Exam I
Administered: Wednesday, September 21, 2021
24 points

For each problem part: 0 points if not attempted or no work shown,
1 point for partial credit, if work is shown,
2 points for correct numerical value of solution

Problem 1. (12 points)

Consider the data for the following **17** refractory ceramics given below. This data is available electronically on the course website in a spreadsheet file.

Material	Melting Point °C	Max Temp °C	Hardness Moh's Scale	Density g/cm3	Specific Heat J/kg °C	Thermal Expansion (Linear) 10-6 / °C	Thermal Conductivity W/m °C
Alumina	2050	1950	9	3.96	1050	8	4
Beryllia	2550	2400	9	3	2180	7.5	29
Magnesia	2850	2400	6	3.6	1170	13.5	59
Thoria	3220	2700	7	9.7	290	9.5	3
Zirconia	2700	2400	6.5	5.6	590	7.5	3
Zircon	2500	1870	7.5	4.6	630	4.5	4
Spinel	2130	1900	8	3.6	1050	8.5	2
Mullite	1850	1800	8	2.8	840	5	4
Sillimanite	1800	1800	6.5	3.2	840	5	2
Silicon Carbide	2200	1400	9	3.2	840	4.5	13
Silicon Nitride	1900	1400	9	3.18	1050	2.9	9.5
Graphite	3600	3273	0.75	2.2	1600	2.2	147
Quartizite	1400	3000	7	2.65	1170	8.6	2.6
Boron Carbide	2350	540	9.3	2.5	2090	5.7	17.3
Boron Nitride	2721	650	2	2.1	1570	7.5	26
Titanium Carbide	3140	1500	9.5	6.5	1050	6.9	40
Tungsten Carbide	2780	1000	9.5	14.3	300	6.3	43.3

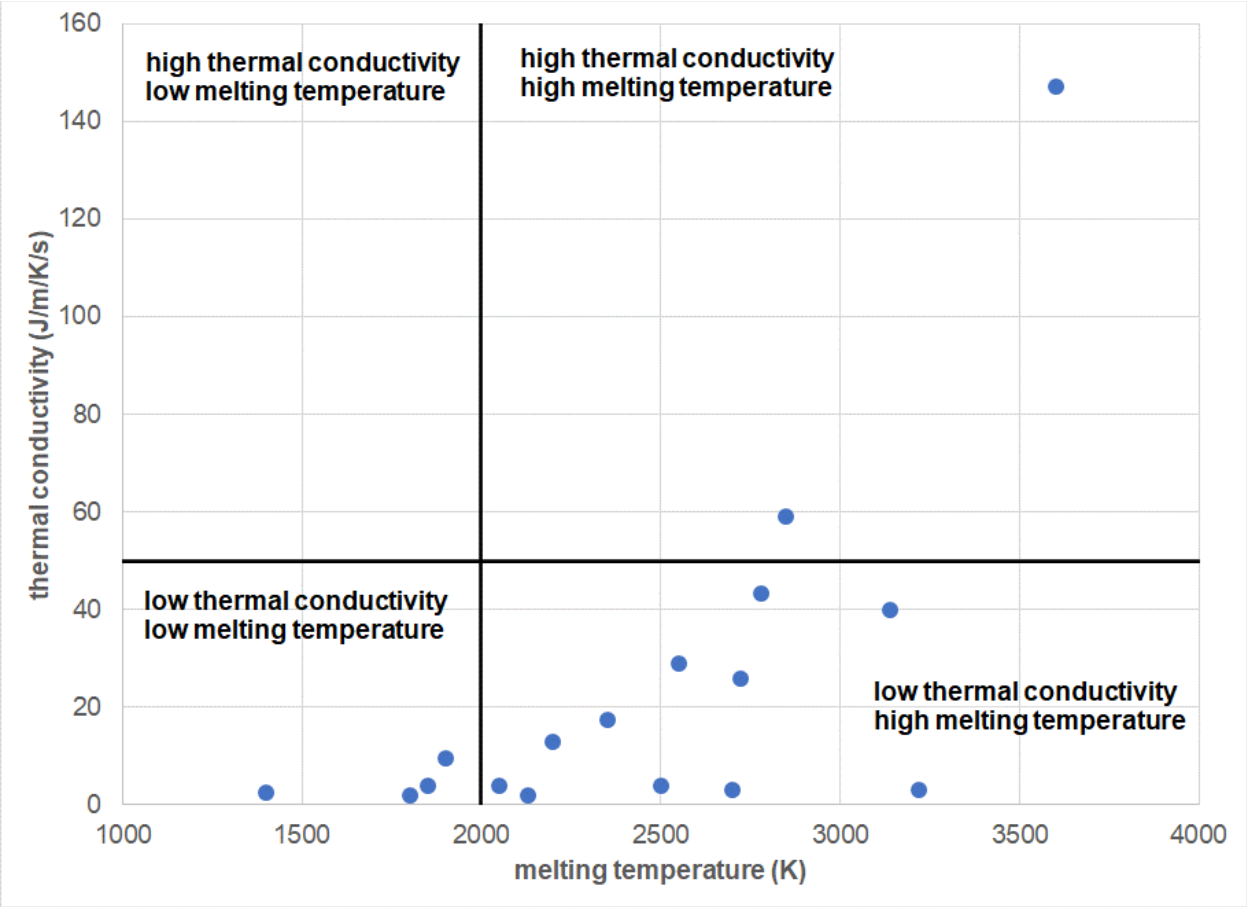
Answer the following questions for the materials in this table.

(a) Determine the mean melting temperature.
(b) Determine the mean specific heat.
(c) Determine the standard deviation of the melting temperature.
(d) Determine the standard deviation of the specific heat.
(e) Determine the correlation coefficient between the melting temperature and the specific heat.
(f) What is the physical significance of your answer to part (e)?

(over)

Problem 2. (12 points)

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.