Assignment 4:

1. An insulated cylinder of 0.05m^3 volume contains Freon-12 at 0.4MPa at 30°C. The valve of the cylinder is opened and the Freon is allowed to escape as vapor from the cylinder until the pressure is reduced to 0.3MPa. Determine the amount of the Freon that escape from the cylinder and the final temperature of Freon in the tank. Assume that during the above mentioned process ***h*** of Freon varies linearly with **1/*v***, and at the end of process also Freon in tank remains in superheated regime.

   Properties of Freon (superheated):

T	*p* = 0.20 MPa (T_{sat} = -12.53°C)			*p* = 0.3 MPa (T_{sat} = -0.86°C)			*p* = 0.4 MPa (T_{sat} = 8.15°C)		
	v	*h*	*s*	*v*	*h*	*s*	*v*	*h*	*s*
Sat.	0.08354	182.07	0.7035	0.05690	187.16	0.6969	0.04321	190.97	0.6928
0	0.08861	189.80	0.7325	0.05715	187.72	0.6989	-	-	-
10	0.09255	196.02	0.7548	0.05998	194.17	0.7222	0.04363	192.21	0.6972
20	0.09642	202.28	0.7766	0.06273	200.64	0.7446	0.04584	198.91	0.7204
30	0.10023	208.60	0.7978	0.06542	207.12	0.7663	0.04797	205.58	0.7428
40	0.10399	214.97	0.8184	0.06805	213.64	0.7875	0.05005	212.25	0.7645
50	0.10771	221.41	0.8387	0.07064	220.19	0.8081	0.05207	218.94	0.7855
60	0.11140	227.90	0.8585	0.07319	226.79	0.8282	0.05406	225.65	0.8060
70	0.15506	234.46	0.8779	0.07571	233.44	0.8479	0.05601	232.40	0.8259
80	0.11869	241.09	0.8969	0.07820	240.15	0.8671	0.05794	239.19	0.8454
90	0.12230	247.77	0.9156	0.08067	246.90	0.8860	0.05985	246.02	0.8645
100	0.12590	254.53	0.9339	0.08313	253.72	0.9045	0.06173	252.89	0.8831
110	0.12948	261.34	0.9519	0.08557	260.58	0.9226	0.06360	259.81	0.9015
120	0.13305	268.21	0.9696	0.08799	267.50	0.9405	0.06546	266.79	0.9194
130	0.13661	275.15	0.9870	0.09041	274.48	0.9580	0.06730	273.81	0.9370
140	0.14016	282.14	1.0042	0.09281	281.51	0.9752	0.06913	280.88	0.9544
150	0.14370	289.19	1.0210	0.09520	288.59	0.9922	0.07095	287.99	0.9714

   Ans: m = 0.245 kg , T_f ~ 20°C.

2. A tank of volume 1m3 initially contains steam at 50 bar , 400C. Steam is slowly withdrawn until the pressure drops to 20bar. Energy is transferred to steam to maintain the temp at 400C throughout the process. Determine the amount of heat transferred to the steam. Ans: 3.603 MJ

3. An insulated tank of 1m^3 capacity contains saturated steam at 100kPa. A supply line containing steam (1Mpa, 200C) is connected to tank and valve is opened until the tank pressure reaches 1Mpa. Prove that the final temperature of the tank is 290°C. Hence calculate the mass entered in the tank. Ans: 3.366 kg.

4. A rigid tank of volume 0.2m^3 contains a moisture of saturated liquid water and saturated water vapor at 120°C. The tank initially contains 0.05m^3 of liquid and 0.15m^3 of vapor. A valve on the top of the tank is opened while energy is transferred as heat to the tank, allowing only vapor to escape till the pressure drops to 1bar and at that instant; the temperature of the contents of the tank is 100°C. Calculate the mass which leaves the tank

and the quantity of energy transferred. Assume that the enthalpy of exiting steam is roughly remains constant and equal to the average of initial and final enthalpy of steam in the tank. **(which is a very crude assumption, however we want some estimate. Best practice will be to get the large number of data points (experimentally measured P and T value) throughout the process).**

Ans: 47.19kg; 150.86MJ

5. An empty insulated tank containing a piston-spring system is connected to steam-supply line (2Map, 300C). Initially the spring is in its natural position, as shown in figure below. When the valve is opened, steam enters the tank and pushes the piston in upward direction (the spring starts getting compressed). Assume spring force is proportion to compression. Determine the state of the steam when pressure in the lower side of tank reaches to 2 MPa. **Ans: 362C**