PHYS102 – Chapter 20 (Instructor: Dr. Al–Shukri)

Q1. Liquid water having a mass of 50 grams was initially at 0 ºC. Heat was added to the water so that its entropy increases by 94.0 J/K, what is the final temperature of the water?

a. 428 K b. 175 K c. 273 K d. 478 K e. Zero

Q2. A 2.50-mole sample of an ideal monatomic gas was initially at a temperature of 300 K. The gas is compressed isobarically to half of its original volume, what is the change of entropy of the gas?

a. – 36.0 J/K b. + 36.0 J/K c. + 21.6 J/K
d. – 21.6 J/K e. – 104 J/K

Q3. A Carnot heat engine operates between two reservoirs at temperatures of 400 K and 500 K. What is the ratio of the work done by the engine to the heat expelled to the low-temperature reservoir?

a. 0.25 b. 0.35 c. 0.75 d. 2.25 e. 0.20

Q4. A system consists of an equilibrium mixture of ice and water at constant pressure. On heating the system, **some** of the ice melts, then

a. the entropy increases.
b. the entropy decreases
c. the temperature decreases.
d. the internal energy decreases
e. the temperature increases.

Q5. The change in entropy for melting 6.0 kg of a solid which melts at 27 ºC is: [The latent heat of fusion of the solid is 2.5×10^4 J/kg]

a. $+5.0\times10^2$ J/K b. -5.0×10^2 J/K
c. 5.6×10^3 J/K d. -5.6×10^3 J/K e. zero

Q6. A Carnot heat engine operates between two reservoirs at temperatures of 500 K and 375 K. If the engine extracts 6.0×10^7 J/cycle, find the heat rejected per cycle.

a. 4.5×10^7 J/cycle b. 1.5×10^7 J/cycle
c. 2.5×10^7 J/cycle d. 7.5×10^7 J/cycle
e. 1.0×10^7 J/cycle

Q7. Container A, of volume 1.0 L, holds 2.0 moles of oxygen (see the **Figure**). Container B, of volume 4.0 L, holds 2.0 moles of nitrogen. Both containers are isolated and are at the same temperature. The valve between the two containers is open and the molecules of each gas spread to fill the whole volume of the two containers. What is the total entropy change in the process?

a. 30 J/K b. 27J/K c. 3.7 J/K
d. 7.4 J/K e. 53 J/K

Q8. An ice cube of mass 400 g at temperature of 0 °C melts to water at 0 °C. The process takes place very slowly, so it is reversible. What is the change in entropy of the ice when it has all melted.

a. **488 J/K** b. –488 J/K c. 1.3×10^5 J/K
d. -1.3×10^5 J/K e. 0

Q9. A Carnot heat engine operates between reservoirs at temperatures of 700 K and 300 K. In one cycle it absorbs 1500 J heat. How much work is done by the engine?

a. 857 J b. 500 J c. 1000 J
d. 1500 J e. 750 J

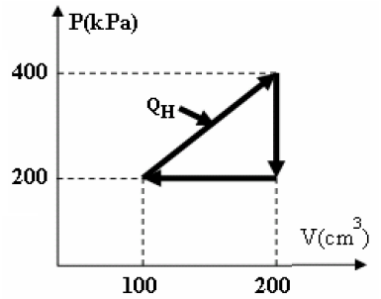
Q10. A Carnot refrigerator operating between -20 °C and +20 °C extracts heat from the cold reservoir at the rate 200 J/s. What is the rate at which work is done on the refrigerator?

a. 32 J/s b. 6.3 J/s c. 100 J/s
d. 50 J/s e. 25 J/s

Q11. A 3.47 mol sample of an ideal gas expands reversibly and isothermally at 400 K until its volume doubled. What is increase in entropy of the gas?

a. 20.0 J/K b. 15.0 J/K c. 10.0 J/K
d. 30.0 J/K e. 25.0 J/K

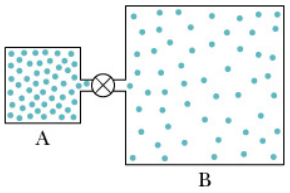
Q12. The **Figure** shows a cycle for a heat engine for which $Q_H = 35$ J. The thermal efficiency of the engine is :



a. 29 % b. 14 %
c. 23 % d. 57 %
e. 19 %

Q13. In an isolated container, a 0.10 kg block of aluminum initially at 600 K is brought into thermal contact with a very large block of iron at 200 K until thermal equilibrium is reached. The iron block is so large that we can assume that its temperature does not change. What is the change in entropy of the iron block and the net change of the entropy of the system of the two metals? (specific heat of iron is 0.11 kcal/kg.K and specific heat of aluminum is 0.22 kcal/kg.K)

a. 44 cal/K & 20 cal/K
b. 44 cal/K & Zero
c. –24 cal/K & Zero
d. 24 cal/K & 20 cal/K
e. Zero & Zero



Q14. A Carnot engine completes 4 cycles per second. In every cycle, it delivers a power 120 W and discharges 40 J. what is the efficiency of the engine?

