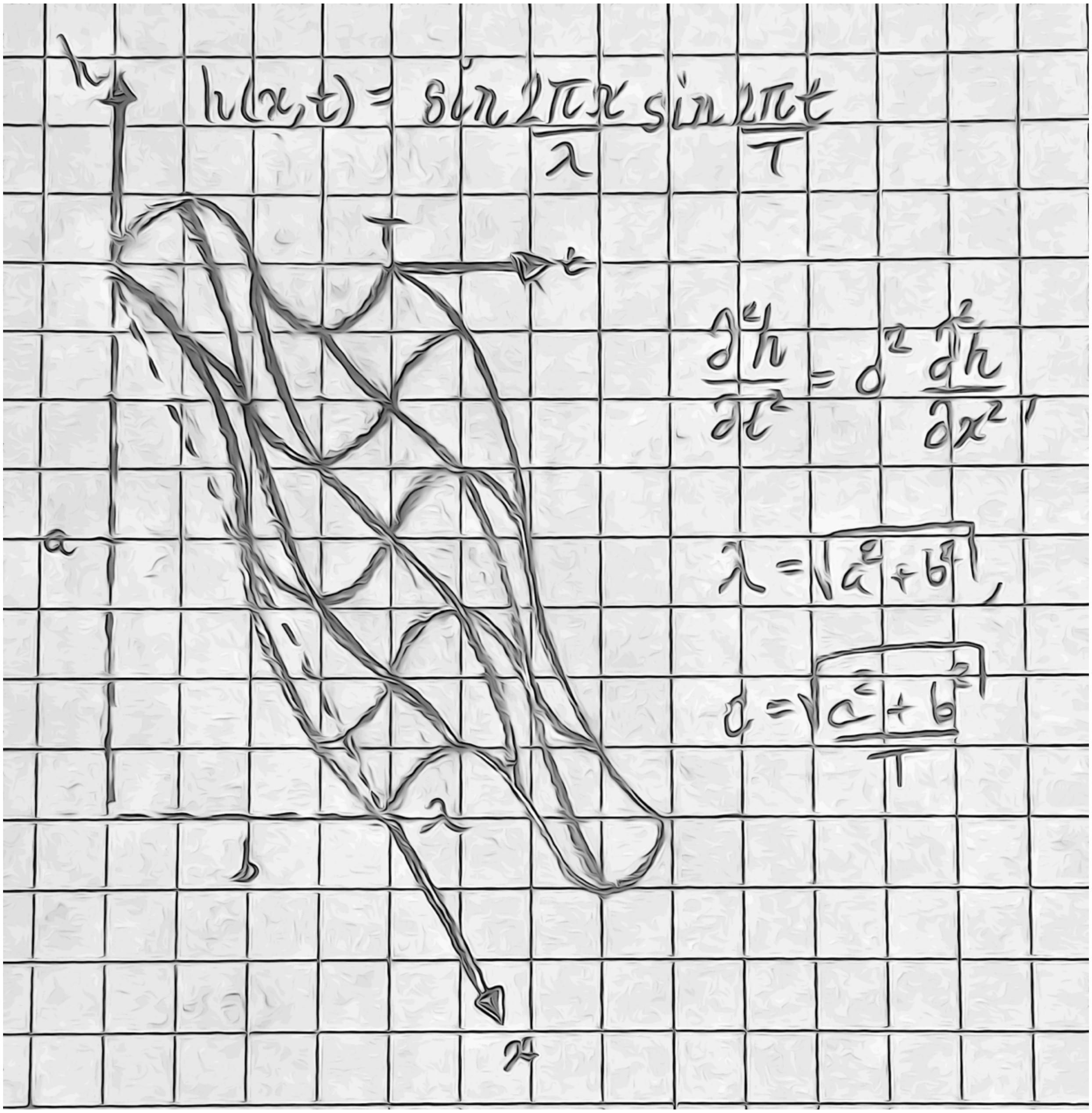
In [53]:
```
from IPython.display import display, Math, Latex
import numpy as np
from sympy import *

init_printing()
display(Math(r'\text{1D Wave Equation },'))
```

1D Wave Equation ,

$$\frac{\delta^2 h}{\delta t^2} = c^2 \frac{\delta^2 h}{\delta x^2}$$

In [54]:
```
from IPython.display import Image
Image(filename='sketch.jpg')
```

Out[54]:



In [55]:

```
a, b, x, t, T = symbols('a b x t T')
px, py, pt = symbols('k_x k_y p_t') # 1, 2, np.sqrt(5)
h, u, v = symbols('h u v', cls=Function)


L = Function("\lambda")(a,b)
c = Function("c")(a,b,T)
h = Function("h")(x, t) # f is a function of x and y

L = sqrt(a**2 + b**2)
c = sqrt(a**2 + b**2)/T
h = sin(2*pi/L*x)*sin(2*pi/T*t)
```

In [56]:
```
# display h
display(h)
```

$$\sin\left(\frac{2\pi t}{T}\right)\sin\left(\frac{2\pi x}{\sqrt{a^2+b^2}}\right)$$

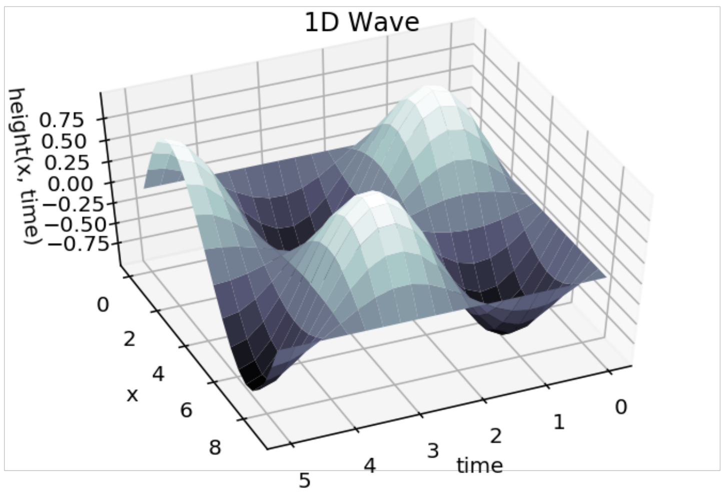
In [59]:
```
# check solution -- should be 0
import sympy

hxx = sympy.diff(sympy.diff(h, x),x)
htt = sympy.diff(sympy.diff(h, t),t)

# wave equation 1d
htt -c**2*hxx
```

Out[59]: 0

In [60]:
```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits import mplot3d

%matplotlib inline
```

In [66]:
```
figure_a, figure_b = 8, 4
wave_length = np.sqrt(figure_a**2 + figure_b**2)
period = 4
wave_speed =wave_length**2/period
N = 20
x = np.linspace(0, wave_length, N)
t = np.linspace(0, period + 1, N)

def height(x, t):
    return np.sin(2*np.pi/wave_length*x)*np.sin(2*np.pi/period*t)


X, T = np.meshgrid(x, t)


H = height(X, T)
```

In [67]:
```
%matplotlib notebook

fig = plt.figure()

ax = plt.axes(projection='3d')
ax.plot_wireframe(T, X, H, color='black', rcount=5, ccount = 5)
ax.set_title('correct aspect model')

plt.axis('off')
ax.grid(False);
```



In [68]:
```
ax = plt.axes(projection='3d')
ax.plot_surface(T, X, H, rstride=1, cstride=1,
                cmap='bone', edgecolor='none')
ax.set_title('1D Wave');

ax.set_xlabel('time')
ax.set_ylabel('x')
ax.set_zlabel('height(x, time)');
```