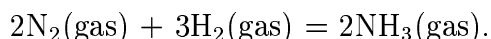


Physics 540 Fall 2005
Homework Assignment No. 1 due Tuesday Sept. 6

The following problems are taken from the book *The Second Law*, by Henry A. Bent (Oxford University Press, New York, 1965) first edition.

1. Read the essay (see the link under “Notes”) **Joseph Black and the Melting of Ice**. What is the heat of melting of ice as determined by Dr. Black’s data?
2. In an article on machine guns in the eleventh edition of the Encyclopaedia Britannica there appears this statement. The great difficulty which has to be met in all single-barrel machine guns is the heating of the barrel. The 7 1/2 pints of water in the water-jacket of the Maxim gun are raised to boiling point by 600 rounds of rapid fire – i.e. in about 1 1/2 minutes – and if firing be continued, about 1 1/2 pints of water are evaporated - for every 1000 rounds. Estimate from these data the energy required to evaporate water in terms of the energy required to heat the same quantity of liquid water one degree centigrade.
3. Consider a chamber containing a gaseous mixture of nitrogen, hydrogen, and ammonia, pressurized by a movable piston, and suppose that the mixture is at equilibrium with respect to the rearrangement of atoms



Suppose, further, that introduction of a catalyst shifts the equilibrium to the left by increasing the rate of the backward reaction (the formation of nitrogen and hydrogen from ammonia) more than it increases the rate of the forward reaction (the formation of ammonia from nitrogen and hydrogen) with a consequent increase in the number of moles of gas in the chamber and rise in the piston’s equilibrium position, and that on removing the catalyst the system returns to its original state. The cycle could then be repeated: catalyst in, piston up; catalyst out, piston down. In effect one has at hand a little engine that should be capable of doing useful mechanical work. To keep the engine from cooling off – presumably this might interfere with its efficient operation, and according to the First Law the energy that appears as work must come from somewhere – it is allowed to remain in thermal contact with its surroundings. This costs nothing. Would not this be a good way to operate ocean-going vessels, particularly in the lower latitudes?