Question 1

Given: $R = 5\,km$ $\quad P_e = 300\,kr/kg$

$v = 2.5\,km/h$ $\quad P_{c_0} = 10\,kr/kg$

$T = 1\,hour$

$P_f = P_e = 300\,kr/kg$ at time $t = T$

Also given:

"price decrease linearly with x" $\rightarrow \frac{\partial P}{\partial x} = f(t) = at + b$

"price change linearly with t" $\frac{\partial P}{\partial t} = g(x) = cx + d$

ALSO given: (BC's)

$$\left.\frac{\partial P}{\partial t}\right|_{x=0} = 0 \;\forall t \Rightarrow d = 0$$

$$\left.\frac{\partial P}{\partial t}\right|_{x=R} = \frac{P_e - P_{c_0}}{T} \Rightarrow c = \frac{P_e - P_{c_0}}{RT}$$

$$\Rightarrow \boxed{\frac{\partial P}{\partial t} = \frac{P_e - P_{c_0}}{RT} x}$$

$$\left.\frac{\partial P}{\partial x}\right|_{t=0} = -\frac{(P_e - P_{c_0})}{R} \Rightarrow b = -\frac{(P_e - P_{c_0})}{R}$$

$$\left.\frac{\partial P}{\partial x}\right|_{t=T} = 0 \Rightarrow a = \frac{P_e - P_{c_0}}{RT}$$

$$\Rightarrow \boxed{\frac{\partial P}{\partial x} = \frac{P_e - P_{c_0}}{RT}(t - T)}$$