

■ Numerische Lösungsverfahren

```
In[217]:= ClearAll[f, x];  
f[x_] = -x;  
m = 1;  
x0 = 0; v0 = 1; p0 = m v0;
```

Euler

```
In[221]:= euler[Δt_, tmax_] := Module[{x, p, xOld, pOld, result},  
  {xOld, pOld} = {x0, p0}; t = 0; result = {{t, x0}};  
  
  Do[t = t + Δt;  
    {x, p} = {xOld, pOld} + Δt {pOld/m, f[xOld]};  
    {xOld, pOld} = {x, p};  
    result = Append[result, {t, x}], Round[tmax/Δt]];  
  result]
```

```
In[192]:= mittelpunkt[Δt_, tmax_] := Module[{x, p, xOld, pOld, result, x1, p1},  
  {xOld, pOld} = {x0, p0}; t = 0; result = {{t, x0}};  
  
  Do[t = t + Δt;  
    {Δx1, Δp1} = Δt {pOld/m, f[xOld]};  
    {x, p} = {xOld, pOld} + Δt {(pOld +  $\frac{1}{2}$  Δp1)/m, f[xOld +  $\frac{1}{2}$  Δx1]};  
    {xOld, pOld} = {x, p};  
    result = Append[result, {t, x}], Round[tmax/Δt]];  
  result]
```

```
In[225]:= DeltaT = 0.1;  
Show[ListPlot[mittelpunkt[2 DeltaT, 20], PlotStyle → Red], ListPlot[euler[DeltaT, 20]],  
  Plot[Sin[t], {t, 0, 20}, PlotStyle → {Gray}], PlotRange → {-3, 3}]
```

