A.P. Physics 2 / Mr. Forrest Name: Forrest

Ch. 12 Conceptual Questions

1. If you double the temperature of a gas,

a. Does the root-mean-square speed of the atoms increase by a factor of $(2)^{1/2}$, 2, or 2^2? Explain.

$T \propto KE \propto \frac{1}{2} K_B (V_{rms})^2$ Doubling the temperature doubles the energy which increases the speed by $2^{1/2}$.

b. Does the average kinetic energy of the atoms increase by a factor of $(2)^{1/2}$, 2, or 2^2? Explain.

By a factor of 2, since KE_{avg} is directly proportional to the temperature

2. Suppose you could suddenly increase the speed of every atom in a gas by a factor of 2.

a. Would the rms speed of the atoms increase by a factor of $(2)^{1/2}$, 2, or 2^2? Explain.

By a factor of 2 (V_{rms} is a measure of average speed)

b. Would the thermal energy of the gas increase by a factor of $(2)^{1/2}$, 2, or 2^2? Explain.

By 2^2 since $U_{Th} \propto \frac{1}{2} M (V_{rms})^2$

c. Would the temperature of the gas increase by a factor of $(2)^{1/2}$, 2, or 2^2? Explain.

By 2^2 since it's directly related to the thermal energy.

3. Lithium vapor, which is produced by heating lithium to a relatively low boiling point of 1340°C, forms a gas of Li_2 molecules. Each molecule has a molecular mass of 14 u. The molecules in nitrogen gas (N_2) have a molecular mass of 28 u. If the Li_2 and N_2 gases are at the same temperature, which of the following is true? (Circle the letter.)

a. v_{rms} of $N_2 = 2.00 \times v_{rms}$ of Li_2.
b. v_{rms} of $N_2 = 1.41 \times v_{rms}$ of Li_2.
c. v_{rms} of $N_2 = v_{rms}$ of Li_2.
d. v_{rms} of $N_2 = 0.71 \times v_{rms}$ of Li_2.
e. v_{rms} of $N_2 = 0.50 \times v_{rms}$ of Li_2.

Explain.

The answer has to be d or e since N_2 is more massive!

Same temperature means the same energy

So $\left(\frac{1}{2}\right)(14)(V_{Lithium})^2 = \frac{1}{2}(28)(V_{nitrogen})^2$

$0.5 = \frac{V_{nitrogen}^2}{V_{Lithium}^2}$

$\frac{1}{\sqrt{2}} = \frac{V_{Nitrogen}}{V_{Lithium}}$

4. Consider an ideal gas contained in a confined volume. How would the pressure of the gas change if

a. the number of molecules of the gas were doubled, without changing the container or the temperature?

Pressure would double!

$PV = nRT$

~~$P_1V_1 = P_2V_2$~~

$\text{Constant} = \frac{P_1}{n_1} = \frac{P_2}{n_2}$

b. the volume of the container was doubled, without changing the number of molecules or the temperature?

$PV = nRT$

$\text{Constant} = P_1V_1 = P_2V_2$

~~Pressure~~ pressure would be halved.

c. the temperature (in K) of the gas was doubled, without changing the number of molecules or the volume of the container?

$PV = nRT$

$\frac{P}{T} = \frac{nR}{V} = \text{Constant}$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (so pressure will double)

d. the rms speed of the molecules was doubled, without changing the number of molecules or the volume of the container?

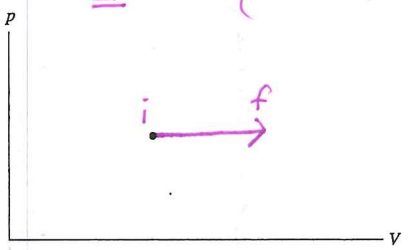
$K = \frac{1}{2}m(v_{rms})^2$; so double the v_{rms} = 4x the KE, 4x the temperature.

So $PV = nRT$, $\frac{V}{nR} = \text{constant}$

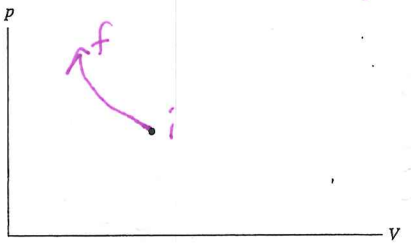
So $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (4x the pressure!)

5) Starting from the point shown, draw a pV diagram for the following processes.

a. An isobaric process in which work is done *by* the system. (constant pressure)

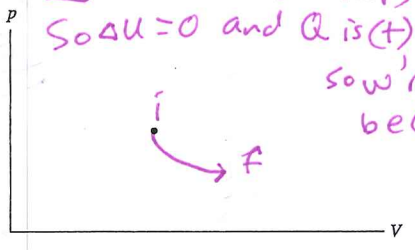


b. An adiabatic process in which work is done *on* the system. (no Q)

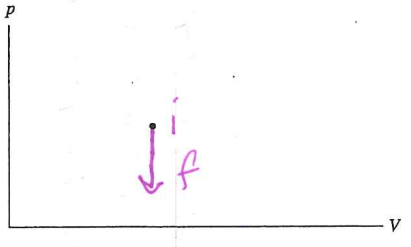


c. An isothermal process in which heat is *added to* the system. (same temp)

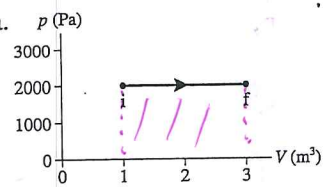
So $\Delta U = 0$ and Q is (+) so W must be (−)



d. A constant-volume process in which heat is *removed from* the system. (V = Const)

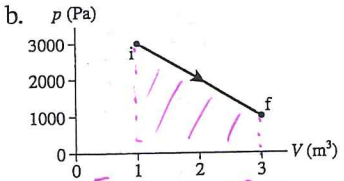


6) How much work is done on the gas in each of the following processes? Think area

a. 

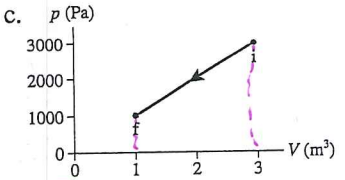
$-P\Delta V = -(3-1)(2000)$

$W = -4000$ J

b. 

$-[(1000 \times 2) + (\frac{1}{2}(3000-1000) \times 2)]$

$W = -4000$ J

c. 

$W = +4000$ J

6 D, E, F – Now answer the question if it were asking about work done *by* the gas.

$W_{gas} = +4000$ J

$W_{gas} = +4000$ J

$W_{gas} = -4000$ J