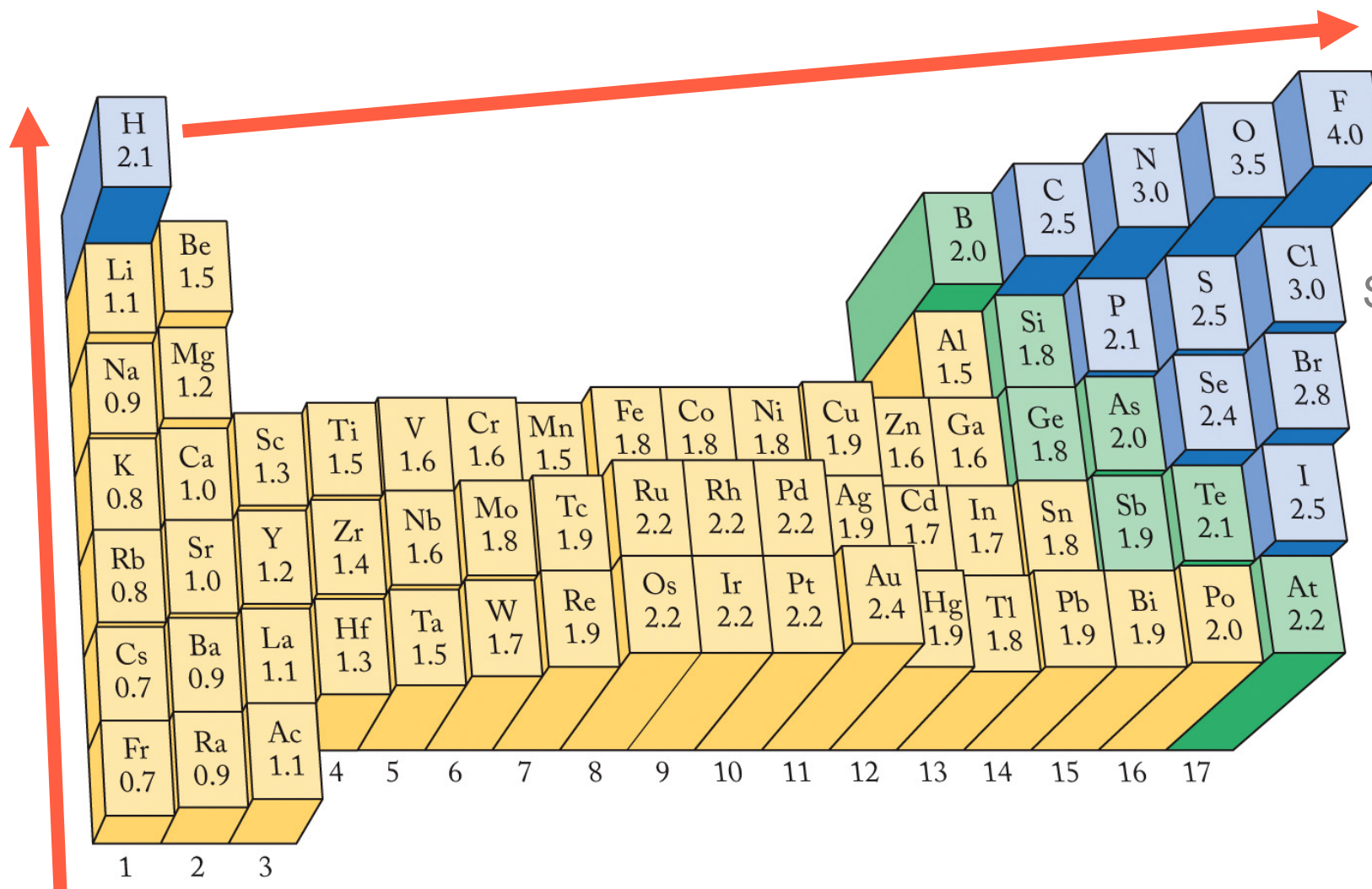# Polarity: Bonds & Molecules

DR. MIOY T. HUYNH

YALE UNIVERSITY

CHEMISTRY 161

FALL 2019

www.mioy.org/chem161

ELECTRONEGATIVITY (EN)
The ability for an atom to attract electrons to itself.
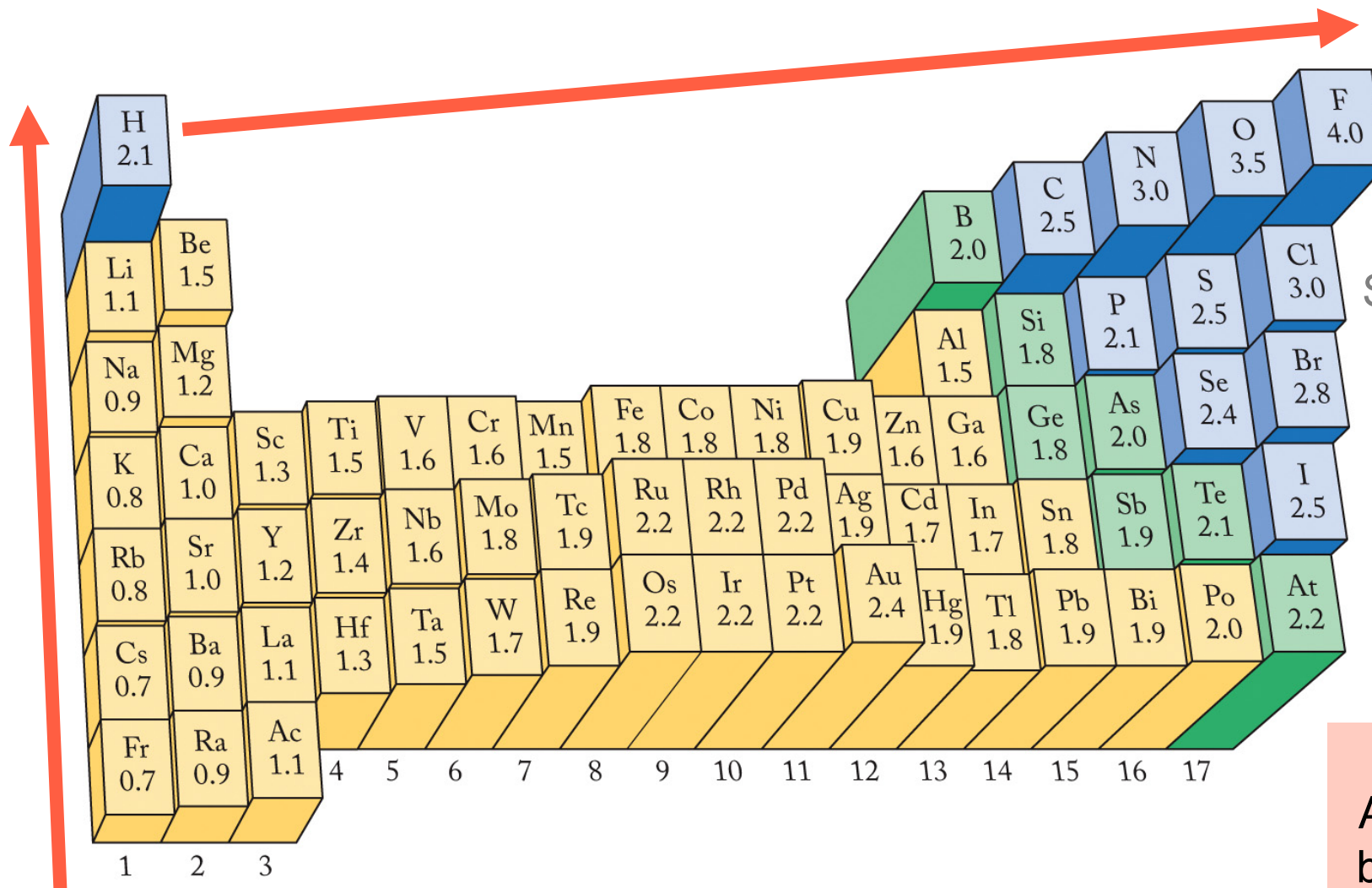

