CM3230
Chemical Engineering Thermodynamics
Fall 2015
Quiz 1a

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. A rigid insulated vessel contains two compartments separated by an impermeable membrane. On one compartment is an ideal gas at $P_i = 4.5\ bar$ occupying one compartment of the vessel. The other compartment is a vacuum and has a volume $V_{vac} = 2\ m^3$. After the membrane ruptures, the whole vessel settles to $P_f = 1.5\ bar$ and $T_f = 40°C$. The total volume is closest to
   a. $V = 1.5\ m^3$
   b. $V = 3.0\ m^3$
   c. $V = 6.0\ m^3$
   d. None of the above

2. At $T = 200°C$ and $P = 15.54\ bar$, saturated steam has specific volumes of liquid and vapor given by $\hat{v}_l = 0.0012\ m^3/kg$ and $\hat{v}_v = 0.1274\ m^3/kg$, respectively. Also, the specific internal energies of liquid and vapor are given by $\hat{u}_l = 740.16\ kJ/kg$ and $\hat{u}_v = 2580.2\ kJ/kg$, respectively. If wet steam at $200°C$ has a specific volume of $\hat{v} = 0.08954$, the specific internal energy of the wet steam is closest to
   a. $\hat{u} = 1310\ kJ/kg$
   b. $\hat{u} = 1720\ kJ/kg$
   c. $\hat{u} = 2030\ kJ/kg$
   d. None of the above

3. Wet steam of quality $x_{in} = 0.60$ at $P_{in} = 50\ bars$ is fed through a throttle and exits at $P_{out} = 1\ bar$. Saturated steam at $P_{in} = 50\ bars$ has specific enthalpy of liquid and vapor given by $\hat{h}_{l,in} = 1154\ kJ/kg$ and $\hat{h}_{v,in} = 2794\ kJ/kg$, respectively. Saturated steam at $P_{out} = 1\ bar$ has specific enthalpy of liquid and vapor given by $\hat{h}_{l,out} = 417.4\ kJ/kg$ and $\hat{h}_{v,out} = 2676\ kJ/kg$, respectively. The quality of the steam coming out of the throttle is closest to
   a. $x_{out} = 0.38$
   b. $x_{out} = 0.76$
   c. $x_{out} = 1.0$
   d. None of the above

4. Ten moles of an ideal gas initially at T_i undergoes an adiabatic compression from a volume V_i to a volume $V_f = 0.5\,V_i$. Assuming $c_v = R/2$, the ratio of final to initial temperature (in K) will be given by
   a. $T_f/T_i = 0.25$
   b. $T_f/T_i = 2.51$
   c. $T_f/T_i = 4.00$
   d. None of the above

5. An ideal gas undergoes a cyclic process as follows. Starting at T_{hi} and v_{small}, it undergoes an isothermal expansion to $v_{large} = 2v_{small}$. Then it is cooled at constant volume to T_{lo}. After this, it is isothermally compressed back to v_{small}. Finally, it is heated at constant volume back to T_{hi} (see Figure 1 for the cycle). Let $c_v = 3/2R$ and $T_{hi} - T_{lo} = 100°C$, then the net molar heat supplied to the cycle is

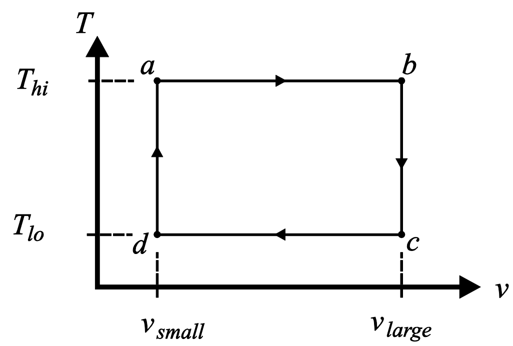

Figure 1. A cyclic process for an ideal gas.

   a. $q_{in} = (373\ K)R\ln(2)$
   b. $q_{in} = (100\ K)R\ln(2)$
   c. $q_{in} = -(200\ K)R\ln(2) + (300\ K/2)\ R$
   d. None of the above

6. An ideal gas with molar internal energy $u_{in} = 400\ kJ/mol$ is fed to a heat exchanger at a rate of $10\ mol/min$ and exits with a molar internal energy $u_{out} = 500\ kJ/mol$. If the rate of heat transferred to the gas is $\dot{q} = 2000\ kJ/min$, the change in temperature from inlet to outlet will be
   a. $\Delta T = T_{out} - T_{in} = \left(100\frac{kJ}{mol}\right)/R$
   b. $\Delta T = T_{out} - T_{in} = \left(200\frac{kJ}{mol}\right)/R$
   c. $\Delta T = T_{out} - T_{in} = \left(300\frac{kJ}{mol}\right)/R$
   d. None of the above