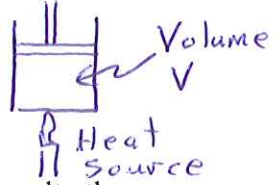# Assignment 3

1. Consider an isolated engine consisting of a gas occupying a volume V at atmospheric pressure. Heat of 10^5 Joules is added. Assuming the internal energy of the gas does not change,
   a) How much work is done on the gas?
   b) How much does the volume change assuming the pressure remains constant?

2. Integrate the following differential along paths 1 and 3. Why or why not are the results the same?

$$dG = 3xy\, dx + x^2\, dy$$
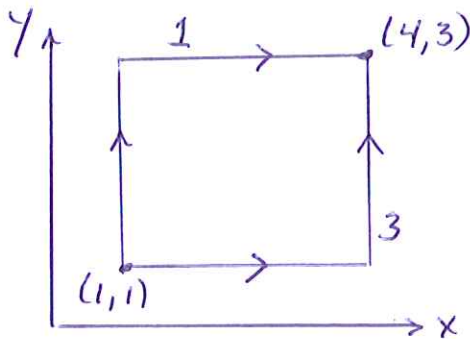
3. Which of the following are exact differentials?

   a) $-y \sin x\, dx + \cos x\, dy$

   b) $y x^3 e^x dx + x^3 e^x dy$

   c) $(1 + x) y e^x dx + x e^x dy$

   d) $4x^3 y^{-2}\, dx - 2x^4 y^{-3}\, dy$

4. Phase Space
   a) One Dimensional Hydrogen Atom: How many quantum states are available to an electron confined to a 1 dimensional region 10^{-9} meters long and whose velocity is between -10^7 and 10^7 m/sec?
   b) How many quantum states are available to a human confined to a jail cell having a volume of 10^3 m^3 and whose maximum speed is 1 m/sec?

5. Show for photons that the density of states is given by

$$\frac{dn}{dE} = \frac{8\pi V}{h^3 c^3} E^2$$