Same trend as ionization energy (IE)!

EN <u>decreases</u> down a column.
EN <u>increases</u> across a row.

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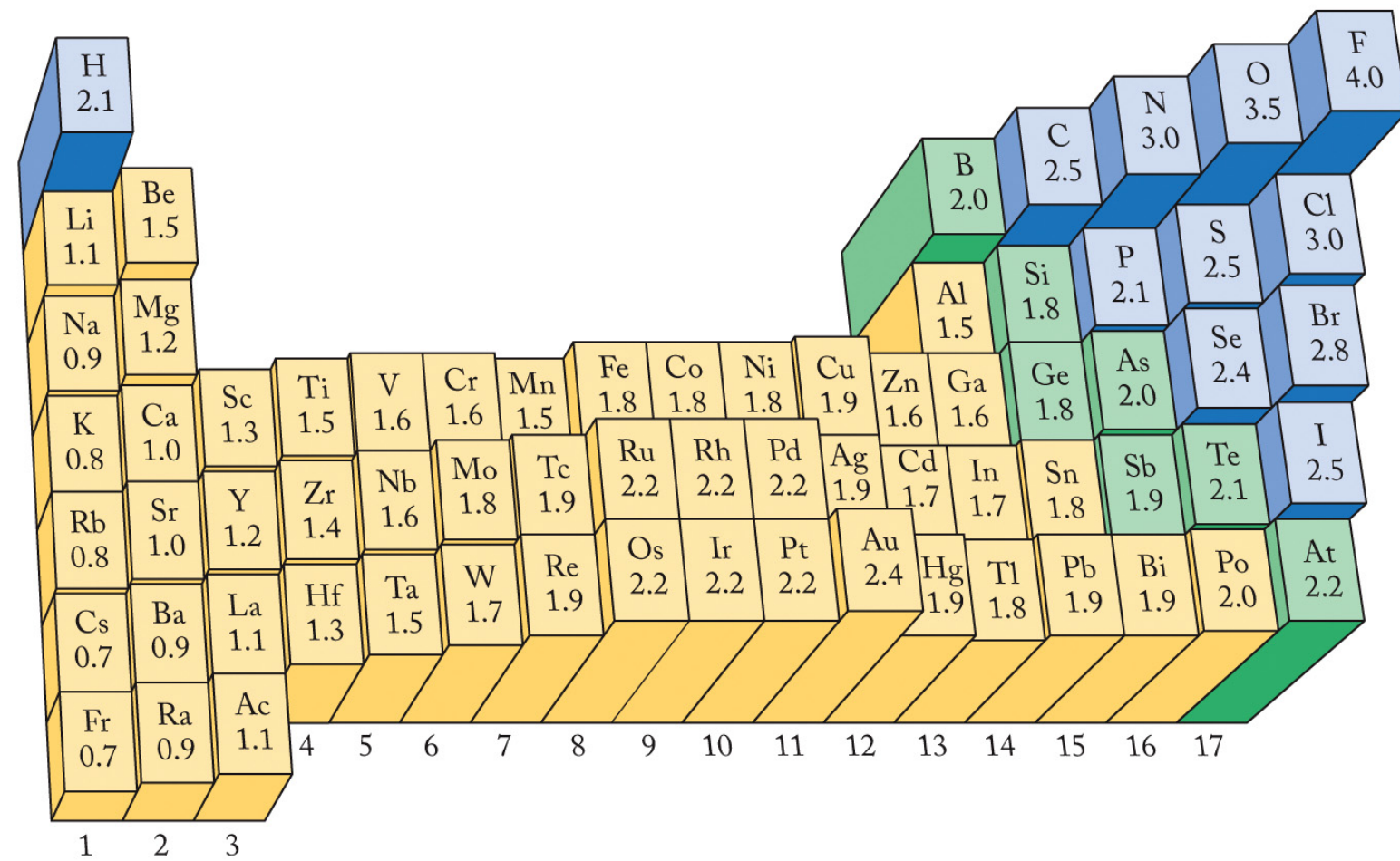

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An <u>unequal</u> sharing of electrons in a bond when difference in EN is large.

BOND POLARITY

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Which is the most polar bond type?

