

[TP] How many electrons are there in the Lewis structure of HNO?

17% 1. 10
17% 2. 12
17% 3. 14
17% 4. 16
17% 5. Something else
17% 6. Not sure

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Response Counter 1 10

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Lecture 4 CH131 Summer 1 2021

Thursday, May 27, 2021

- Lewis diagrams
- Shapes and polarity of molecules

Begin ch9 (9.1—9.6): The gaseous state

- Gas properties: temperature, volume, amount, and pressure
- Gas behavior
- Ideal gas law

Next lecture: Continue ch9 (9.1—9.6)

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Lewis diagram of acetic acid, CH_3COOH

0. skeleton

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Lewis diagram of acetic acid, CH_3COOH

0. skeleton
1. e's we have = 4 + 8 + 12 = 24
2. e's needed: 8 + 32 = 40
3. e's shared single
   = needed – have = 40 – 24 = 16

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Lewis diagram of acetic acid, CH_3COOH

0. skeleton
1. e's we have = 4 + 8 + 12 = 24
2. e's needed: 8 + 32 = 40
3. e's shared single = needed – have = 40 – 24 = 16
4. e's shared multiple = shared single – shared = 16 – 14 = 2
5. e's unshared lone = have – shared = 24 – 16 = 8

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Lewis diagram of acetic acid, CH_3COOH

0. skeleton
1. e's we have = 4 + 8 + 12 = 24
2. e's needed: 8 + 32 = 40
3. e's shared single = needed – have = 40 – 24 = 16
4. e's shared multiple = shared single – shared = 16 – 14 = 2
5. e's unshared lone = have – shared = 24 – 16 = 8
6. formal charge determines "best" place for shared double pair

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[TP] How many electrons are there is the Lewis structure of HNO?

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Response Counter 10

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Formal charge determines "best" structure

41. Determine the formal charges on all the atoms in the following Lewis diagrams.

H—N̈=Ö and H—Ö=N̈

Which one would best represent bonding in the molecule HNO?

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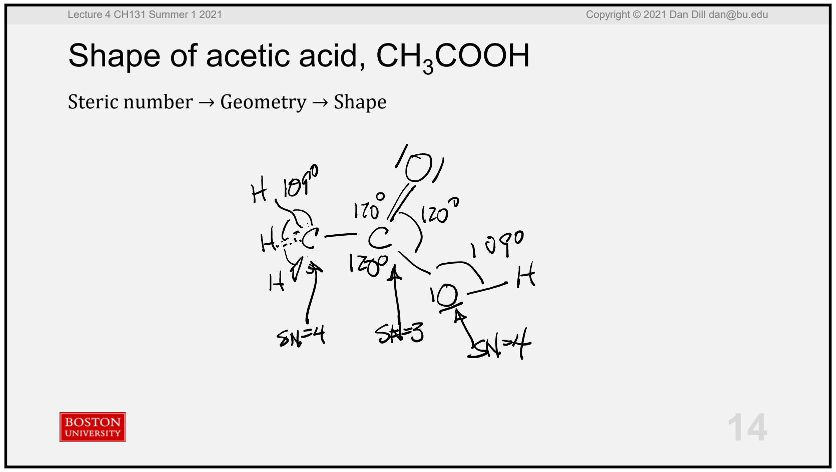
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Shape of acetic acid, CH_3COOH
Steric number → Geometry → Shape
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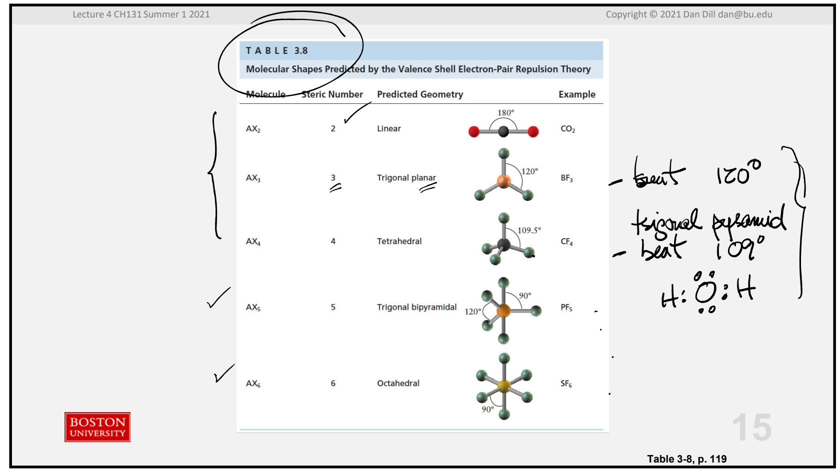
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TABLE 3.8
Molecular Shapes Predicted by the Valence Shell Electron-Pair Repulsion Theory
Molecule | Steric Number | Predicted Geometry | Example
AX_2 | 2 | Linear | CO_2
AX_3 | 3 | Trigonal planar | BF_3
AX_4 | 4 | Tetrahedral | CF_4
AX_5 | 5 | Trigonal bipyramidal | PF_5
AX_6 | 6 | Octahedral | SF_6
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Table 3-8, p. 119

