Chapter 12 HW

Chapter 12-- 24, 25, 27, 28, 32, 42, 43, 45

Problem 24

0.1mol of gas, 50 cm^3, 20C, P?

.1mol of gas, $50 \text{ x} 10^{-6}\, m^3$, 293K (note that NIST recently declared that we don't need to use the degree symbol when denoting temperature so I'm not being lazy)

First we must solve for the initial pressure. Remember that the gas laws are path independent so we must know where we are starting from.

$$P = \frac{n R T}{V} = \frac{(0.1 \text{ mol})(8.3)(293\, K)}{50 \text{ x} 10^{-6}\, m^3} = 4.87 \text{ x} 10^6 \text{ Pa} = 48 \text{ atm}$$

$$P_f V_f = P_i V_i$$

$$P_f = \frac{P_i V_i}{V_f} = \frac{(4.87 \text{ x} 10^6 \text{ Pa})(50 \text{ x} 10^{-6}\, m^3)}{200 \text{ x} 10^{-6}\, m^3} = 1.2 \text{ x} 10^6 \text{ Pa} = 12 \text{ atm}$$

Problem 25

part a.

This process keeps volume constant. This is referred to as isovolumetric or isochoric.

part b.

$$\text{T}=\frac{\text{PV}}{\text{nR}} = \frac{(3 \text{ x} 10^5 \text{ Pa})(100 \text{ x} 10^{-6}\, m^3)}{(0.004 \text{ mol})(8.3)} = 914\, K$$

$$\frac{P_i}{T_i} = \frac{P_f}{T_f}$$

$$T_f = P_f \frac{T_i}{P_i} = \frac{(3 \text{ x} 10^5 \text{ Pa})}{10^5 \text{ Pa}} 914\, K = 300\, K$$

Problem 27

part a.

isobaric (constant pressure)

part b.

rearranging the ideal gas equation once again:

$$T_f = V_f \frac{T_i}{V_i} = \frac{(100 \text{ x} 10^{-6}\, m^3)}{300 \text{ x} 10^{-6}\, m^3} 1173\, K = 391\, K$$

part c.

$n=\frac{PV}{RT}=\frac{(3\,x10^5\,\text{Pa})(100\,x10^{-6}\,m^3)}{(391\,K)(8.3)}=9.4\,x10^{-3}\,\text{mol}$

Problem 28

For this problem we simply want the areal under the curve. Since the curve is a horizonal line $W=\text{P}\Delta\text{V}=-(2\,x10^5\,\text{Pa})(200\,x10^{-6}\,m^3)=-40\,J$

Problem 32

The specific heat of mercury is c=140J/(kg*K)

The specific heat of water is c=4190J/(kg*K)

part a.

Q=mcΔT

$\Delta\text{T}=\frac{100\,J}{(0.02\,\text{kg})\,(140\,J/(\text{kg}*K))}$=35.7K=35.7C

part b.

Now we are solving for Q

Q=mcΔT=(0.02 kg) (4190 J/(kg*K))(35.7K)=3000J

Guys note that this is a general property of metals: it doesn't take much to heat them up or cool them down. Water now. It takes longer to boil water than to get your stovetop to the several hundred degrees necessary to boil that water, right? A lot longer.

Problem 42

part a.

$Q=\text{nC}_p\Delta\text{T}$

so now that we are counting with moles instead of mass we must have different units for c. Be carefull!

c=29.2J/(mol K)

n=1.0g/32g/mol=0.03125mol where we have divided 1g by the mass per mol of O_2

Q=(0.03125mol)(29.2J/(mol K))(100K)=91.2J

part b.

for an isovolumetric process c=20.9J/(mol K)

$Q=\text{nC}_v\Delta\text{T}$

we are solving for ΔT

$\Delta T = Q/(\text{nC}_v) = \frac{91.2\,J}{(0.03125\text{ mol})\,(20.9\,J/(\text{mol}\,K))} = 140\,K = 140\,C$

Problem 43

part a.

This problem in theory is poorly defined since either pressure or volume could be held constant. However, in practice it's a lot easier to hold volume constant so using our trusty $Q = \text{nC}_v\Delta\text{T}$.

Where the change in total energy is Q when W=0. W=0 for systems whose volume does not change.

I looked up the specific heat of a monoatomic gas.

$\frac{1\,J}{((1\text{ mol})\,(12.5\,J/(\text{mol}\,K)))} = 0.08\,K$

part b.

For a diatomic gas $C_v = 20.8\,J/(\text{mol}\,K)$

$\frac{1\,J}{((1\text{ mol})\,(20.8\,J/(\text{mol}\,K)))} = 0.048\,K$

Problem 45

The work done in the cycle is the area under each curve. The purely vertical leg makes no contribution to the work. The slanted curve is negative work done by the gas. This negative work is smaller than the positive work done by the horizontal (isobaric) curve. So the negative work cancels with part of the positive work. The work that is not canceled out is the area within the triangle in the diagram.

$W = A_{\text{triangle}} = \frac{1}{2}\left(400\text{ x}10^{-6}\,m^3\right)\left(2\text{ x}10^5\text{ Pa}\right) = 41\,J$