C–Se
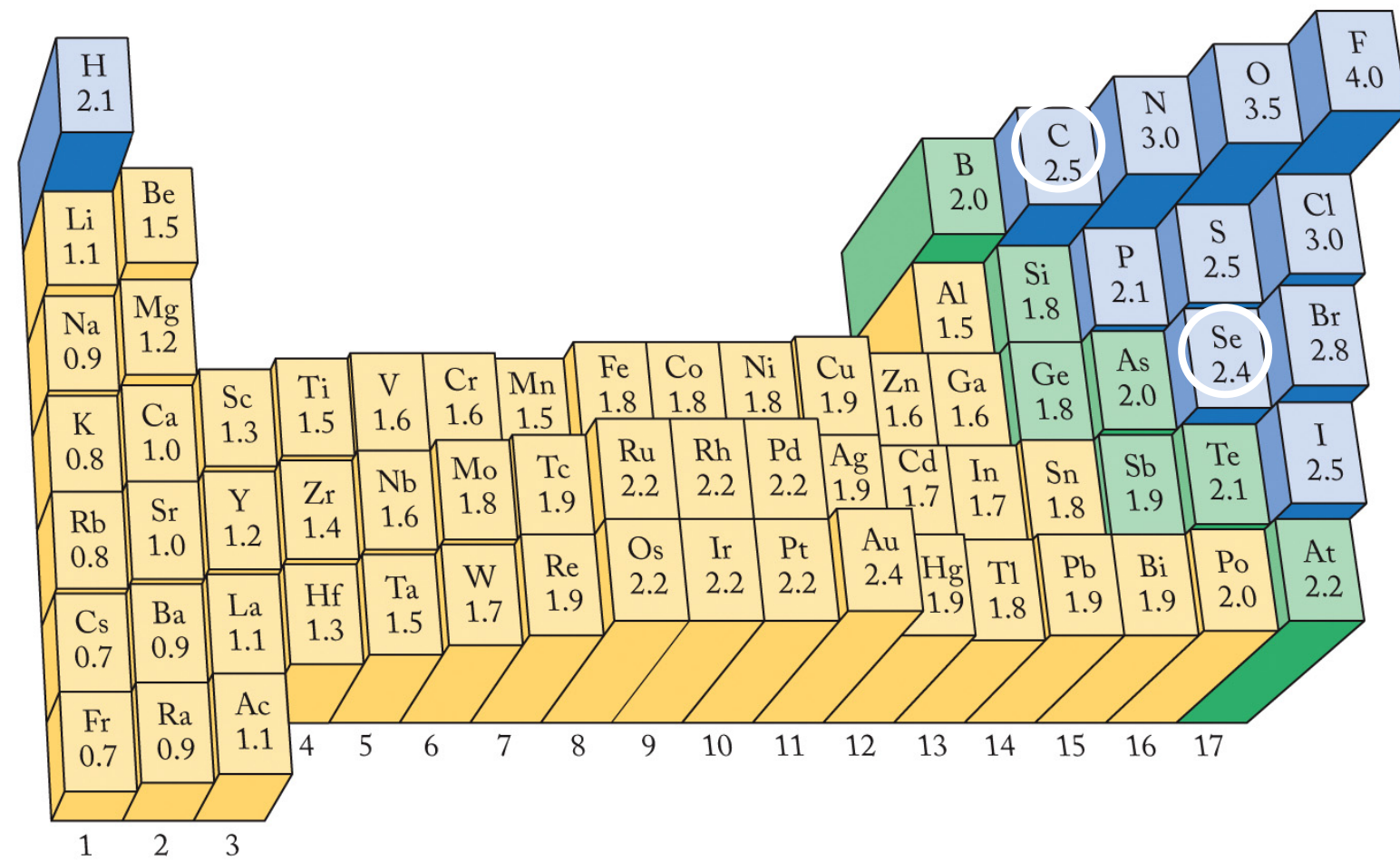
C=O

Cl–Br

O=O

N–H

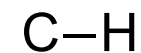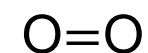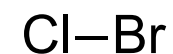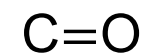C–H

BOND POLARITY

An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

Which is the most polar bond type?

C−Se   ΔEN = 2.5 − 2.4 = 0.1

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N−H

C−H
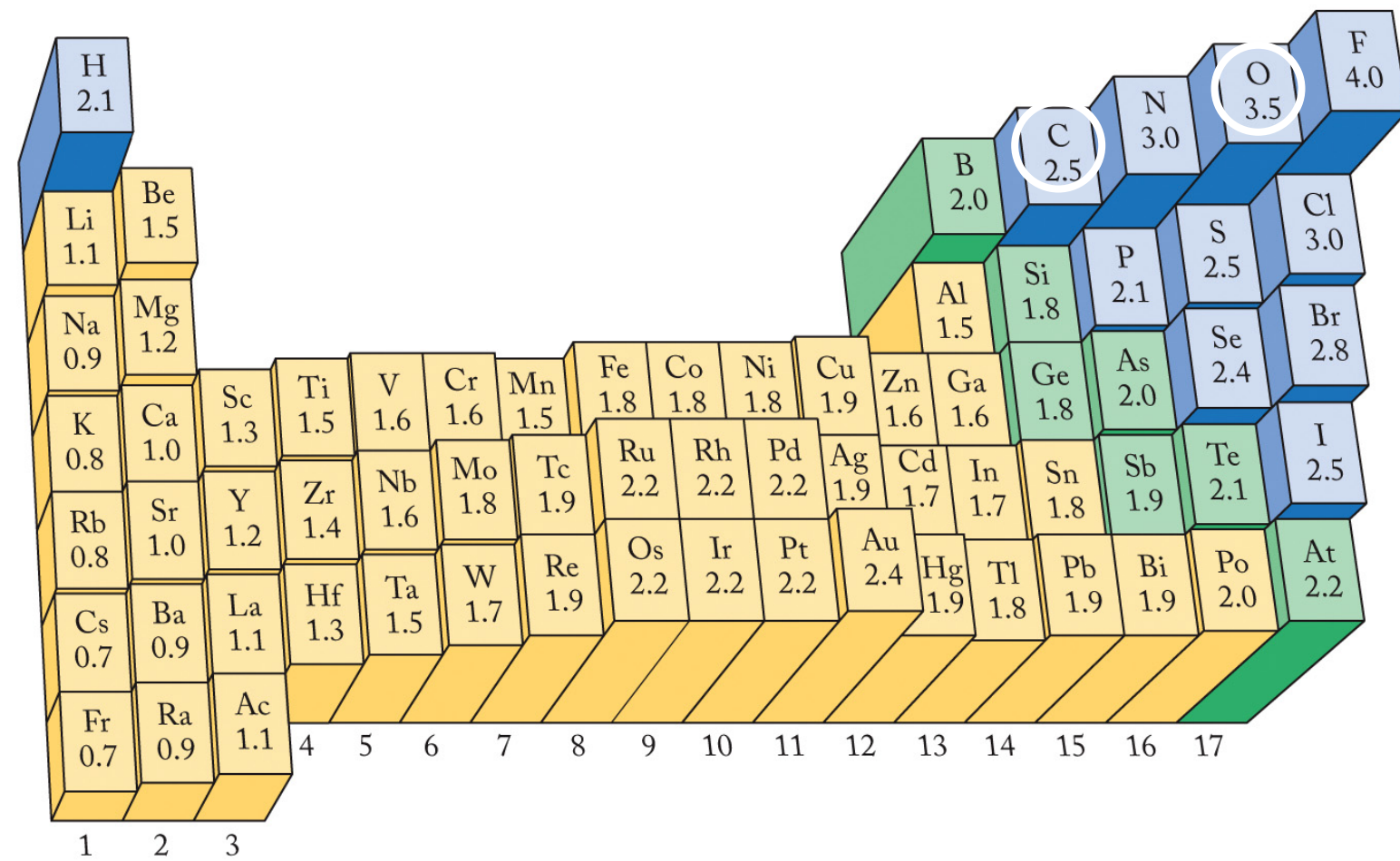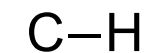
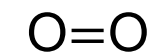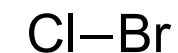## BOND POLARITY

