1. Water stored in a large, well insulated storage tank at 21.0 °C and atmospheric pressure is being pumped at steady state from this tank by a pump at the rate of 40 m³/h. The motor driving the pump supplies energy at the rate of 8.5 kW. The water is used as a cooling medium and passes through a heat exchanger, where 255 kW of heat is added to the water. The heated water then flow to a second large, vented tank, which is 25 m above the first tank. Determine the final temperature of the water delivered to the second tank. (you may need the steam table below) [25%]

Temperature (°C)	Vapor Pressure (kPa)	Specific Volume (m³/kg)		Enthalpy (kJ/kg)		Entropy (kJ/kg·K)	
		Liquid	Sat'd Vapor	Liquid	Sat'd Vapor	Liquid	Sat'd Vapor
0.01	0.6113	0.0010002	206.136	0.00	2501.4	0.0000	9.1562
3	0.7577	0.0010001	168.132	12.57	2506.9	0.0457	9.0773
6	0.9349	0.0010001	137.734	25.20	2512.4	0.0912	9.0003
9	1.1477	0.0010003	113.386	37.80	2517.9	0.1362	8.9253
12	1.4022	0.0010005	93.784	50.41	2523.4	0.1806	8.8524
15	1.7051	0.0010009	77.926	62.99	2528.9	0.2245	8.7814
18	2.0640	0.0010014	65.038	75.58	2534.4	0.2679	8.7123
21	2.487	0.0010020	54.514	88.14	2539.9	0.3109	8.6450
24	2.985	0.0010027	45.883	100.70	2545.4	0.3534	8.5794
25	3.169	0.0010029	43.360	104.89	2547.2	0.3674	8.5580
27	3.567	0.0010035	38.774	113.25	2550.8	0.3954	8.5156
30	4.246	0.0010043	32.894	125.79	2556.3	0.4369	8.4533
33	5.034	0.0010053	28.011	138.33	2561.7	0.4781	8.3927
36	5.947	0.0010063	23.940	150.86	2567.1	0.5188	8.3336
40	7.384	0.0010078	19.523	167.57	2574.3	0.5725	8.2570
45	9.593	0.0010099	15.258	188.45	2583.2	0.6387	8.1648
50	12.349	0.0010121	12.032	209.33	2592.1	0.7038	8.0763
55	15.758	0.0010146	9.568	230.23	2600.9	0.7679	7.9913
60	19.940	0.0010172	7.671	251.13	2609.6	0.8312	7.9096
65	25.03	0.0010199	6.197	272.06	2618.3	0.8935	7.8310
70	31.19	0.0010228	5.042	292.98	2626.8	0.9549	7.7553
75	38.58	0.0010259	4.131	313.93	2635.3	1.0155	7.6824
80	47.39	0.0010291	3.407	334.91	2643.7	1.0753	7.6122
85	57.83	0.0010325	2.828	355.90	2651.9	1.1343	7.5445
90	70.14	0.0010360	2.361	376.92	2660.1	1.1925	7.4791
95	84.55	0.0010397	1.9819	397.96	2668.1	1.2500	7.4159
100	101.35	0.0010435	1.6729	419.04	2676.1	1.3069	7.3549

2. The solute HCl is diffusing through a thin film of water 2.0 mm thick at 283 K. The concentration of HCl at point 1 at one boundary of the film is 12 wt % HCl (density= 1060.7 kg/m³), and at the other boundary at point 2 it is 6 wt % HCl (density = 1030.3 kg/m³). The diffusion coefficient of HCl in water is 2.5×10^{-9} m²/s. Assuming steady state and one boundary impermeable to water, calculate the flux of HCl in kgmol/s·m². [25%]

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3. A plastic tube with an inside diameter of 0.5 mm is connected to a pressure tank where the pressure of water (density of 1000 kg/m^3 and viscosity of 0.001 Pa·s) is 10^5 Pa above atmosphere. Estimate the length of tube so that the delivery is 2.5 liter/day. The inlet and delivery end are at ground level. (Hint: the average velocity of laminar flow in a tube is 1/2 of maximum velocity) [25%]

4. Solve the following problem by the concept of dynamic similarity: A new type of heat exchanger has been designed for cooling water. No data exist on the resistance to flow in such a heater. It is proposed to study a scale model of the heat exchanger having a length ratio of 1:10 with the commercial prototype. Flow in the prototype will be 800 liter/min of water at 50 °C (density of 988 kg/m^3 and viscosity of 5.5×10^{-4} Pa·s). (a) What flow rate of air at 20 °C and 1 atm (density of 1.21 kg/m^3 and viscosity of 1.83×10^{-5} Pa·s) in the model will give flow conditions similar to those in the prototype? (b) If the pressure drop across the model for the flow rate obtained in (a) is 9.8×10^4 N/m^2, what will be the pressure drop across the prototype? [25%]