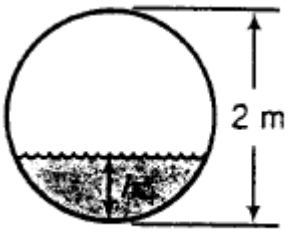
Assignment 1

Q.1 A supersonic aircraft consumes 5320 imperial gallons of kerosene per hour of flight and flies an average of 14 hours per day. It takes roughly seven tons of crude oil to produce one ton of kerosene. The density of kerosene is 0.965g/cm3. How many planes would it take to consume the entire annual world production of $4.02*10^9$ metric tons of crude oil.

Q.2 A horizontal cylindrical drum is 2.0m in diameter and 4.0m long. The drum is slowly filled with benzene (density=0.879g/cm^3). Derive a formula for W, the weight in newtons of the benzene in the tank, as a function of h, the depth of the liquid in centimeters.



Q.3 Two thermocouples are tested by inserting their probes in boiling water, recording the readings, removing and drying the probes, and then doing it again. The results of five measurements are as follows:

T(°C) – Thermocouple A	72.4	73.1	72.6	72.8	73.0
T(°C) – Thermocouple B	97.3	101.4	98.7	103.1	100.4

a) For each set of temperature readings, calculate the sample mean, the range and the sample standard deviation.
b) Which thermocouple readings exhibit the higher degree of scatter? Which thermocouple is more accurate?

Q.4 Find out the formula for Prandtl number and write its dimension using the concept of dimensional homogeneity.

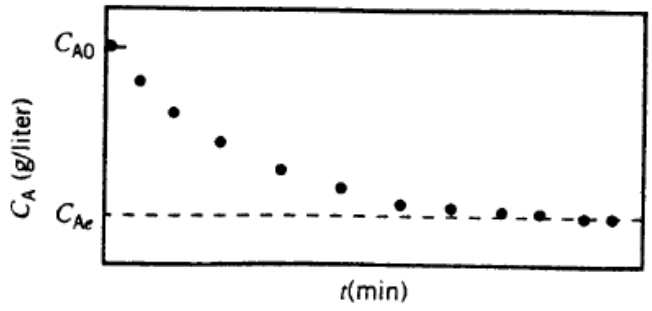
Q.5 A concentration C (mol/L) varies with time (min) as C = 3.00exp(-200t).

a) What are the units of 3.00 and 2.00?

b) Suppose the concentration is measured at t=0 and t=1 min. Use two point linear interpolation or extrapolation to estimate C (t=0.6 min) and t (C=0.10 mol/L) from the measured values and compare these results with the true values of these quantities. Also find the error percentage.

c) Sketch a curve of C vs t, and show graphically the points you determined in part (b).

Q.6 A chemical reaction A $\longrightarrow$ B is carried out in a closed vessel. The following data are taken for the concentration of A, C_A (g/L), as a function of time, t(min). From the start of the reaction:



t(min)	0	36	65	100	160	∞
C_A(g/liter)	0.1823	0.1453	0.1216	0.1025	0.0795	0.0495

C_{A0} C_{Ae}

A proposed reaction mechanism predicts that C_A and t should be related by the expression $\ln(C_A-C_{Ae}/C_{Ao}-C_{Ae}) = -kt$ where k is the reaction rate constant.

a) Do the data support this prediction? If so, determine the value of k.
b) If the tank volume is 30.5 gallons and there is no B in the tank at t=0 , how much B does the tank contain after two hours?