Problem 1

Separate variables in the Helmholtz equation $\nabla^2 \psi + k^2 \psi = 0$ in spherical polar coordinates splitting off the radial dependence first. Show that your separated equations have the same form as the equations we obtained in class by splitting off the azimuthal angle dependence as the first step.

Problem 2

Use separation of variables to find the steady-state solution $\Theta(x, y)$ to the heat equation $\frac{\partial \Theta}{\partial t} = \alpha \nabla^2 \Theta$ for a semi-infinite slab of metal of unit thickness with boundary conditions $\Theta = 0$ at $y = 0, 1$ and $\Theta = 1$ at $x = 0$. 