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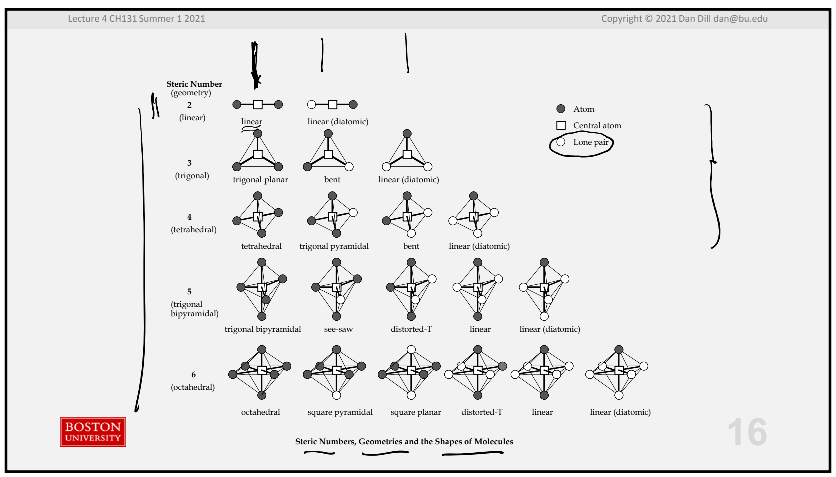
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Steric Number (geometry)
2 (linear)
3 (trigonal)
4 (tetrahedral)
5 (trigonal bipyramidal)
6 (octahedral)
linear
linear (diatomic)
trigonal planar
bent
linear (diatomic)
tetrahedral
trigonal pyramidal
bent
linear (diatomic)
trigonal bipyramidal
see-saw
distorted-T
linear
linear (diatomic)
octahedral
square pyramidal
square planar
distorted-T
linear
linear (diatomic)
Atom
Central atom
Lone pair
Steric Numbers, Geometries and the Shapes of Molecules
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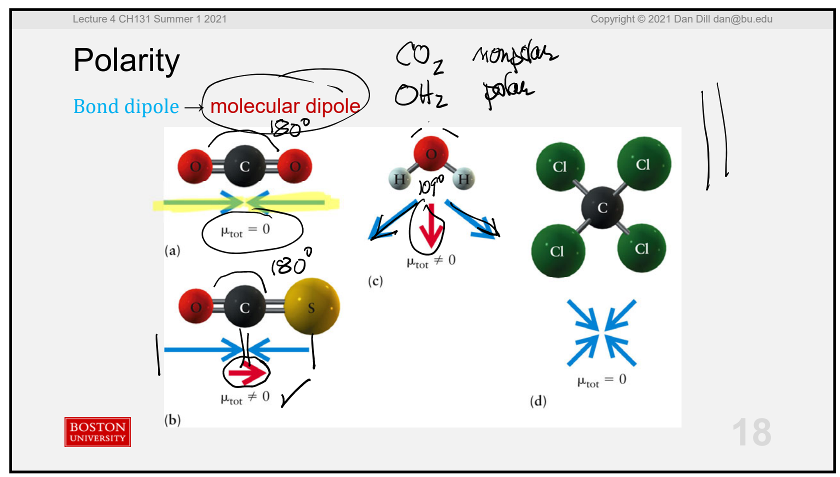
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Polarity
Bond dipole → molecular dipole
(a)
$\mu_{tot} = 0$
(b)
$\mu_{tot} \neq 0$
(c)
$\mu_{tot} \neq 0$
(d)
$\mu_{tot} = 0$
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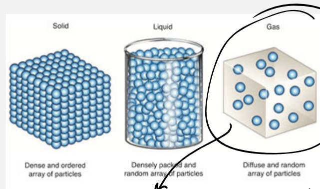
Gases

The particles of solids are close together in orderly arrangement.