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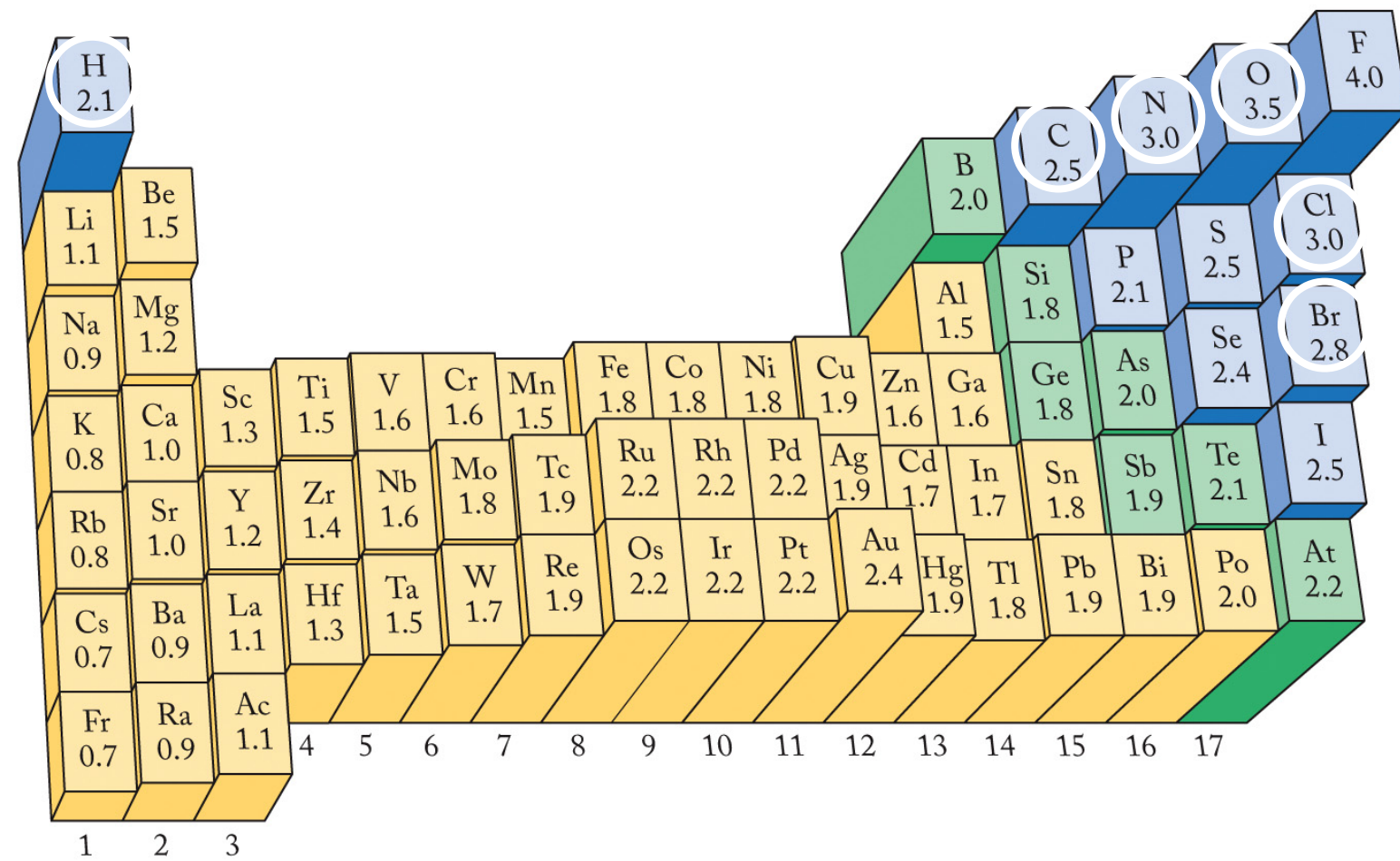
C=O   ΔEN = 3.5 – 2.5 = 1.0

Cl–Br

O=O

N–H

C–H

BOND POLARITY

An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

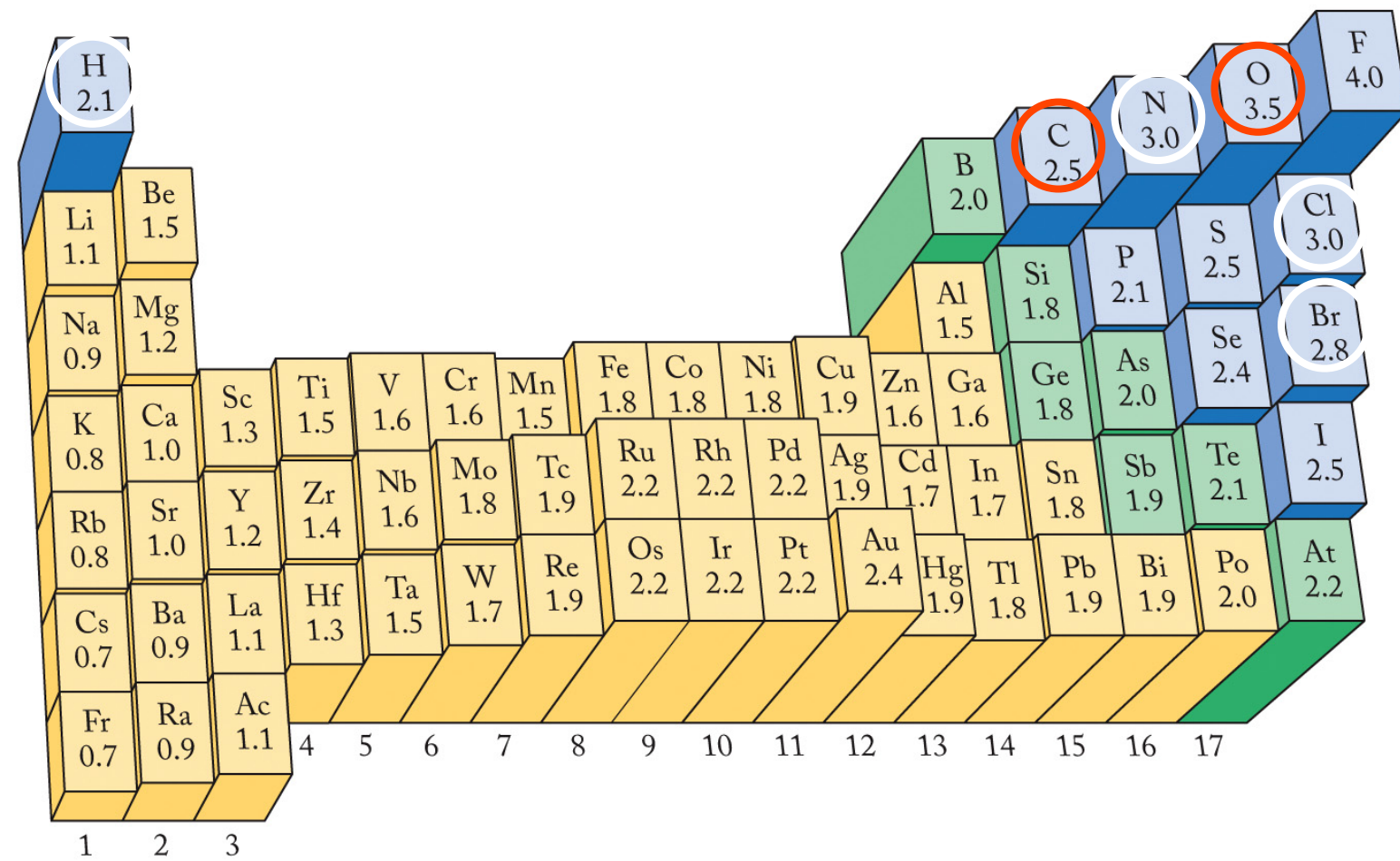Which is the most polar bond type?

