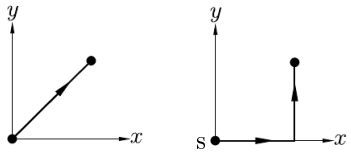
Assignment 3: Due 4 Sep 2023 before midnight

1. Consider the processes $(x, y) : (0, 0) \rightarrow (1, 1)$ shown in the following plots :



   (a) Calculate the change in the function $f(x, y) = xy$ for the two processes by integrating df over the paths shown.

   (b) Is df an exact or an inexact differential?

   (c) Calculate the change in the quantity g defined by $dg = ydx$ for the two processes by integrating dg over the paths.

   (d) Is dg an exact or an inexact differential?

   (e) Which of the two : f and g, should be called a state function and which one a path function? Why?

2. Assuming $U = C_V T$ for a perfect gas, find (i) the internal energy per unit mass and (ii) the internal energy per unit volume, in terms of mass density, pressure and the heat capacity ratio γ.

3. For a van der Waals gas, obtain an expression for the coefficient of thermal expansion, α. The isothermal compressibility of a substance is defined as $\kappa_T = -\frac{1}{V}\left(\frac{\partial V}{\partial p}\right)_T$ .Why is the negative sign there? Show that $\kappa_T R = \alpha(V_m – b)$, where V_m is the molar mass.

4. A sample of liquid water supercooled to -10^{o}C placed in a thermally insulated compartment undergoes a spontaneous crystallisation to form a mixture of ice and liquid water. Calculate q, w, ΔT, ΔU, ΔH, ΔS for the process.