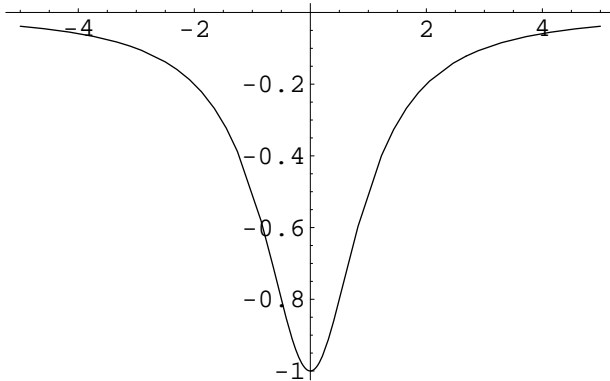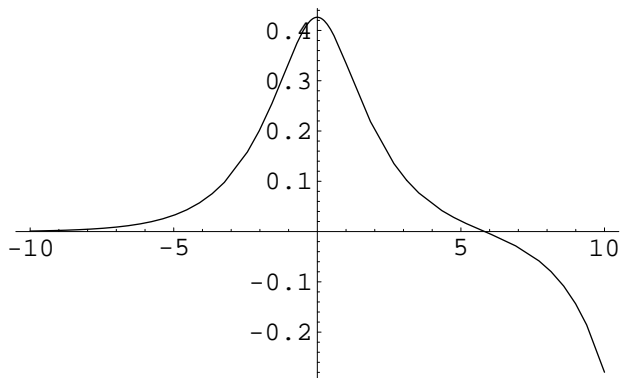```
In[1]:= (* potential *)
         (* --------- *)
         v[x_] := -1 / (1 + x^2)
         Plot[v[x], {x, -5, 5}]
```



```
Out[2]=  - Graphics -
```

```
In[3]:=  (* plot solution of schreodinger equation for trial e *)
         (* note: all numerical constants (hbar,m,..)==1           *)
         (* ------------------------------------------------- *)
         plotsol[e_] :=
          Block[{x0 = 10}, sol = NDSolve[{-psi''[x] + (v[x] - e) * psi[x] == 0, psi[-x0] == 0.001,
             psi'[-x0] == 0.001}, psi, {x, -x0, x0}];
          Plot[Evaluate[psi[x] /. sol], {x, -x0, x0}]]
```
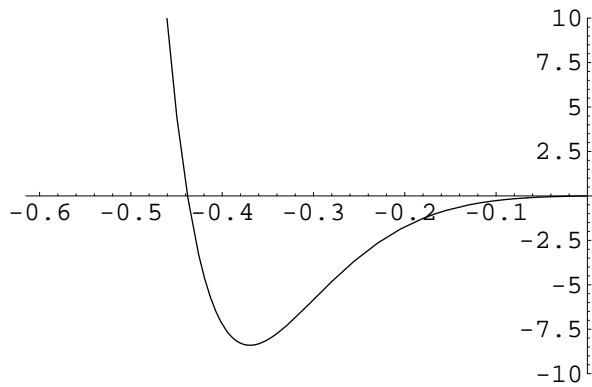
```
In[4]:=  (* you can play with this ! *)
         (* ----------------------- *)
         plotsol[-0.437]
```



```
Out[4]=  - Graphics -
```

```
In[5]:=  (* shooting method *)
         (* --------------- *)
         shoot[e_] :=
          Block[{x0 = 10}, sol = NDSolve[{-psi''[x] + (v[x] - e) * psi[x] == 0, psi[-x0] == 0.001,
             psi'[-x0] == 0.001}, psi, {x, -x0, x0}];
         psi[
            x0] /.
            sol]
```
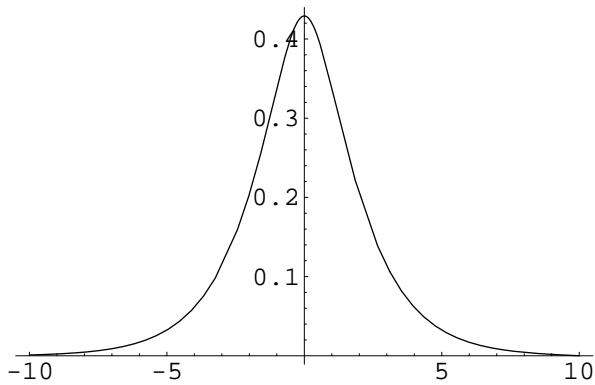
In[6]:= **Plot[shoot[e], {e, -0.6, 0}, PlotRange → {-10, 10}]**

Out[6]= ▪ Graphics ▪

In[7]:= **(* find ground state energy *)**
(* ------------------------ *)
Off[NDSolve::ndnum]
Off[NDSolve::dsvar]
Off[ReplaceAll::reps]
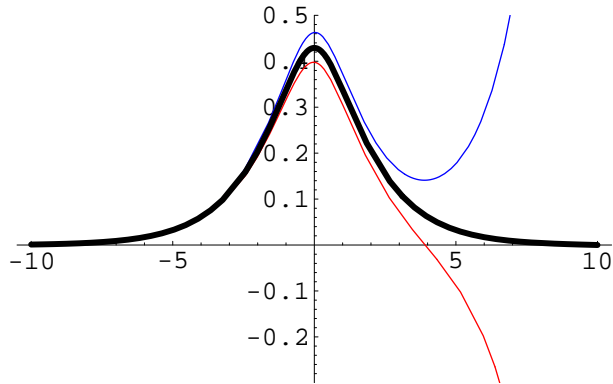**e0 = e /. FindRoot[shoot[e] == 0, {e, -0.5}]**
plotsol[e0]

Out[10]= −0.437881

Out[11]= ▪ Graphics ▪

```
In[12]:= (* look at solutions for e0 +/- de *)
         (* ------------------------------ *)
         x0 = 10;
         e = e0; sol0 = NDSolve[{-psi''[x] + (v[x] - e) * psi[x] == 0,
            psi[-x0] == 0.001, psi'[-x0] == 0.001}, psi, {x, -x0, x0}];
         e = e0 + 0.01;
         sol1 = NDSolve[{-psi''[x] + (v[x] - e) * psi[x] == 0,
             psi[-x0] == 0.001, psi'[-x0] == 0.001}, psi, {x, -x0, x0}];
         e = e0 - 0.01;
         sol2 = NDSolve[{-psi''[x] + (v[x] - e) * psi[x] == 0,
             psi[-x0] == 0.001, psi'[-x0] == 0.001}, psi, {x, -x0, x0}];
         Plot[{Evaluate[psi[x] /. sol1], Evaluate[psi[x] /. sol2], Evaluate[psi[x] /. sol0]},
          {x, -x0, x0}, PlotStyle → {RGBColor[1, 0, 0], RGBColor[0, 0, 1], Thickness[0.01]},
          PlotRange → {-0.3, 0.5}]
```



```
Out[18]=  - Graphics -
```