Homework Assignment Number One

Problem 1. Permutations & Combinations (6 points)

Consider sputtering an film with 8 layers that are designated A-rich, A-lean, B-rich, B-lean, C-rich, C-lean, D-rich and D-lean. In how many different ways can the layers be put down

(a) with no restrictions?

(b) if the corresponding rich and lean layers must be adjacent?

(c) if all the rich layers are sputtered first, followed by all the lean layers?

Problem 2. Permutations & Combinations (4 points)

(a) A preliminary engineering design involves three stages where different solvents are used to perform liquid-liquid extraction. If you are considering 5 different solvents, each of which will be used in no more than one extractor, how many different possible designs would you need to investigate?

(b) Now make the assumption that it doesn't matter what order the three extractions are performed in. How many different possible designs would you need to investigate?

Problem 3. Counting (2 points)

A drug for the relief of arthritis can be purchased from 8 different manufacturers in liquid, tablet, or capsule form, all of which come in 100, 200 and 400 mg doses. How many different ways can a doctor prescribe the drug to a patient suffering from arthritis?

Problem 4. Probabilities – Union, Intersection and Sums (6 points)

A group of 500 college freshman are surveyed on the subject of fossil energy, climate change and sustainability. 210 believe sustainability is a legitimate global issue. 258 believe that anthropogenic climate change exists. 216 believe that fossil energy will be exhausted in their lifetime. 122 believe in both sustainability and anthropogenic climate change. 83 believe in both the exhaustion of fossil energy and anthropogenic climate change. 97 believe in both the sustainability and the exhaustion of fossil energy. 52 believe all three statements.

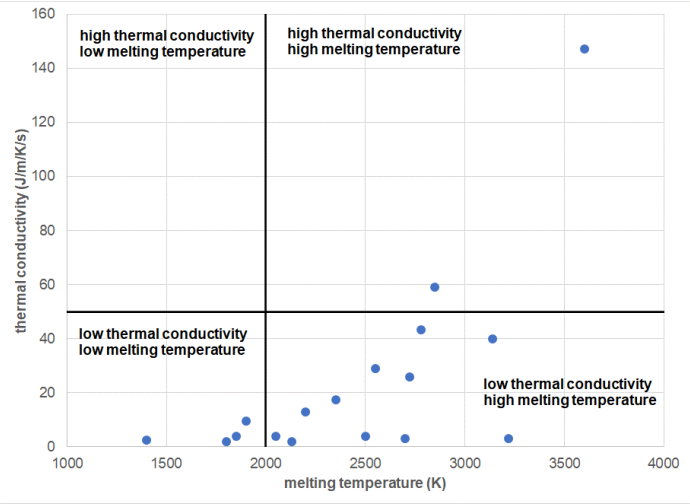
(a) Find the probability of those who believe in sustainability but not in anthropogenic climate change.

(b) Find the probability of those who believe fossil fuel will be exhausted in their lifetimes and in anthropogenic climate change but not in sustainability.

(c) Find the probability of those who believe in neither sustainability nor that fossil fuel will be exhausted.

Problem 5. Conditional Probability (12 pts)

Consider the 17 ceramic materials in the table in Problem 1. We are evaluating these materials in terms of low or high thermal conductivity and low or high melting temperature. A plot of the thermal conductivity vs the melting temperature is shown below.



Using this information, answer the following questions.

(a) Draw a Venn Diagram of the sample space for this data.

(b) What is the probability that a material has high thermal conductivity and high melt temperature?

(c) What is the probability that a material has high thermal conductivity?

(d) What is the probability that a material has high melt temperature given that it had high thermal conductivity?

(e) What is the probability that a material has low thermal conductivity given that it had low melt temperature?

(f) Given this classification, prove that thermal conductivity and melt temperature are not independent of each other.