a. 43% b. 75% c. 33% d. 10% e. 8.3%

Q15. A refrigerator converts 7.0 kg of water at 0 °C into ice at 0 °C in one hour. What is the coefficient of

performance of the refrigerator if its power input is 300 W? Heat of fusion for water is 333 kJ/kg.

a. 2.2 b. 7.7 c. 6.0 d. 1.7 e. 1.2

Q16. A piece of metal at 80 °C is placed in 1.2 kg of water at 72 °C. The system is thermally isolated and reaches to a final temperature of 75 °C. Find the change in entropy for the metal. The specific heat of water is 4.19 kJ/kgK.

a. – 43.0 J/K b. + 43.0 J/K c. – 200 J/K
d. – 194 J/K e. + 194 J/K

Q17. Two moles of an ideal gas undergo an adiabatic free expansion from an initial volume of 0.60 L to 1.2 L. Calculate the change in entropy of gas.

a. + 12 J/K b. – 24 J/K c. + 24 J/K
d. – 12 J/K e. Zero

Q18. An ideal Carnot heat engine operates between 40 ºC and 300 ºC. If the engine absorbs heat at a rate of 40 kW, at what rate does it exhaust heat?

a. 22 kW b. 5.3 kW c. 73 kW
d. 300 kW e. 35 kW

Q19. An ideal refrigerator has a coefficient of performance of 5. If the temperature inside the refrigerator is –20 ºC, what is the temperature at which it releases heat?

a. 31 ºC **b. -5 ºC** c. 20 ºC
d. 27 ºC e. 42 ºC

Q20. The efficiency of a car engine is 20% when the engine does 1.2 kJ of work per cycle. What is the energy $|Q_L|$ the engine loses per cycle as heat?

a. 4.8 kJ b. 1.2 kJ c. 6.1 kJ
d. 3.1 kJ e. 7.0 kJ

Q21. The freezing compartment of a Carnot refrigerator is at 269 K while outside air in the room is at 298 K. If the power of refrigerator motor is 150 W, what is maximum amount of energy that can be extracted as heat from the freezing compartment in 10.0 min?

a. 8.35×10^5 J b. 4.72×10^5 J c. 2.16×10^5 J
d. 5.04×10^5 J e. 3.51×10^5 J

Q22. Calculate the change in entropy of 1.0 kg of ice at 0.0 °C when its temperature is increased to 20.0 °C [L_f = 333 kJ/kg; c_w = 4190 J/kg.K]

a. 1.5×10^3 J/K b. 2.9×10^3 J/K
c. 5.2×10^3 J/K d. 4.1×10^3 J/K
e. 3.2×10^3 J/K

Q23. A 5.00 mol sample of an ideal gas expands reversibly and isothermally at 355 K until its volume doubled. What is the change in entropy of the gas?

a**. 28.8 J/K** b. 80.0 J/K c. 11.0 J/K
d. 70.5 J/K e. 50.9 J/K

Q24. A heat engine operates between 200K and 100K. In each cycle it takes 100 J of heat from the hot reservoir, loses 25 J of heat to the cold reservoir, and does 75 J of work. This heat engine VIOLATES:

a. The second law but not the first law of thermodynamics
b. The first law but not the second law of thermodynamics
c. Both the first and second laws of thermodynamics
d. Neither the first law nor the second law of thermodynamics
e. Cannot answer without knowing the mechanical equivalent of heat.

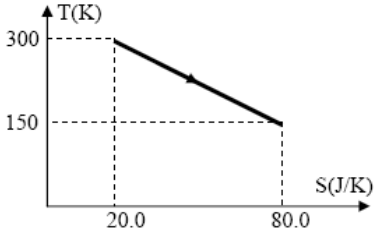
Q25. An ideal (Carnot) refrigerator has a coefficient of performance equal to 5.0. If the temperature inside the refrigerator is −20 ºC, what is the temperature at which heat is rejected?

a. 31 ºC b. 20 ºC c. − 45 ºC d. 16 ºC e. −20 ºC

Q26. Calculate the change in entropy when 10.0 g of ice at −10.0 ºC is heated until it completely melts.

a. 13.0 J/K b. 12.3 J/K c. 10.5 J/K
d. 15.0 J/K e. 20.1 J/K

Q27. 2.0 moles of an ideal monatomic gas undergo the reversible process shown in the **Figure**. How much energy is absorbed as heat by the gas during this process?



a. 13.5 kJ
b. 12.0 kJ c. 10.6 kJ
d. 14.1 kJ e. 21.5 kJ

Q28. A heat pump delivers heat to a room at the rate of 34 kJ per second and maintains the room at a temperature of 293 K when the outside temperature is 229 K. The power requirement for the heat pump under these operating conditions is :

a. 7.4 kW b. 13 kW c. 6.0 kW
d. 15 kW e. 5.6 kW

Q29. Which of the following is TRUE?

a. The thermal efficiency of a heat engine is always less than one.
b. The thermal efficiency of a Carnot engine can be greater than one.
c. The coefficient of performance of a heat pump cannot be greater than one.
d. For an irreversible process the change in entropy of a system and its surroundings is equal to zero.
e. For any reversible process the change in entropy of a system and its surroundings is greater than zero.