Transport processes

P64. The distance between the two glass walls of a double-walled window is 5.00 cm. Calculate the energy flux through this window when the temperature inside the room is 25.0 °C and the outside temperature is –10 °C. The surface area of the window is 1.00 m^2 and for air, κ = 0.0241 J K^{-1} m^{-1} s^{-1} at 273.0 K temperature and 1.00 atm pressure. *[16.87 J/s]*

P65. A manometer was connected to a low-pressure nitrogen bottle. The gas was released *via* a small hole and in the manometer, the fluid level was lowered from 65.1 cm to a height of 42.1 cm in 18.5 s. If the experiment was carried out with a fluorinated hydrocarbon, then the same pressure change required 82.3 s. Calculate the molar mass of the fluorinated hydrocarbon. *[555 g/mol]*

P66. Calculate the viscosity of the air at 293.15 K based on the kinetic theory of gases, if σ = 0.40 nm^2. How much is the error of the theory if the experimental value is 182 μP? *[$\eta = 1.313\times10^{-1}$ kg m^{-1} s^{-1} =131.3 μP. The error of the value is –27.8%]*

P67. A steel ball having a 4.0 mm diameter and 7.9 g cm^{-3} density, has a fall time of 55 s through an oil layer with 1.0 m thickness and 1.1 g cm^{-3} density. Calculate the viscosity of the oil in poise. *[32.6 P]*

P68. The dilute sugar solution is placed into a 10.00-cm long tube to produce a linear gradient in the concentration. The initial concentration on the left end of the tube is 0.1 mol dm^{-3} and 0.05 mol dm^{-3} on the right end. The experiment was carried out at 298 K. Calculate the thermodynamic force from the chemical potential gradient in the middle of the tube at the initial moment of the experiment. *[1.65×10^4 N/mol]*

P69. Concentrated saccharose solution (5.0 g sugar in 5.0 cm^3 of water) was poured into a 5.0 cm diameter cylinder. Onto this solution, 1.0 liter of water is layered gently without mixing. Considering the effect of diffusion (excluding gravity), calculate the concentration at 5.0 cm from the layer after

a. 10 s, *[0 mol/dm^3]*
b. 10 min, *[0 mol/dm^3]*
c. 10 hour *[3.4×10^{-15} mol/dm^3]* and
d. 1.0 year. *[0.0315 mol/dm^3]* Molar weight of the sugar is 342 g mol^{-1} and its diffusion coefficient in water is $5.216\cdot10^{-10}$ m^2 s^{-1}.

P70. Calculate the effective radius of the sucrose molecule in water at 25.0 ° C if its diffusion coefficient is $5.20\cdot10^{-10}$ m^2 s^{-1} and the viscosity of water is 1.00 cP. *[Using the Stokes-Einstein equation, a = 420 pm]*