C–Se   ΔEN = 2.5 – 2.4 = 0.1

C=O   ΔEN = 3.5 – 2.5 = 1.0

Cl–Br   ΔEN = 3.0 – 2.8 = 0.2

O=O   ΔEN = 3.5 – 3.5 = 0.0

N–H   ΔEN = 3.0 – 2.1 = 0.9

C–H   ΔEN = 2.5 – 2.1 = 0.4

BOND POLARITY

An unequal sharing of electrons in a bond when difference in EN (ΔEN) is large.

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BOND POLARITY

An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

Which is the <u>least</u> polar bond type?

C–Se   ΔEN = 2.5 – 2.4 = 0.1

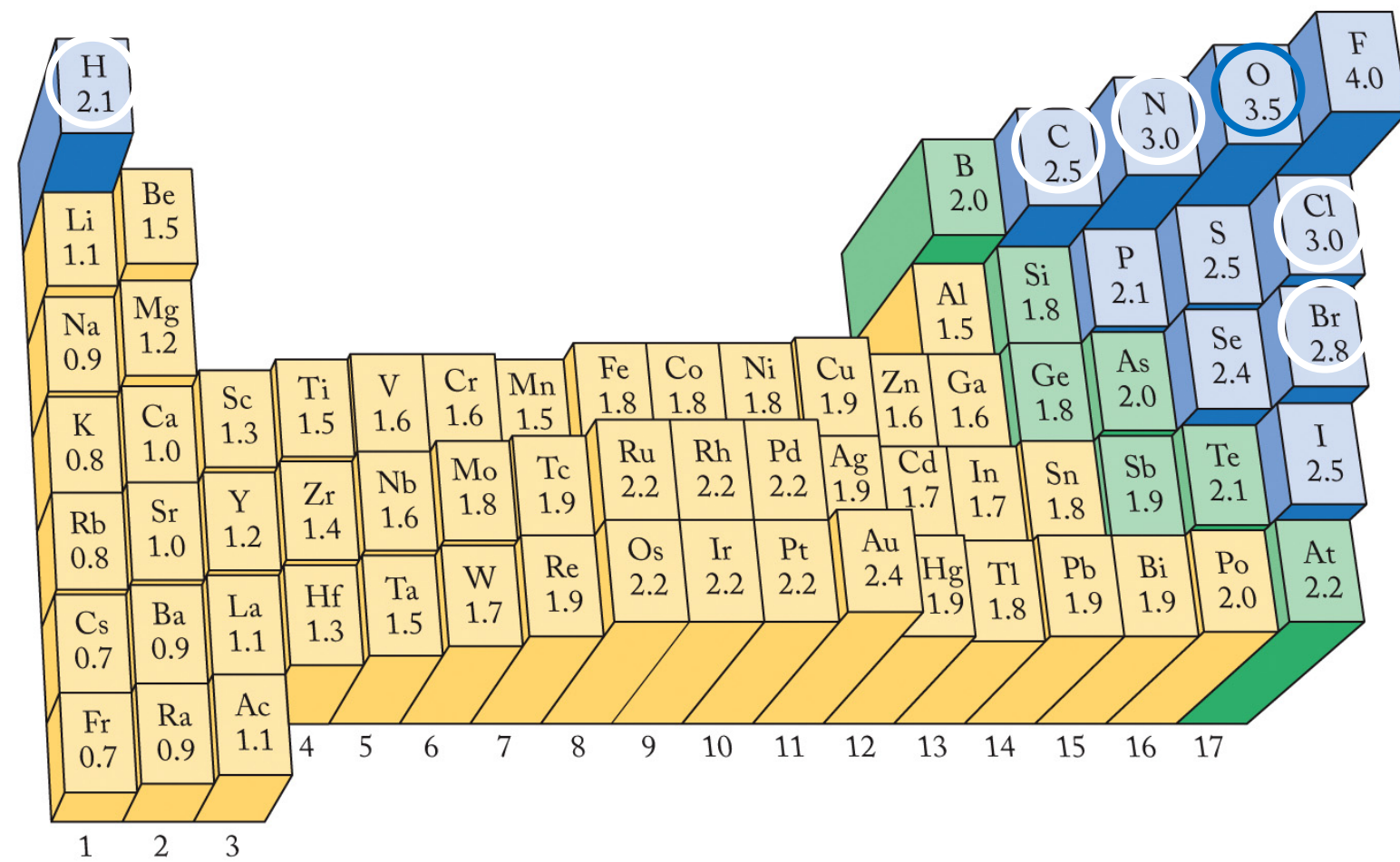C=O   ΔEN = 3.5 – 2.5 = 1.0

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BOND POLARITY

An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

Which is the least polar bond type?

