

Outline

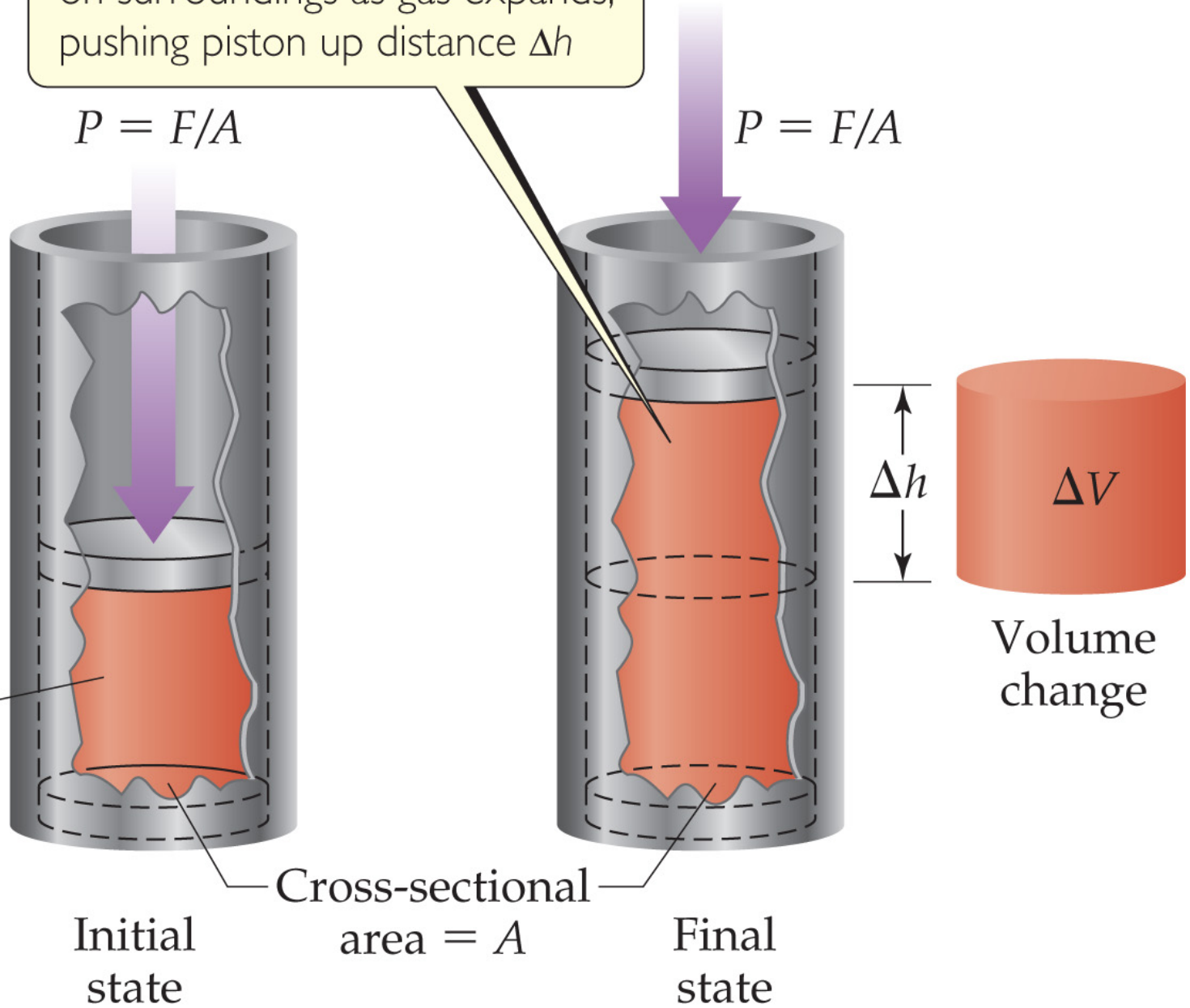
- Course details – web page
- Computers
- Lab announcements
 - Temperature vs. Heat
 - System and Surroundings
 - First Law – ΔH , ΔU , Q , work
 - Second Law - ΔS

System does work $w = -P\Delta V$ on surroundings as gas expands, pushing piston up distance Δh

