Challenge Set 5

Deadline: Mar 17 2017 at 5pm

Challenge problems are ***optional*** problems for those interested in testing their abilities. For each correct answer to a challenge question, bonus points of 0.1 are given towards the *final overall grade,* i.e., you can potentially earn up to 1.5 points towards the final grade if you get all questions correct. Proper workings must be shown to get any points, and there is no partial credit. Also, because these are bonus questions, instructors will not provide any help or hints (unlike typical problem or practice set questions where generous assistance will be provided) to be fair to all students. Please submit your solutions via the Turnitin assignment "Challenge Set 5" on TED@UCSD (you can simply take a good resolution photo/scan of your solutions with your student ID number and name clearly labelled and convert it to a PDF for upload) by the deadline.

Q1: The rate of evaporation for a small droplet suspended in air is given by the following equation, where M is the mass flow rate, ρ is the density of the evaporating species, D is the diffusion coefficient, R is the radius of the droplet, w_s is the mass fraction of the evaporating species at the surface of the droplet, and w_e is the mass fraction of the evaporating species in the surrounding environment. All variables are in SI units.

$$M = \frac{\rho D}{R} \ln\left(1 + \frac{w_s - w_e}{1 - w_s}\right)$$

Data was collected in lab and is tabulated below. Estimate w_s and its uncertainty. Show all work by hand for full credit.

M	ρ	D	R	w_e
1.73	791	$1.08 * 10^{-5}$	$6.1 * 10^{-3}$	0.008
1.68	775	$1.25 * 10^{-5}$	$5.2 * 10^{-3}$	0.012
1.81	783	$0.98 * 10^{-5}$	$5.9 * 10^{-3}$	0.011
1.79	802	$1.12 * 10^{-5}$	$7.1 * 10^{-3}$	0.006
1.75	793	$1.20 * 10^{-5}$	$6.6 * 10^{-3}$	0.015
1.61	799	$1.03 * 10^{-5}$	$6.3 * 10^{-3}$	0.009

Q2: Over-speeding is one of the leading cause of accidents. The police have set up three speed detection sensors on the road. It is known that the measurement error of the sensor can be modelled as a Normal distribution with mean 0 and variance 25. The readings from the three sensors are averaged to give a single estimate (denoted by K) of the speed of the vehicle. Determine a threshold for K such that the probability of issuing a ticket for over-speeding in error is no more than 4%..

Q3: An article in the Food Technology Journal (1956, Vol. 10, pp. 39–42) described a study on the protopectin content of tomatoes during storage. Four storage times were selected, and samples from nine lots of tomatoes were analyzed. The protopectin content (expressed as hydrochloric acid soluble fraction mg/kg) is in the table below. The researchers in this study hypothesized that mean protopectin content would be different at different storage times. Perform a test at $\alpha = 0.05$ to confirm this hypothesis. Which specific storage times are different? Would you agree with the statement that protopectin content decreases as storage time increases?

	Lot								
Time	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0 days	1694.0	989.0	917.3	346.1	1260.0	965.6	1123.0	1106.0	1116.0
7 days	1802.0	1074.0	278.8	1375.0	544.0	672.2	818.0	406.8	461.6
14 days	1568.0	646.2	1820.0	1150.0	983.7	395.3	422.3	420.0	409.5
21 days	415.5	845.4	377.6	279.4	447.8	272.1	394.1	356.4	351.2