Homework #9
Due: 4/23/18

1. (20) Text question 11.70.

2. (20) Calculate the maximum packing factor and corresponding weight fraction of fine particles in a bimodal mixture of monosized particles, 100 μm and 1 μm in diameter, and of the same material. Assume the large particles exhibit simple cubic packing and the fine particles exhibit loose random packing. Assume $V_o = 1.0$.

3. (30) Powder compacts were uniaxially pressed in a cylindrical die of 13 mm diameter at varying levels of applied force. The compact height and mass was measured after pressing as compiled in the table below. (a) Calculate and plot the mean relative density (%) for the level of applied pressure (MPa). Explain trends in the data. (b) Fit the data with the empirical model given in lecture, $\rho = \rho_o + A \cdot \log(P)$ where ρ is the relative density, P is the applied pressure and ρ_o and A are constants. (c) Propose a model that would fit the data better.

Applied Force (lbs)	Compact Height (mm)	Compact Mass (g)	Applied Force (lbs)	Compact Height (mm)	Compact Mass (g)
500	2.51	0.501	5000	1.96	0.492
500	2.52	0.507	5000	1.98	0.502
500	2.50	0.496	7500	1.91	0.494
500	2.50	0.496	7500	1.88	0.487
1000	2.43	0.494	7500	1.91	0.493
1000	2.45	0.495	7500	1.89	0.491
1000	2.47	0.499	10000	1.86	0.500
1000	2.45	0.493	10000	1.86	0.494
3000	2.17	0.495	10000	1.85	0.490
3000	2.15	0.491	10000	1.85	0.492
3000	2.18	0.494	15000	1.73	0.490
3000	2.16	0.493	15000	1.71	0.488
5000	1.97	0.495	15000	1.74	0.492
5000	1.96	0.494	15000	1.72	0.489

4. (30) An alumina powder having an average particle size of 1.6 μm is dry-pressed in a die, producing a 2 cm diameter x 2 cm high cylindrical compact having a mass of 12.75 g. The theoretical density of alumina is 3.97 g/cm^3. (a) Calculate the packing density of the as-pressed compact. (b) Upon firing, the compact densifies uniformly to a relative bulk density of 0.81. Calculate the diameter (or height) of the fired cylinder. (c) Suggest two changes in process variables or material characteristics that would help achieve a higher fired density and explain why.