Free Particle Propagation.

Given an initial wavefunction Ψ(x,0), find the future evolution of the free-particle wavefunction Ψ(x,t)

Griffiths Problem 2.20

Here we calculate the time evolution of the wavefunction from part (c) of the question

$\Psi(x,t) = \frac{a^{3/2}}{\pi} \int \frac{1}{a^2 + k^2} e^{i(kx - \hbar k^2 t/2m)}\, dk$

We take a = 1 and $\hbar/2m = 1$ for simplicity in the calculations that follow.

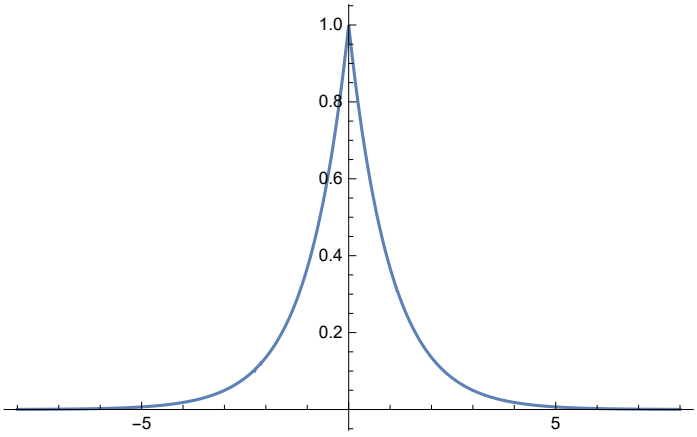
In[1]:=
```
Ψ[x_, t_] := 1/π NIntegrate[1/(1 + k^2) Exp[i (k x - k^2 t)], {k, -∞, ∞}]
```

In[2]:=
```
Ψ[0, 0]
```

Out[2]=
```
1.
```

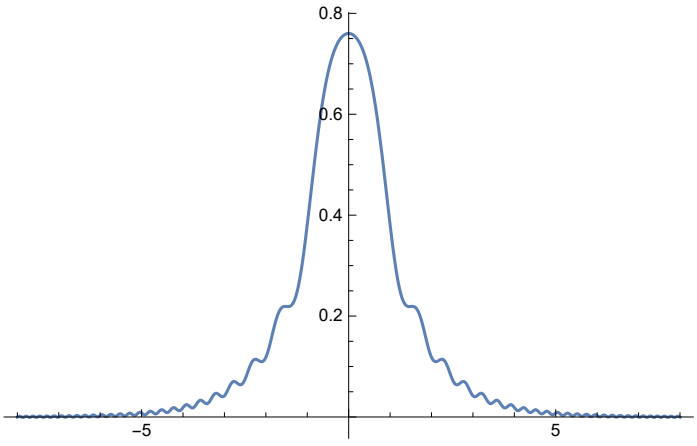
In[3]:=
```
plot0 = Plot[ Re[Ψ[x, 0]], {x, -8, 8}, PlotRange → All]
 (* Wavefunction at t = 0, i.e. the initial wavefunction *)
```

Out[3]=



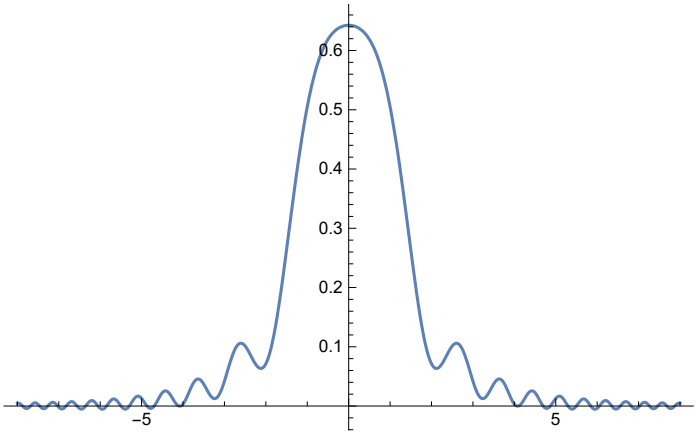
In[4]:=
```
plotp1 = Plot[ Re[Ψ[x, 0.1]], {x, -8, 8}, PlotRange → All] (* Wavefunction at t = 0.1 *)
```

Out[4]=



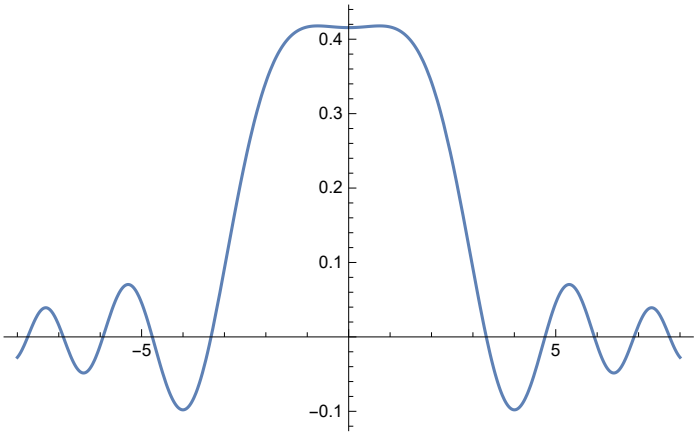
In[5]:=
```
plotp25 = Plot[ Re[Ψ[x, 0.25]], {x, -8, 8}, PlotRange → All]
  (* Wavefunction at t = 0.25 *)
```

Out[5]=



In[6]:=
```
plot1 = Plot[ Re[Ψ[x, 1]], {x, -8, 8}, PlotRange → All]  (* Wavefunction at t = 1 *)
```

Out[6]=



In[7]:=
```
Show[plot0, plotp1, plotp25, plot1] (* Overlay of wavefunctions at t = 0, 0.1, 0.25, 1 *)
```

Out[7]=