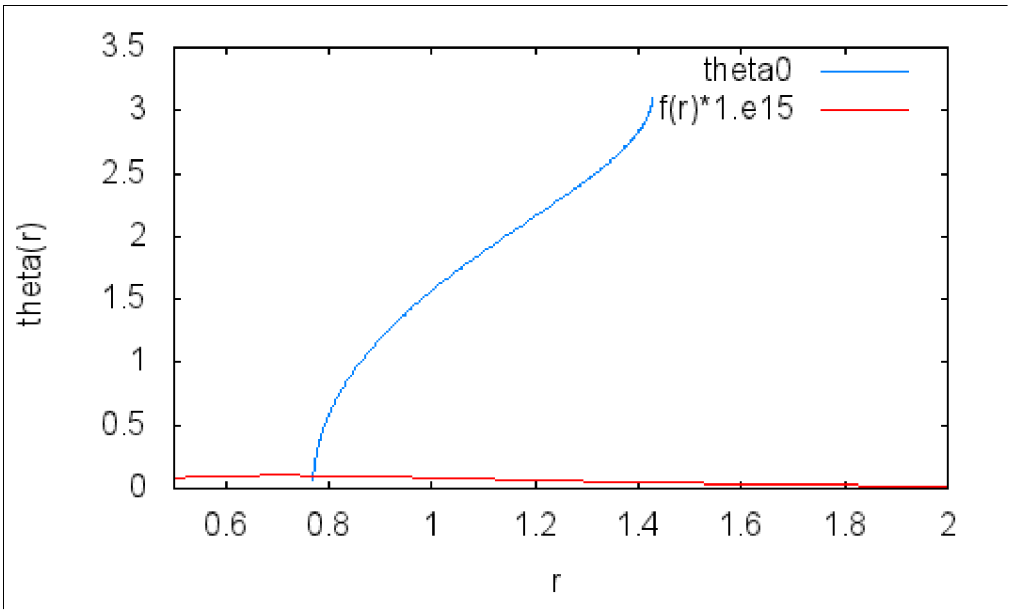
```
(%i19) th01: ev(theta0, str, eval);
```

(%o19) $\operatorname{acos}\left(3.333333333333334\left(\frac{1}{r}-1\right)\right)$

```
(%i20) th11: ev(realpart(fr), str, eval)$
```

```
(%i21) wxplot2d([th01,th11*1.e15], [r,0.5,2],
       [xlabel, "r"], [ylabel, "theta(r)"], [legend, "theta0", "f(r)*1.e15
plot2d: expression evaluates to non-numeric value somewhere in plotting ra
```

(%t21)



```
(%i22) str: [L0=1, H=-1., alpha=1, epsilon=0.3, m=1];
```

(%o22) $[L0=1, H=-1, \alpha=1, \varepsilon=0.3, m=1]$

```
(%i23) th01: ev(theta0, str, eval);
```

(%o23) $\operatorname{acos}\left(3.333333333333334\left(\frac{1}{r}-1\right)\right)$

```
(%i24) th11: ev(realpart(fr), str, eval)$
```

```
(%i25) wxplot2d([th01,th11*1.e15], [r,0.5,2],
       [xlabel, "r"], [ylabel, "theta(r)"], [legend, "theta0", "f(r)*1.e15
plot2d: expression evaluates to non-numeric value somewhere in plotting ra
```

(%t25)