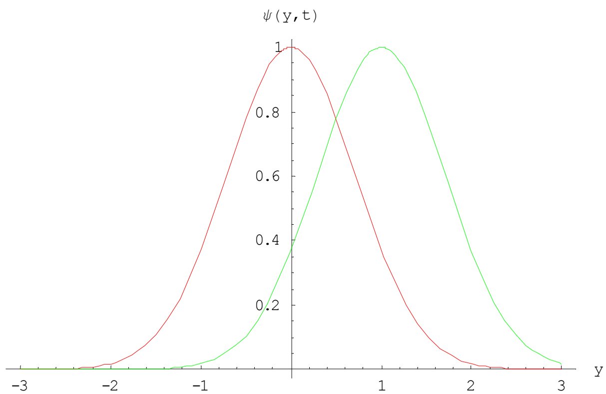
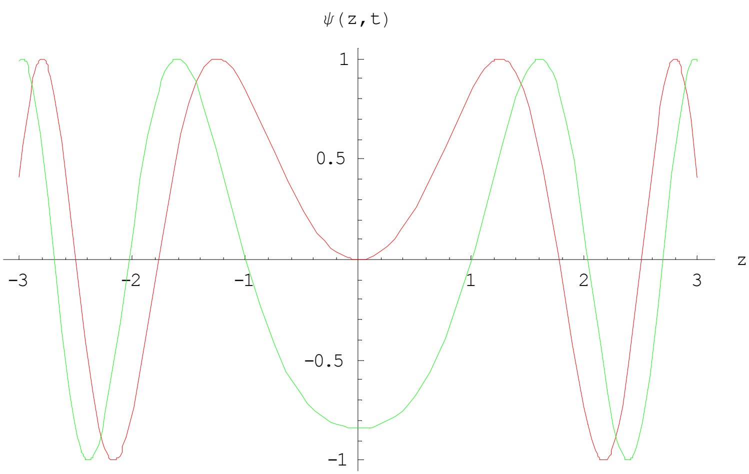
1.1 The function can be rewritten as

$$\psi(y,t) = e^{-a^2\left(y-\frac{b}{a}t\right)^2}$$

and is therefore of the form $f(y-vt)$ with $v = b/a$. The direction of motion is positive if $b/a > 0$. For $a = b = 1$ the plot at t=0 (red) and t=1(green) is:




1.2 The function is not of the form $f(z-vt)$, is not a wave. For $A = a = b = 1$ the plot at t=0 (red) and t=1(green) is:

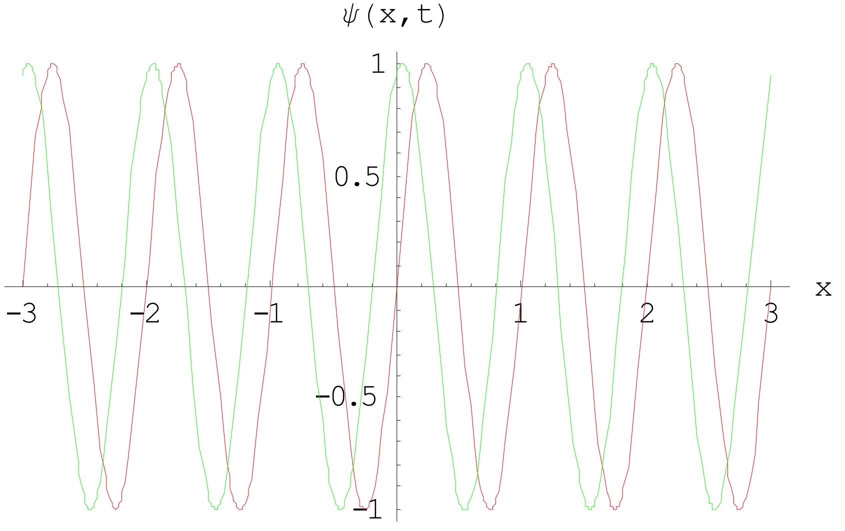



notice that the shape of the function has changed.