C–Se ΔEN = 2.5 – 2.4 = 0.1

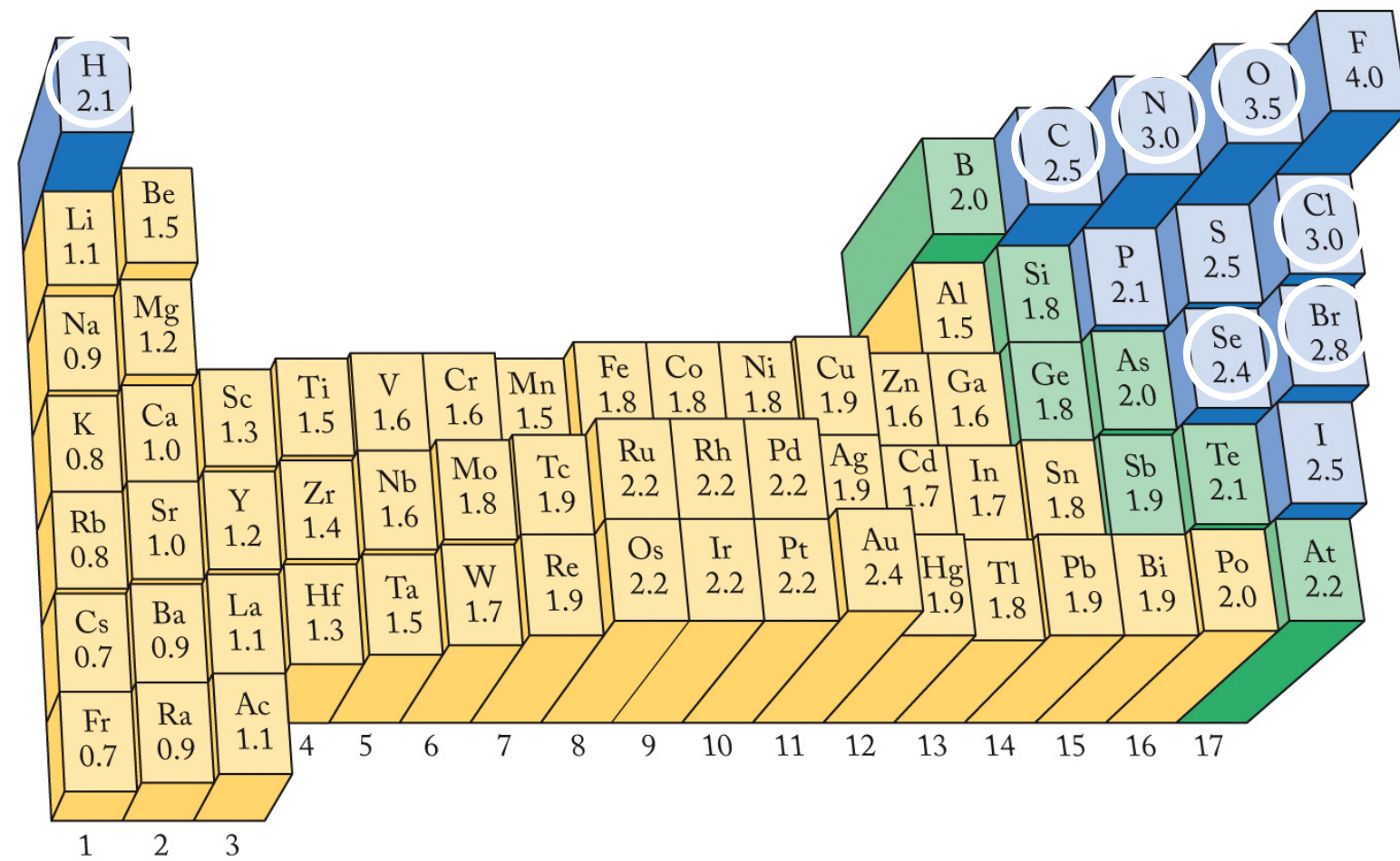C=O ΔEN = 3.5 – 2.5 = 1.0

Cl–Br ΔEN = 3.0 – 2.8 = 0.2

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BOND POLARITY

An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

Draw the bond dipole for each:

