1. Finite differences in heat conduction

   A polymer rod with square cross section 25mm $\times$ 25mm cools after extrusion by radiation and natural convection. Because both of these forms of heat transfer are nonlinear in temperature, and the geometry is not simple, analytical calculation of the temperature profile is not practical, and a 2-D finite difference model is developed, with mesh 5×10 intervals across representing half of the part (since it is symmetric), such that Δx and Δy are equal and uniform throughout the model.

   (a) Assuming the properties (k, ρ, c_p) are uniform throughout the part, how many explicit timesteps are required to model the process from start to steady-state?

   (b) The analysis in part 1a is deemed "not accurate enough", and the resolution (number of intervals) must be doubled in both the x and y-directions to 10×20. How does the amount of computational work (defined as grid points times timesteps) increase?