1.3 The function can be written as

$$\psi(x,t) = A\sin[\frac{2\pi}{a}(x+\frac{a}{b}t)]$$

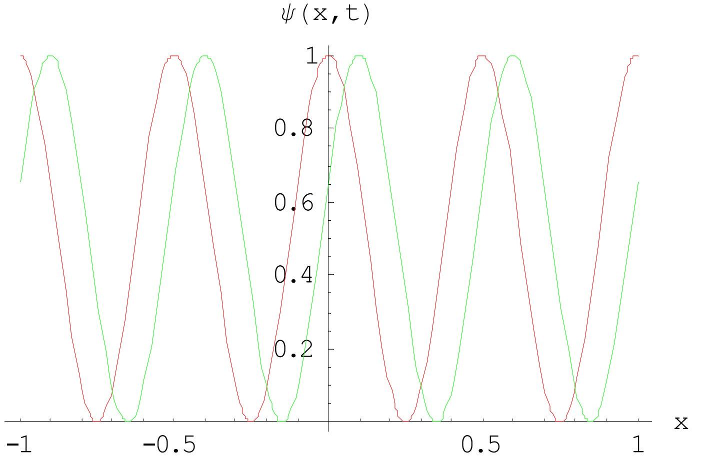
and is therefore of the form $f(x-vt)$ with $v=-a/b$. The direction of motion is negative if $a/b>0$. For $A=a=b=1$ the plot at t=0 (red) and t=0.2(green) is:




1.4 The function ca be written as

$$\psi(x,t) = A\cos^2[2\pi(x-t)]$$

since $\cos(x)=\cos(-x)$. Is of the form $f(x-vt)$ with $v=1$. The wave is moving in the positive direction. For $A=1$ the plot at t=0 (red) and t=0.1(green) is:



5.2

$$\frac{\partial^2\psi}{\partial x^2} = -k^2 A\sin(kx - \omega t)$$

$$\frac{\partial^2\psi}{\partial t^2} = -\omega^2 A\sin(kx - \omega t)$$

Therefore

$$\frac{\partial^2\psi}{\partial x^2} - \frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2} = \left[-k^2 + \left(\frac{\omega}{v}\right)^2\right] A\sin(kx - \omega t) = 0$$

for $v = \dfrac{\omega}{k}$ .

**6.3** Using $c = \frac{\lambda}{T} = 3 \cdot 10^8 m/s$ we have in the three cases:

a) $\lambda_a \sim 1.8m$ thus $f_a = \frac{1}{T} = \frac{c}{\lambda_a} = \frac{3 \cdot 10^8}{1.8} = 166 \cdot 10^6 \, Hz = 166 MHz$.

This is a radio wave. The period of oscillation is $T = \frac{1}{f} = 6 \cdot 10^{-9} s = 6ns$ (nanoseconds).

b) $\lambda_b \sim 0.1mm$ thus $f_b = \frac{1}{T} = \frac{c}{\lambda_b} = \frac{3 \cdot 10^8}{100 \cdot 10^{-6}} = 3 \cdot 10^{12} \, Hz = 3THz$ ( terahertz).

This wave is in the far infrared part of the spectrum. The period of oscillation is $T = \frac{1}{f} = 0.3 \cdot 10^{-12} s = 0.3 ps$ (picoseconds) or $300 fs$ (femtoseconds).

c) $\lambda_c \sim 1 \mathring{A} = 10^{-10} m$ thus $f_c = \frac{1}{T} = \frac{c}{\lambda_c} = \frac{3 \cdot 10^8}{1 \cdot 10^{-10}} = 3 \cdot 10^{18} \, Hz$

This wave is an X-Ray. The period of oscillation is $T = \frac{1}{f} = 3 \cdot 10^{-19} s$.