CM3230, Fall 2015
Quiz 3a
Name ______________________________

Answer 5 items for full 100 points. The 6th correct answer will be considered a 20 point bonus.

1. For an ideal gas undergoing an isentropic process, the rate of change in molar enthalpy h per change in molar volume v is given by
   a. $(\partial h/\partial v)_s = (c_p - c_v)T/v$
   b. $(\partial h/\partial v)_s = RT/v$
   c. $(\partial h/\partial v)_s = -(c_p/c_v)P$
   d. $(\partial h/\partial v)_s = [RTc_p]/[vc_v]$
   e. None of the above

2. An ideal vapor-refrigeration cycle (composed only of the evaporator, compressor, condenser and throttle) was found to have a coefficient of performance, $COP = 3$. Assuming the rate of work done by the compressor is $50\ MW$ on the refrigerant, the rate of heat removal from the refrigerant at the condenser section is given by
   a. $|\dot{Q}_H| = 150\ MW$
   b. $|\dot{Q}_H| = 200\ MW$
   c. $|\dot{Q}_H| = 250\ MW$
   d. $|\dot{Q}_H| = 300\ MW$
   e. None of the above

3. Assuming the gas with heat capacities c_p and c_v behaves according to the virial equation given by

$$Z = \frac{Pv}{RT} = 1 + Bv + Cv^2$$

   where B and C are constants. Then rate of change of pressure per change of molar volume for an isentropic expansion of the gas is given by

   a. $(\partial P/\partial v)_s = (c_p/c_v)RT([B/v] + C)$
   b. $(\partial P/\partial v)_s = (c_p/c_v)RT([1/v^2]\ln(Bv) + C)$
   c. $(\partial P/\partial v)_s = [(c_p - c_v) + R\ln(Bv + Cv^2)](T/v^2)$
   d. $(\partial P/\partial v)_s = (c_p/c_v)(RT/v)(C - [1/v^2])$
   e. None of the above

4. An important term that will be useful in analyzing multiphase system is the relationship between the change in (g/T) and the change in T along an isobaric process. Assuming heat capacities c_P and c_v, this is given by
   a. $[\partial(g/T)/\partial T]_P = (u - 2Pv)/T^2$
   b. $[\partial(g/T)/\partial T]_P = (c_P - c_v)/T$
   c. $[\partial(g/T)/\partial T]_P = -h/T^2$
   d. $[\partial(g/T)/\partial T]_P = (R/T)\ln(c_P/c_v)$
   e. None of the above

5. Suppose a real gas was empirically modeled as follows:

$$Z = \frac{Pv}{RT} = \frac{A}{\alpha + \beta\sqrt{T}} + BP$$

   where α, β, A and B are constant parameters. Then the ratio of $[\partial T/\partial v]_P$ to $[\partial T/\partial P]_v$ is given by: (Hint: you can apply cyclic relationship)

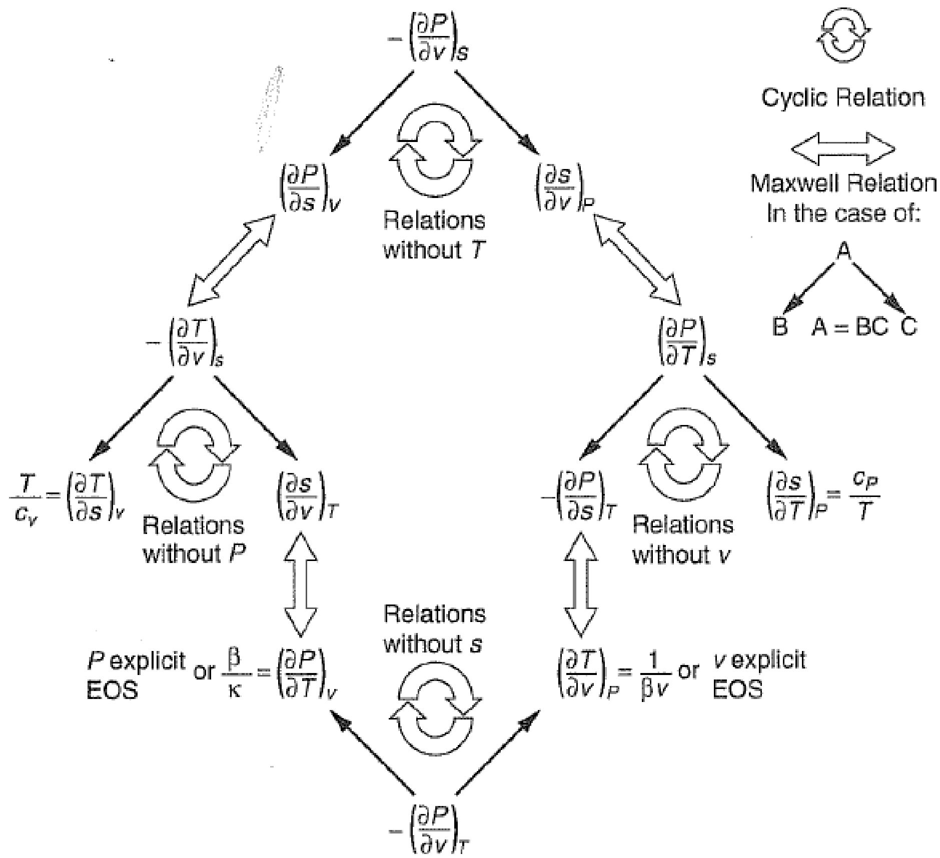
   a. $\frac{[\partial T/\partial v]_P}{[\partial T/\partial P]_v} = BP^2/(Av)$
   b. $\frac{[\partial T/\partial v]_P}{[\partial T/\partial P]_v} = -(P/v)\left(\frac{A}{[\alpha+\beta\sqrt{T}]}\right)$
   c. $\frac{[\partial T/\partial v]_P}{[\partial T/\partial P]_v} = P/\,(v - BRT)$
   d. $\frac{[\partial T/\partial v]_P}{[\partial T/\partial P]_v} = \frac{AR}{v^2}\left(\frac{1}{\alpha+\beta\sqrt{T}} + \frac{\beta}{(\alpha+\beta\sqrt{T})^2\sqrt{T}}\right)\left(\frac{BT}{P}\right)$
   e. None of the above

6. For a reversible piston-cylinder process in which work done by the gas is equal to the heat input, we get a path in which internal energy remain constant. For this type of process, the increase in entropy per increase in volume for a gas obeying the Van der Waals equation of state,

$$\left(P + \frac{a}{v^2}\right)(v - b) = RT$$

   is given by

   a. $(\partial s/\partial v)_u = -P/T$
   b. $(\partial s/\partial v)_u = R/(v - b)$
   c. $(\partial s/\partial v)_u = (RT/(v - b) - a/v^2)(P/T)$
   d. $(\partial s/\partial v)_u = 0$
   e. None of the above



(Figure taken from M. Koretsky, "Engineering and Chemical Thermodynamics, 2nd Ed.", J. Wiley, 2013, p. 274)