Due Mon., Mar 19

2012 Heat and Thermo 11

1. Heat is added to a gas.
   A. Q for the gas is:
   B. Give one way that the gas could not change its temperature.
   C. * True or false and why: "A gas's temperature must decreases when it releases heat."

2. 5 kg of an unknown substance requires 60kJ to vaporize completely. What is the latent heat of vaporization for this substance?

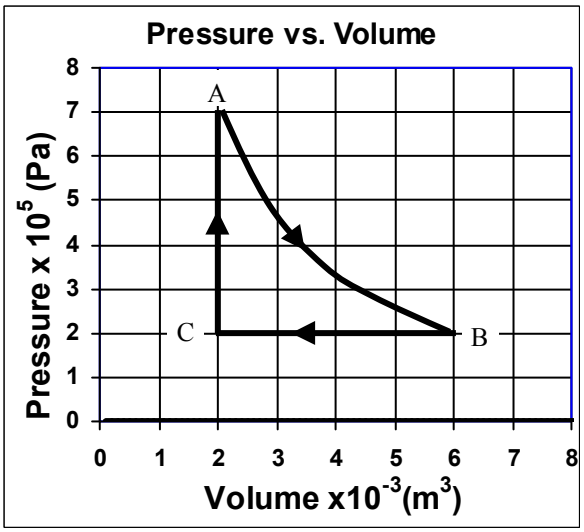
3. 350g of water at 15°C is placed inside a refrigerator. The water is cooled to 4°C in 12 minutes. 25 kJ of heat is dissipated into the room from the coils behind the refrigerator.
   A. Calculate the heat removed from the water.

   B. The heat you just calculated, is that Q_C or Q_H?
   C. Is 25kJ Q_C, Q_H, or W?
   D. Remembering that 1 kJ = 1000 J, how much work was done by the compressor?

   E. What is the efficiency of the refrigerator?

   F. What is the power used by the compressor during the 12 minutes?

The graph below is known as a "PV diagram" or a "Pressure/Volume diagram". Let's learn how to read it. Be sure to notice that the numbers on each axis are multiplied by a factor.



4. * What is the pressure at point A?
5. * What is the volume at point B?
6. As the gas moves from point B to point C the volume changes at constant pressure.
   A. Did the gas expand or contract?
   B. Is this + or − work done by the gas?
   C. Calculate the work done by the gas from B to C.

Actually point C is at a lower temperature than B. Since PV = nRT, if P stays the same and V decreases, then T must decrease, too.

7. Since the gas compresses from B to C and the temperature decreased,
   A. Is ΔU +, −, or 0? B. Is $W_{\text{by the gas}}$ +, −, or 0? C. Is Q +, −, or 0?

   D. Which is greater: the magnitude of Q or W?

8. * How much work is done from C to A?
   B and A are on a curved line known as an isotherm.
9. If B is at 350K, what is the temperature of A?
10. From A to B is an isothermal process.
    A. ΔU = +, −, or 0?
    B. Did the gas expand or contract from A to B?
    C. So is $W_{\text{by the gas}}$ +, −, or 0?
    D. Q = +, −, or 0?
    E. Which is greater: the magnitude of Q or W?

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2012 Heat and Thermo 11

1. Heat is added to a gas.
   A. Q for the gas is: +
   B. Give one way that the gas could not change its temperature. let it expand.
   C. * True or false and why: "A gas's temperature must decreases when it releases heat."

1C: false. You could do work on it.

2. 5 kg of an unknown substance requires 60kJ to vaporize completely. What is the latent heat of vaporization for this substance?
   $Q = mL_v \quad L_v = \frac{Q}{m} = \frac{60\,kJ}{5\,kg} = 12\,kJ/kg$

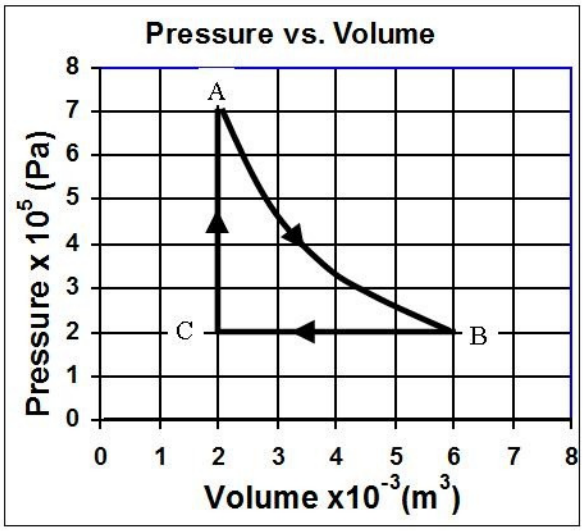
2. See "Latent Heat" notes

3. 350g of water at 15°C is placed inside a refrigerator. The water is cooled to 4°C in 12 minutes. 25 kJ of heat is dissipated into the room from the coils behind the refrigerator.
   A. Calculate the heat removed from the water.
   $Q = mc_p\Delta T = .35(4186)(4-15) = -16,116\,J$

A.

   B. The heat you just calculated, is that Q_C or Q_H? inside frig.
   C. Is 25kJ Q_C, Q_H, or W? behind refrig is hotter
   D. Remembering that 1 kJ = 1000 J, how much work was done by the compressor?
   $Q_H = Q_c + W \quad W = Q_H - Q_c = 25\,kJ - 16\,kJ = 9\,kJ$
   E. What is the efficiency of the refrigerator?
   $eff = \frac{W}{Q_H} = \frac{9}{25} = 36\%$
   F. What is the power used by the compressor during the 12 minutes?
   $P = \frac{W}{t} = \frac{9\,kJ}{12(60)} = 12.5\,watts$

The graph below is known as a "PV diagram" or a "Pressure/Volume diagram". Let's learn how to read it. Be sure to notice that the numbers on each axis are multiplied by a factor.



4. * What is the pressure at point A? $7\times10^5\,Pa$
5. * What is the volume at point B? $6\times10^{-3}\,m^3$
6. As the gas moves from point B to point C the volume changes at constant pressure.
   A. Did the gas expand or contract?
   B. Is this + or − work done by the gas?
   C. Calculate the work done by the gas from B to C.
   $W_{by} = P\Delta V = 2\times10^5(-4\times10^{-3}) = -800\,J$

Actually point C is at a lower temperature than B. Since PV = nRT, if P stays the same and V decreases, T must also decrease.

7. Since the gas compresses from B to C and the temperature decreased,
   A. Is ΔU +, −, or 0? T went ↓ B. Is $W_{by\ the\ gas}$ +, −, or 0? compressed C. Is Q +, − or 0?
   D. Which is greater: the magnitude of Q or W? see right →

since $\Delta U = Q + W$ (− = − + +)
Q must be neg to make up for the compression.

8. * How much work is done from C to A? 0 J. No change of volume.
   B and A are on a curved line known as an isotherm.
9. If B is at 350K, what is the temperature of A? 350 K – isotherm means isothermal = same T
10. From A to B is an isothermal process.
    A. ΔU = +, −, or 0? again; isothermal. if $\Delta T = 0$, then $\Delta U = 0$
    B. Did the gas expand or contract from A to B? expand
    C. So is $W_{by\ the\ gas}$ +, −, or 0? and the gas wants to lose T
    D. Q = +, −, or 0?
    E. Which is greater: the magnitude of Q or W? same $\Delta U = Q + W \quad 0 = - + +$ they must balance