Q.1 The feed to an ammonia synthesis reactor contains 25 mol% nitrogen and balance hydrogen. The flow rate of the stream is 3000 kg/h. Calculate, the flow rate of nitrogen to the reactor in kg/h. (Ans: 2470 kg/h)

Q.2 The heat capacity of CO_2 is given as

$C_p = 2.675\times10^4 + 42.27T$

Where Cp is in J/(kmol ^oC) and T is in ^oC. Modify the equation so that the units of Cp are Btu/(lbmol ^{0} F) and T can be inserted in the equation in ^0F.

*Ans: C_p (Btu/lbmol ^0F) = 6.22 + 5.611*10^{-3} T where T is in ^oF.*

Q.3 Wet air containing 4 mol% water vapor is passed through a column of calcium chloride pellets. The pellets adsorb 97% of the water. The column packing was initially dry and had a mass of 3.4 kg. After five hours of operation, the pellets are weighed again and found to have a mass of 3.54 kg. Calculate the molar flow rate (mol/h) of the feed gas and mole fraction of water vapor in the product gas.

*Ans: Feed = 40 mol/hr; mole fraction of water in product= 1.25*10^{-3}*

Q.4

A rectangular block of solid carbon (graphite) floats at the interface of two immiscible liquids. The bottom liquid is a relatively heavy lubricating oil, and the top liquid is water. Of the total block volume, 54.2% is immersed in the oil and the balance is in the water. In a separate experiment, an empty flask is weighed, 35.3 cm^3 of the lubricating oil is poured into the flask, and the flask is reweighed. If the scale reading was 124.8 g in the first weighing, what would it be in the second weighing? (*Suggestion:* Recall Archimedes' principle, and do a force balance on the block.)

Data: Density of block = 2.26 g/cm^3, Density of water = 1 g/cm^3

(Ans: 242 gm)