$\frac{\partial^2 w}{\partial x^2} = \frac{1}{k}\frac{\partial w}{\partial t}, \quad 0 < x < a, 0 < t$ $w(0,t) = 0,\ w(a,t) = 0, \quad 0 < t$ $w(x,0) = g(x), \quad 0 < x < a$	*Are the partial differential equation and boundary conditions homogeneous? Check.*
Look for solutions in the form $w(x,t) = \phi(x)T(t)$ with neither factor identically zero.	*Why require that neither factor be zero?*
Then $\phi''(x)T(t) = \frac{1}{k}\phi(x)T'(t)$	*Where did the equation come from?*
$\frac{\phi''(x)}{\phi(x)} = \frac{T'(t)}{kT(t)}, \quad 0 < x < a, 0 < t$	*Where did the equation come from?*
Therefore, both sides of the equation above are constant.	*Why are both sides constant?*
Also, $\phi(0)T(t) = 0, \phi(a)T(t) = 0, \quad 0 < t$	*Where are these equations from?*
Therefore, $\phi(0) = 0, \phi(a) = 0$	*How can we conclude this?*
Choosing the constant $= p^2$ gives $\frac{\phi''}{\phi} = p^2 > 0$ and $\phi(0) = 0, \phi(a) = 0$ and this doesn't work.	*Why not?*
Choosing the constant $= 0$ gives $\frac{\phi''}{\phi} = 0$ and $\phi(0) = 0, \phi(a) = 0$ and this doesn't work either.	*Why not?*
Choosing the constant $= -\lambda^2$ gives $\begin{cases} \phi'' + \lambda^2\phi = 0, 0 < x < a \\ \phi(0) = 0, \phi(a) = 0 \end{cases}$	*What is the name for this kind of problem? What is to be found? Solve it.*

Solution: $\lambda_n = \frac{n\pi}{a}, \quad \phi_n(x) = \sin(\lambda_n x),$ $n = 1,2,3,\ldots$	*Where did this come from? What are names for ϕ and λ?*
$T_n(t) = \exp(-\lambda_n^2 kt)$	*Where did this come from? Can you derive it?*
$w_n(x,t) = \sin(\lambda_n x)\exp(-\lambda_n^2 kt)$	*Where did this come from? What properties does the function have?*
$w(x,t) = \sum_{n=1}^{\infty} b_n \sin(\lambda_n x)\exp(-\lambda_n^2 kt)$	*How did the sum and the b's come in?What properties does w have?*
Next, satisfy $\sum_{n=1}^{\infty} b_n \sin(\lambda_n x) = g(x), \quad 0 < x < a$	*Where did this come from?*
Then b_n must be $b_n = \frac{2}{a}\int_0^a g(x)\sin(\frac{n\pi x}{a})dx$	*Justify this equation. Why are the limits on the integration as shown?*
Done!	*How can we say this? What is the solution of the problem stated at the beginning?*