CM3230
Chemical Engineering Thermodynamics
Fall 2016
Quiz 2a

Name: ____

(Circle only one answer for each item. Each item is worth 20 points. Answer 5 items correctly for full 100 points. If all 6 items are correct, then a bonus of 20 points will be awarded.)

1. Ideal gas having heat capacity c_P is passed through a throttle (isenthapic process) where the inlet pressure P_{in} is reduced to $P_{out} = \left(\frac{1}{5}\right) P_{in}$ at a rate of $\dot{n}$ (moles/sec). Then the rate of change in entropy of the universe for the throttling process is given by
   a. $\Delta\dot{S}_{univ} = \dot{n}R\ln(1/5)$
   b. $\Delta\dot{S}_{univ} = \dot{n}R\ln(5)$
   c. $\Delta\dot{S}_{univ} = \dot{n}(c_P - R)\ln(1/5)$
   d. None of the above

2. A Carnot engine using an ideal gas of molar heat capacity $c_P$takes in heat of the amount $|Q_H|$ per cycle from a hot reservoir having a temperature T_H and later releases heat to a cold reservoir having a temperature T_C. The net work done by the engine per cycle will then be given by
   a. $w_{by,net} = \frac{T_C}{T_H}|Q_H|$
   b. $w_{by,net} = \left(1 - \frac{T_C}{T_H}\right)|Q_H|$
   c. $w_{by,net} = |Q_H|T_H/(T_H - T_C)$
   d. None of the above

3. A rigid insulated vessel contains three compartments of equal volume separated by two membranes. Compartment 1 contains 2 mole of compound A. Compartment 2 contains 1 mole of compound B. Compartment 3 contains 1 mole of compound C. All three compounds behave as ideal gases and are initially at the same temperature. After the separating membranes rapture, all the gases mixes completely. The total change in entropy of the universe for the process is then
   a. $\Delta S_{univ} = 2R\ln(6/4) + R\ln(3/4) + R\ln(3/4)$
   b. $\Delta S_{univ} = -R\ln(1/4)$
   c. $\Delta S_{univ} = 4R\ln(3)$
   d. None of the above

4. A cold incompressible liquid of solution A of molar heat capacity $c_{P,A} = \gamma R$ flows through a heat exchanger and raises its temperature from an inlet temperature of T_{in} to an outlet temperature of $T_{out} = (1 + \alpha^2)\, T_{in}$ and an inlet pressure of P_{in} to an outlet pressure $P_{out} = (1 - \epsilon^2) P_{in}$. Then the change in molar entropy for the liquid is
   a. $\Delta s = R \ln([1 + \alpha^2]^\gamma / [1 - \epsilon^2])$
   b. $\Delta s = R \ln(1 + \alpha^2)^\gamma$
   c. $\Delta s = R(\gamma \ln(1 + \alpha^2) + \ln(1 - \epsilon^2))$
   d. None of the above

5. One mole of saturated vapor product stream at temperature T of quality x_1 is cooled down with further partial condensation as it pass through a pipe (i.e. no shaft work) with a surrounding temperature $T_{surr}$and exits with a quality $x_2 = \alpha x_1$ where $0 < \alpha < 1$. If the molar heat of vaporization of the product stream is given by Δh_{vap}, then the change in entropy of the surroundings is given by
   a. $\Delta S_{surr} = \alpha\, x_1 \Delta h_{vap} / (T_{surr} - T)$
   b. $\Delta S_{surr} = [1/(1 - \alpha)]\, x_1\, \Delta h_{vap} / T_{surr}$
   c. $\Delta S_{surr} = (\alpha - 1) x_1 \Delta h_{vap} / T_{surr}$
   d. None of the above

6. An ideal gas with molar heat capacity $c_V = 3R\backslash 2$ undergoes a process that changes it initial condition of T_i and P_i to a final condition $T_f = 1.5\, T_i$ and $P_f = 0.8\, P_i$. Then the molar change in entropy of the gas is closest to (within $\pm$ 5%) (Hint: $c_P = c_V + R$)
   a. $\Delta s = 5.23\, J/(mol \cdot K)$
   b. $\Delta s = 6.91\, J/(mol \cdot K)$
   c. $\Delta s = 10.3\, J/(mol \cdot K)$
   d. None of the above