$$P = F/A$$

$$P = F/A$$

Gas enclosed
in cylinder



Initial
state

Cross-sectional
area = A

Final
state

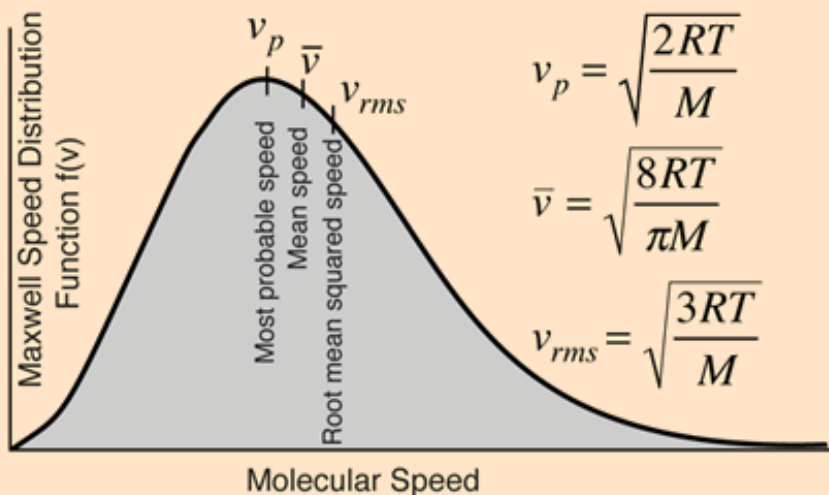
Volume
change

Maxwell Speed Distribution

The speed distribution for the molecules of an [ideal gas](#) is given by

$$f(v) = 4\pi \left[\frac{M}{2\pi RT} \right]^{\frac{3}{2}} v^2 \exp \left[\frac{-Mv^2}{2RT} \right]$$

From this function can be calculated several characteristic molecular speeds and such things as what fraction of the molecules have speeds over a certain value at a given temperature. It is involved in many rates of phenomena.



$$v_p = \sqrt{\frac{2RT}{M}}$$

$$\bar{v} = \sqrt{\frac{8RT}{\pi M}}$$

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

[Calculation](#)

Note that **M** is the molar mass and that the [gas constant R](#) is used in the expression. If the mass **m** of an individual molecule were used instead, the expression would be the same except that Boltzmann's constant **k** would be used instead of the molar gas constant **R**.

[Why does the probability peak at some finite value, when the average velocity is zero?](#)

[Development of Maxwell speed distribution from Boltzmann distribution](#)

[Some comments about developing the relationship](#)

[Index](#)

[Kinetic theory concepts](#)

Vitamin D Milk

Nutrition Facts

Serving Size 1 cup (236mL)

Amount Per Serving

Calories 150 **Calories from Fat** 70

% Daily Value*

Total Fat 8g **12%**

Saturated Fat 5g **25%**

Trans Fat 0g

Cholesterol 35mg **11%**

Sodium 125mg **5%**

Total Carbohydrate 12g **4%**

Dietary Fiber 0g **0%**

Sugars 12g

Protein 8g

Vitamin A 6% • Vitamin C 4%

Calcium 30% • Iron 0%

Vitamin D 25%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400g	2,400g
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Ingredients: Grade A Pasteurized Milk, Vitamin D3.



Average Single Bond Energies (kJ per mole)

	H	C	N	O	F	Si	P	S	Cl	Br	I
H	436	414	389	464	569	293	318	339	431	368	297
C		347	293	351	439	289	264	259	330	276	238
N			159	201	272		209		201	243	
O				138	184	368	351		205		201
F					159	540	490	285	255	197	
Si						176	213	226	360	289	
P							213	230	331	272	213
S								213	251	213	
Cl									243	218	209
Br										192	180
I											151

Average Multiple Bond Energies (kJ per mole)

N = N	418	C = C	611
N ≡ N	946	C ≡ C	837
N = O	590	C = O	803
C ≡ N	891	C = O	745
O = O	498	C ≡ O	1075

In CO₂ Only

TABLE 5.3 • Standard Enthalpies of Formation, ΔH_f° , at 298 K

Substance	Formula	ΔH_f° (kJ/mol)	Substance	Formula	ΔH_f° (kJ/mol)
Acetylene	$C_2H_2(g)$	226.7	Hydrogen chloride	$HCl(g)$	-92.30
Ammonia	$NH_3(g)$	-46.19	Hydrogen fluoride	$HF(g)$	-268.60
Benzene	$C_6H_6(l)$	49.0	Hydrogen iodide	$HI(g)$	25.9
Calcium carbonate	$CaCO_3(s)$	-1207.1	Methane	$CH_4(g)$	-74.80
Calcium oxide	$CaO(s)$	-635.5	Methanol	$CH_3OH(l)$	-238.6
Carbon dioxide	$CO_2(g)$	-393.5	Propane	$C_3H_8(g)$	-103.85
Carbon monoxide	$CO(g)$	-110.5	Silver chloride	$AgCl(s)$	-127.0
Diamond	$C(s)$	1.88	Sodium bicarbonate	$NaHCO_3(s)$	-947.7
Ethane	$C_2H_6(g)$	-84.68	Sodium carbonate	$Na_2CO_3(s)$	-1130.9
Ethanol	$C_2H_5OH(l)$	-277.7	Sodium chloride	$NaCl(s)$	-410.9
Ethylene	$C_2H_4(g)$	52.30	Sucrose	$C_{12}H_{22}O_{11}(s)$	-2221
Glucose	$C_6H_{12}O_6(s)$	-1273	Water	$H_2O(l)$	-285.8
Hydrogen bromide	$HBr(g)$	-36.23	Water vapor	$H_2O(g)$	-241.8