The particles of liquids are close together but able to move about.



The particles of gases are about 10 times farther apart than those of solids or liquids.

about 10 times farther apart than right next

Since particles need to be close together to "sense" one another (by electron wave overlap), particles of gases move freely.

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Gas properties

Gases are characterized by the following:

- the temperature (T) of the gas, a measure of how fast their particles are moving;
- the volume (V) of the container;
- the number of moles (n) of particles enclosed in the container;
- and, the pressure (P) exerted by the particles on the walls of the container.

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Gas pressure

Pressure is the force exerted on the walls of the container, per unit area.

$$P = \frac{\text{force}}{\text{area}} = \frac{\text{energy/distance}}{\text{area}} = \frac{\text{energy}}{\text{volume}}$$

The standard unit of energy is Joule and of volume is cubic meter (m^3) and the corresponding unit of pressure is the Pascal,

$$1\ \text{Pa} = 1\,\frac{\text{J}}{\text{m}^3}$$

Atmospheric pressure is close to exactly 100,000 Pa, known as 1 bar.

The historical unit of pressure is 1 atm, slightly larger than 1 bar.

1 atm = 1.01325 bar (exactly)

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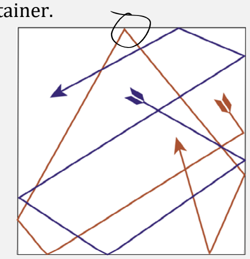
Gas behavior

Let's explore how a gas is affected by changes in T, V, n, and P.

Doing this, visualize gases as collections of widely separated particles, moving faster as temperature increases, generating pressure as a result of collisions with the walls of the container.



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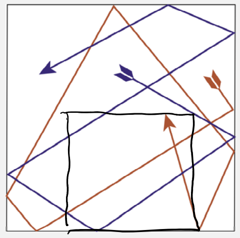
[TP] A container is filled with gas A. At 20°C the volume of the container is V. If V is decreased, then the pressure P exerted by the gas on the walls of the container ...

- 0% 1. goes down
- 0% 2. stays the same
- 100% 3. goes up
- 0% 4. further information needed



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Gas behavior

If V is decreased, then the particles travel less far between collisions with the walls, and so collide with the walls more often, generating greater pressure.

We can express this as P being inversely proportional to V,

$P = c(T, n) 1/V$

Let's explore next how the constant of proportionality, $c(T, n)$, depends on the number of particles (the number of moles n).

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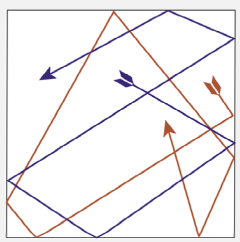
[TP] When more particles are added to the same V at the same T, the pressure ...

- 0% 1. goes down
- 0% 2. stays the same
- 100% 3. goes up
- 0% 4. further information needed



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Gas behavior

When more particles are added to the same V at the same T, there will be more collisions with the walls, and so the pressure must go up.

We can express this as P being proportional to n,

$P = c'(T) n/V$

Let's explore next how the constant of proportionality, $c'(T)$, depends on the temperature, T.

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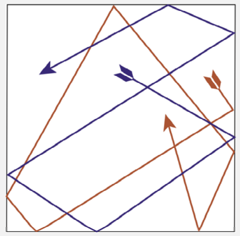
[TP] Heating a gas at constant V, and constant number of moles n, the pressure ...

0%	1.	goes down
0%	2.	stays the same
100%	3.	goes up
0%	4.	further information needed



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Gas behavior

Heating a gas at constant V, the particles will move faster, so collide with the wall more often, and so the pressure must go up.

We can express this as P being proportional to T,

$P = c''nT/V$

In this expression temperature is measured in Kelvin,

T (in K) = t (in °C) + 273.15

$T = 0$ K is the temperature at which particles would not be moving at all and so would not exert any pressure.

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Ideal gas law

In the expression $P = c''nT/V$, the remaining constant of proportionality, c'', is known as the gas constant R, $P = RnT/V$.

This expression is written as

$$PV = nRT$$

and it is known as the ideal gas law.

The adjective "ideal" signifies that this relation does not depend of what the gas particles are.

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