Selected Problems From Chapter 20 (answers are in **BOLD** font)

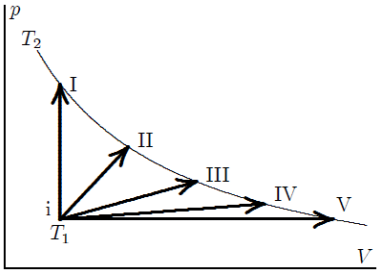
1. Which of the following situations is considered to be a reversible process?

a) A raw egg is thrown from a second story window to the ground below.
b) The pizza is put into the 425 °F oven and baked for 15 minutes.
c) After the party, Joe damages his car by striking a traffic light.
d) The tornado levels an entire neighborhood.
e) None of these are reversible processes.

2. Which of the following is NOT a state variable?

a) Work b) Internal energy
c) Entropy d) Temperature e) Pressure

3. An ideal gas is to be taken reversibly from state i, at temperature T_1, to any of the other states labeled I, II, III, IV, and V on the p-V diagram to the right. All are at the same temperature T_2. Rank the five processes according to the change in entropy of the gas, least to greatest.



a) I, II, III, IV, V b) V, IV, III, II, I
c) I, then II, III, IV, and V tied d) I, II, III, and IV tied, then V
e) I and V tied, then II, III, IV

4. An ideal gas, consisting of n moles, undergoes a reversible isothermal process during which the volume changes from V_i to V_f. The change in entropy of the thermal reservoir in contact with the gas is given by:

a) $nR(V_f - V_i)$ b) $nR\,ln(V_f - V_i)$ **c) $nR\,ln(V_i/V_f)$** d) $nR\,ln(V_f/V_i)$
e) none of the above (entropy can't be calculated for a reversible process)

5. Two moles of an ideal gas expands reversibly and isothermally at temperature T until its volume is doubled. Find the change of entropy of this gas for this process. Answer: $\Delta S = nR\,ln(V_f/V_i) = 2\times 8.31\times ln(2) =$ **11.5 J/K**

6. For all adiabatic processes:

A. the entropy of the system does not change
B. the entropy of the system increases
C. the entropy of the system decreases
D. the entropy of the system does not increase
E. the entropy of the system does not decrease

7. For all reversible processes involving a system and its environment:

A. the entropy of the system does not change
B. the entropy of the system increases
C. the total entropy of the system and its environment does not change
D. the total entropy of the system and its environment increases
E. none of the above

8. For all irreversible processes involving a system and its environment:

A. the entropy of the system does not change
B. the entropy of the system increases
C. the total entropy of the system and its environment does not change
D. the total entropy of the system and its environment increases
E. none of the above

9. A block that slides on a rough surface slows down and eventually stops. The reverse process never occurs. That is, a block at rest never begins to move and accelerate on a rough surface without the action of an external agent. The second situation is forbidden because it would violate which of the following choices.

a) second law of thermodynamics
b) first law of thermodynamics
c) both the first and second laws of thermodynamics
d) conservation of momentum
e) conservation of total energy

10. The maximum theoretical efficiency of a Carnot heat engine operating between reservoirs at the steam and at the freezing points temperatures of water is about: Answer: **(27 %)**

11. A perfectly reversible heat pump with a coefficient of performance of 14 supplies energy to a building as heat to maintain its temperature at 27 ºC. If the pump motor does work at the rate of 1 kW, at what rate does the pump supply energy to the building as heat? Answer: $W + Q_L = W(1 + K) =$ **Q_H = 15 kW**

12. A certain heat engine draws 500 cal/s from a water bath at 27 ºC and transfers 400 cal/s to a reservoir at a lower temperature. Find the efficiency of this engine. Answer: **(20 %)**

13. A heat engine operates between 200K and 100K. In each cycle it takes 100 J from the hot reservoir, loses 25 J to the cold reservoir, and does 75 J of work. This heat engine violates:

max theoretical efficiency = Carnot Efficiency = $1- T_C/T_H = 1 – 100/200 = 0.5$
but actual efficiency = $W/Q_H = 75/100 = 0.75 > 0.5$

a) both the first and second laws of thermodynamics
b) the first law but not the second law of thermodynamics
c) the second law but not the first law of thermodynamics
d) neither the first law nor the second law of thermodynamics
e) cannot answer without knowing the mechanical equivalent of heat

14. Which one of the following statements is consistent with the second law of thermodynamics?

a) Heat flows spontaneously from a hot object to a cooler object.
b) A refrigerator can cool the room it is in if the door is left open.
c) The temperature of an ice cube can sometimes be lowered as it spontaneously gives heat to the surroundings.
d) The internal energy of a system is determined by the flow of heat into or out of the system and the amount of work done.
e) The specific heat capacity at constant volume of a monatomic gas is different than that of a diatomic gas.

15. Which one of the following statements best describes the operation of a heat engine?

a) A heat engine uses input heat to perform work and rejects excess heat to a lower temperature reservoir.
b) A heat engine performs work and generates an equal amount of heat in a cyclic process.
c) A heat engine decreases the entropy of the universe by generating an equal amount of heat and work.
d) A heat engine transfers heat from a lower temperature reservoir to a higher temperature reservoir through work performed on the system.
e) A heat engine transfers heat from a higher temperature reservoir to a lower temperature reservoir through work performed on the system.

16. Which one of the following statements concerning the efficiency of a Carnot heat engine is true?

a) One hundred percent efficiency would be possible if heat could be rejected into a cold reservoir at zero kelvin.
b) The efficiency of an irreversible engine is typically greater than that of a reversible engine operating under the same circumstances.
c) The efficiency is dependent on whether an ideal or a non-ideal gas is used.
d) One hundred percent efficiency would be possible if the engine can be operated in reverse..
e) The efficiency is not dependent on the temperatures of the hot and cold reservoirs.