Study Questions for Chang (2004) *Inventing Temperature*.

Chapter 3.

1. What was wrong with Gmelin's observation of −120ºF in Siberia?
2. Why did De Luc think there was no reason to distrust mercury thermometers at low tempertures?
3. What were some questionable assumptions of the Hutchins-Cavendish experiment to establish the freezing point of mercury?
4. What were some of the characteristics of Pouillet's experiments that established that the freezing point of mercury was somewhere near −400ºC?
5. What was Wedgewood's method of measuring very high temperatures?
6. How did Wedgewood link his scale with the mercury-based Fahrenheit scale?
7. Why did Wedgewood's method come under sharp criticism?
8. According to Chang, why were the following alternatives to Wedgewood's method just as poorly established: the expansion of platinum, ice or water calorimetry, time of cooling, air pyrometry?
9. According to Bridgeman, what forces us to use different operations in measuring the same concept in different realms of phenomena? How does this apply to the example of length?
10. What is Bridgeman's "reductive doctrine of meaning"? According to Chang, what problem does it face?
11. What are Chang's concepts of "semantic extension", "operational extension", and "metrological extension"?
12. What is the "use theory of meaning"?
13. What are the criteria of "conformity" and "overlap" that Chang thinks must be satisfied in order for an extension of a concept to be valid?
14. Explain the following strategies that were used in extending the concept of temperature into new domains: disconnected extension, the Wedgewood patch, whole-range standards, leapfrogging, theoretical unification.
15. What is Otto Neurath's metaphor of the ship at sea? How does it suggest Chang's method of "mutual grounding" of standards? How does it explain why Wedgewood's method of extension was rejected, even though alternative methods were just as poorly established?

Chapter 4.

1. Describe Pictet's experiment. How can it be interpreted as evidence for the radiation of cold?
2. How did Irvinists attempt to locate the absolute zero of temperature? According to Chang, why did this lead to the demise of Irvinist calorific theories of heat?
3. According to Chang, what was a major problem with chemical calorific theories of heat?
4. How did chemical calorific theories of heat explain away Rumford's experiments that suggested that an indefinite amount of heat could be generated by friction?
5. How were early to mid-19th century dynamical theories of heat different from the contemporary kinetic theory?
6. What was the goal of William Thomson's attempt to define an absolute concept of temperature?
7. What is a "heat engine"?
8. What was Watt's innovation in steam engine design?
9. What is a "Carnot cycle"?
10. What is the very important result that Carnot derived for the efficiency of a Carnot cycle?
11. What was Thomson's first absolute temperature scale?
12. According to Carnot, what is the relation between the total amount of heat input to a heat engine, and the total amout of heat output? Why did Joule object to this?
13. What is the simple definition of Thomson's second concept of absolute temperature?
14. How could Thomson's first concept of absolute temperature be measured? What was the problem with this?
15. What was Thomson's proposed solution to the problem in #14? Describe some problems with this solution.
16. What is "Mayer's Hypothesis"? How did Thomson argue that, if Mayer's Hypothesis is true, then an ideal gas thermometer gives Thomson's second concept of absolute temperature exactly?
17. How did Joule and Thomson test Mayer's Hypothesis?
18. Why must we be careful in defining absolute temperature in terms of pressure and volume?
19. Why does Chang claim that "All in all, no simple reductive scheme has been adequate for the operationalization of absolute temperture"?
20. According to Chang, what is an *abstraction*? How does an *abstraction* differ from an *idealization*?
21. According to Chang, what are the two steps involved in operationalization?
22. According to Chang, does an unoperationalized abstract concept (like absolute temperature) correspond to anything *real*? If not, then how do we know when an operationalization is valid?
23. What is involved in Callendar and Le Chatelier's operationalization of absolute temperature?
24. According to Chang, what is the aim of operationalizing an abstract concept?