C−Se   ΔEN = 2.5 − 2.4 = 0.1

C=O   ΔEN = 3.5 − 2.5 = 1.0

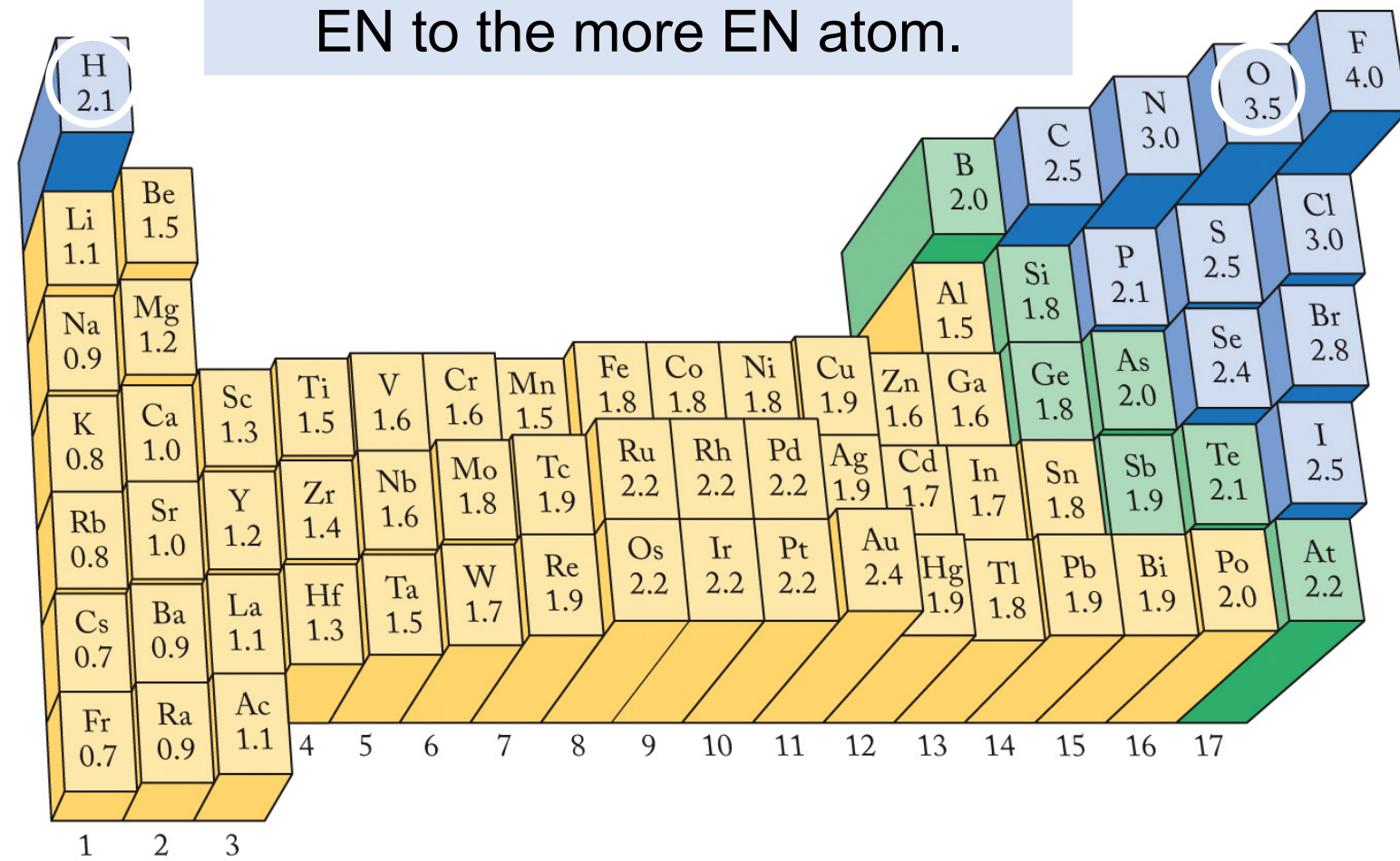Cl−Br   ΔEN = 3.0 − 2.8 = 0.2

O=O   ΔEN = 3.5 − 3.5 = 0.0

N−H   ΔEN = 3.0 − 2.1 = 0.9

C−H   ΔEN = 2.5 − 2.1 = 0.4

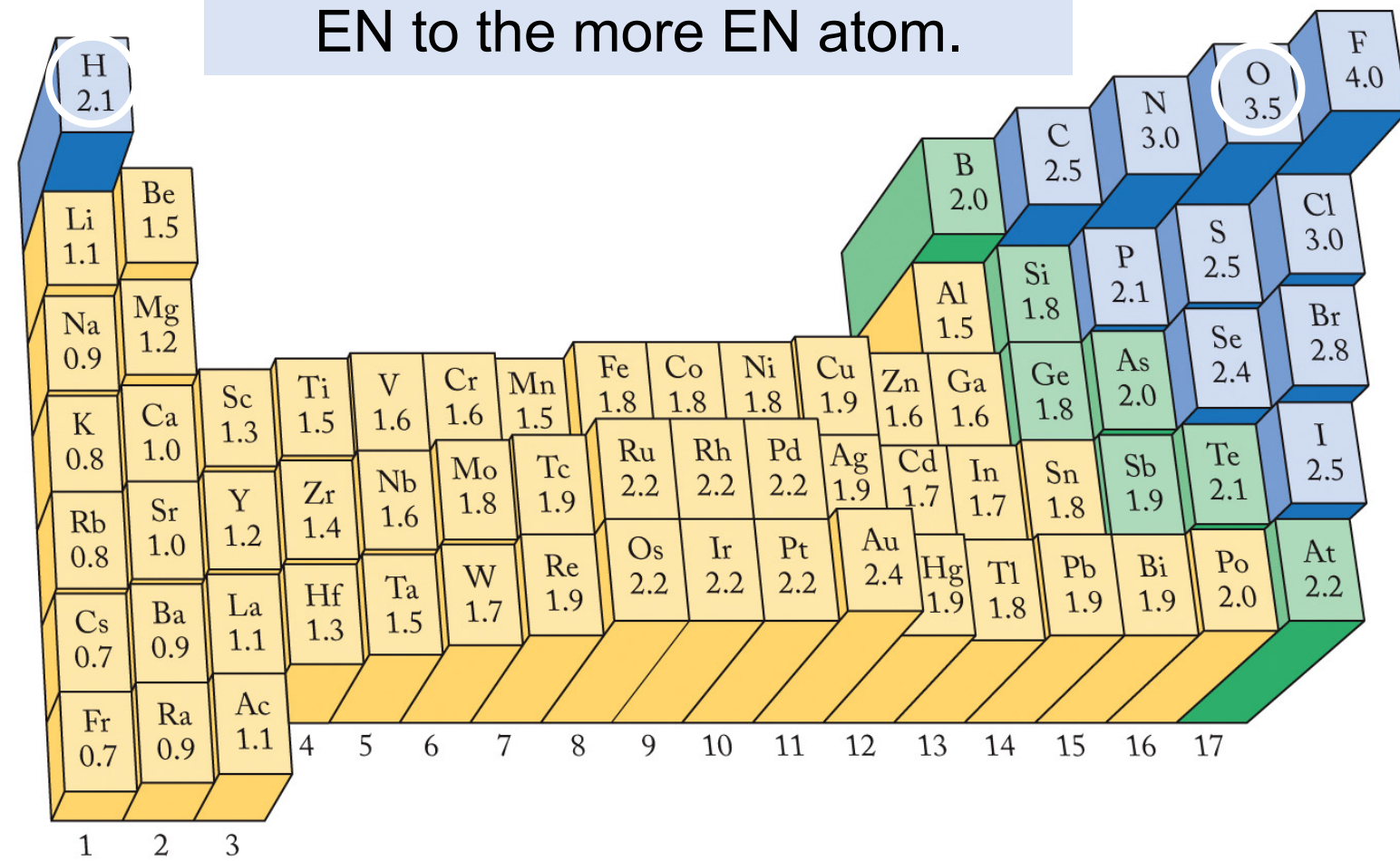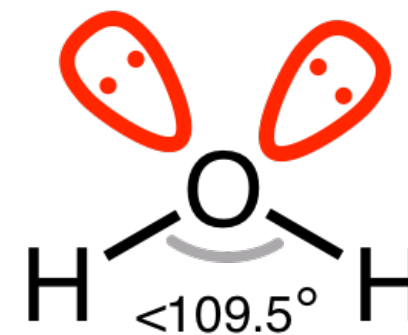## BOND DIPOLE
An arrow pointing from the less EN to the more EN atom.

BOND POLARITY
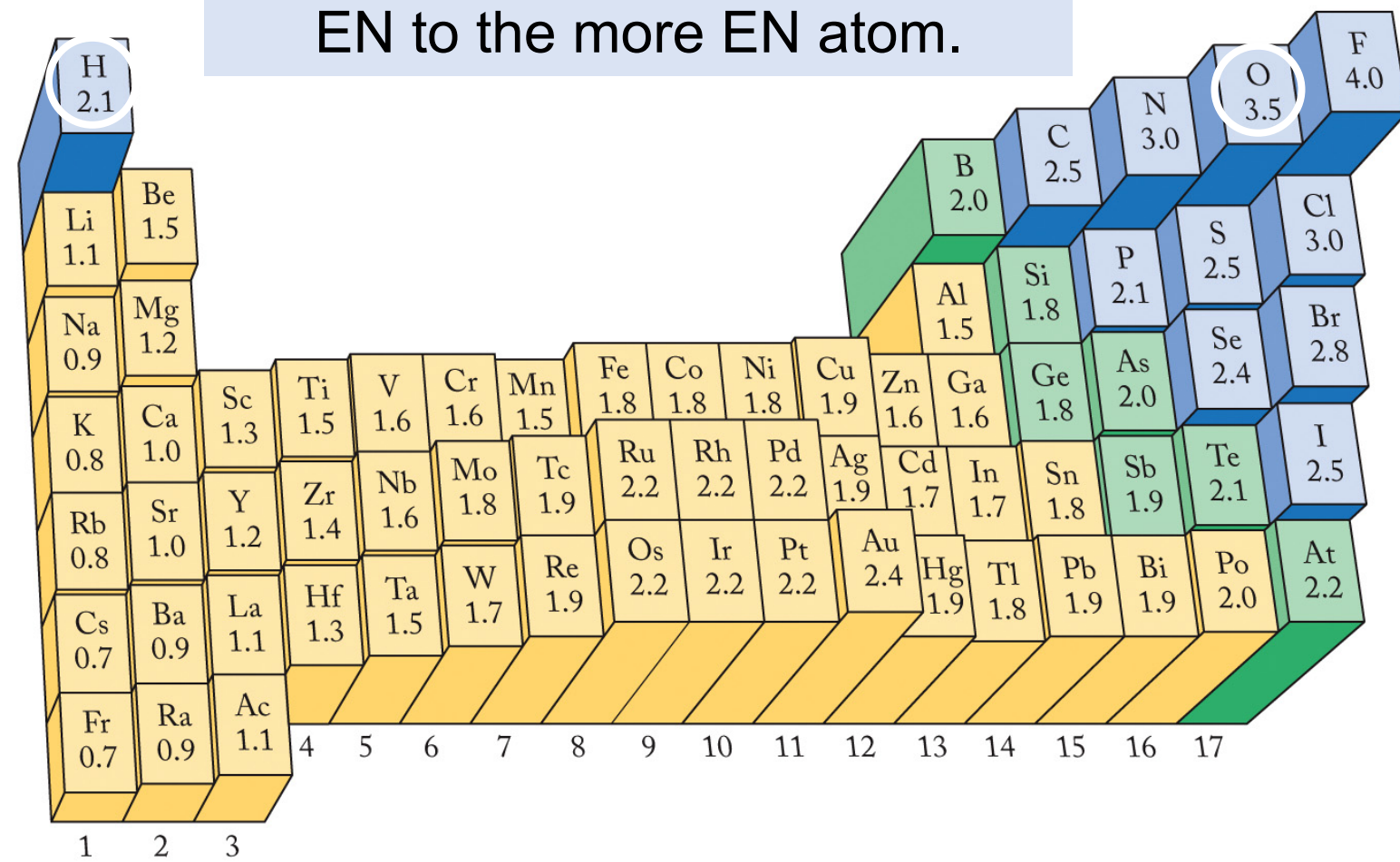An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

