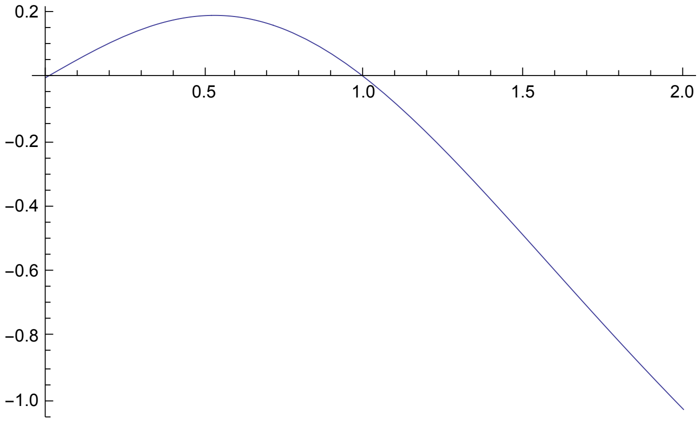
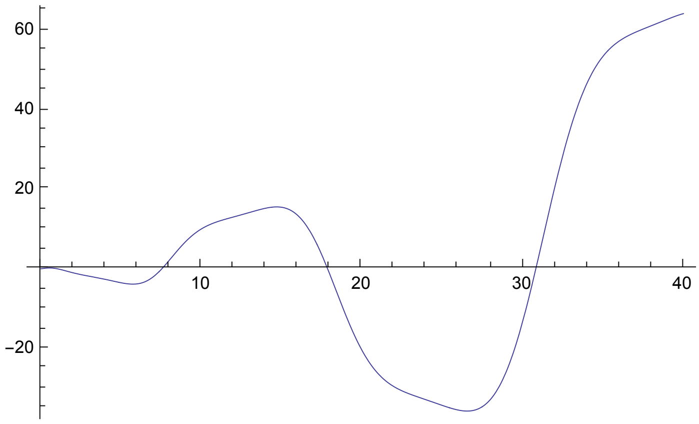
Finding the parameter by dichotomy

```
F[a_, ϵ_] := v'[1] /. NDSolve[{v''[r] == -v'[r]/r + v[r] - v[r]^3, v[ϵ] == a, v'[ϵ] == 0, w'[r] == r v[r]^4, w[ϵ] == 0},
    {v, v', w}, {r, ϵ, 1}][[1]]
```

```
Plot[F[a, 10^-8], {a, 0, 2}]
```




```
Plot[F[a, 10^-8], {a, 0, 40}]
```




```
Iter[a_, h_, f_, ϵ_, η_] := Module[{M = F[a, ϵ]},
  If[Abs[M] < η, a, If[M f > 0, Iter[a + h, h, M, ϵ, η], Iter[a - h / 2, -h / 2, M, ϵ, η]]]]
```

```
G[ϵ_, η_] := Iter[7.1, 0.1, F[7, ϵ], ϵ, η]
```

```
Table[G[10^-p, 10^-6], {p, 2, 8}]
Table[G[10^-p, 10^-8], {p, 2, 8}]
```

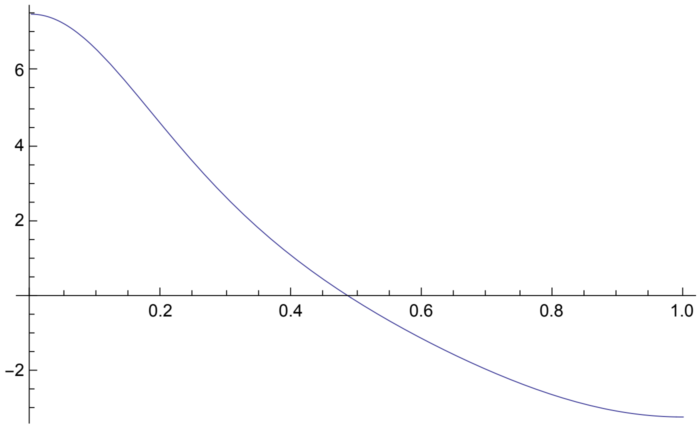
```
{7.46936, 7.52345, 7.52448, 7.52449, 7.52449, 7.52449, 7.52449}
```

```
{7.46936, 7.52345, 7.52448, 7.52449, 7.52449, 7.52449, 7.52449}
```

```
eps = 10^-8;
adicho = G[eps, 10^-8]
```

```
7.52449
```

```
P[a_, ϵ_] := Plot[v[s] /. NDSolve[{v''[r] == -v'[r]/r + v[r] - v[r]^3, v[ϵ] == a, v'[ϵ] == 0, w'[r] == r v[r]^4, w[ϵ] == 0,
    ww'[r] == r v[r]^2, ww[ϵ] == 0}, {v, v', w, ww}, {r, ϵ, 1}][[1]], {s, ϵ, 1}]
P[
 adicho,
 eps]
```



Computation of the optimal constant

```
G[a_, ϵ_] := {Sqrt[w[1]], v'[1]} /. NDSolve[{v''[r] == -v'[r]/r + v[r] - v[r]^3, v[ϵ] == a, v'[ϵ] == 0, w'[r] == r v[r]^4, w[ϵ] == 0},
    {v, v', w}, {r, ϵ, 1}][[1]]
G[adicho, eps]
%[[1]] Sqrt[2 π]
Cstar = 1 / %
```

$\{7.0619, -7.4692\times10^{-9}\}$

17.7015

0.0564922

```
N[2/Sqrt[π]]
% / Cstar
```

1.12838

19.9741