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Cl–Br $\Delta EN = 3.0 - 2.8 = 0.2$

O=O $\Delta EN = 3.5 - 3.5 = 0.0$

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C–H $\Delta EN = 2.5 - 2.1 = 0.4$
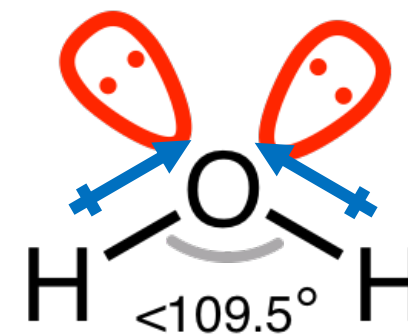
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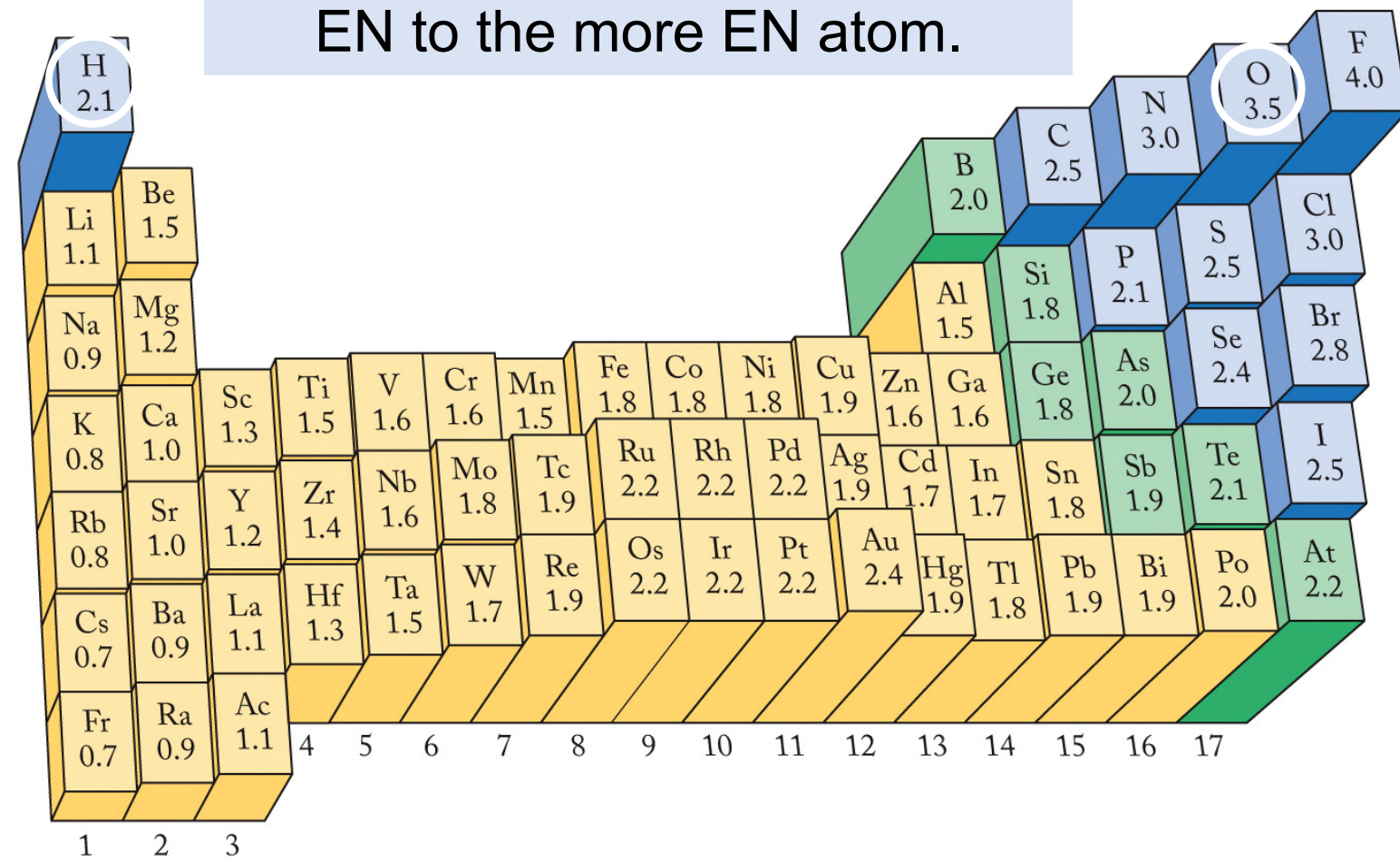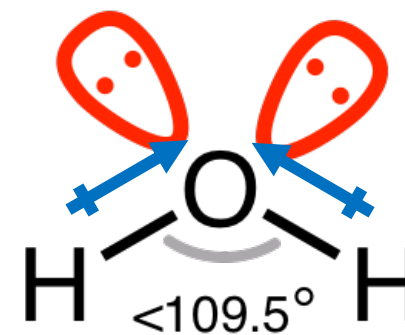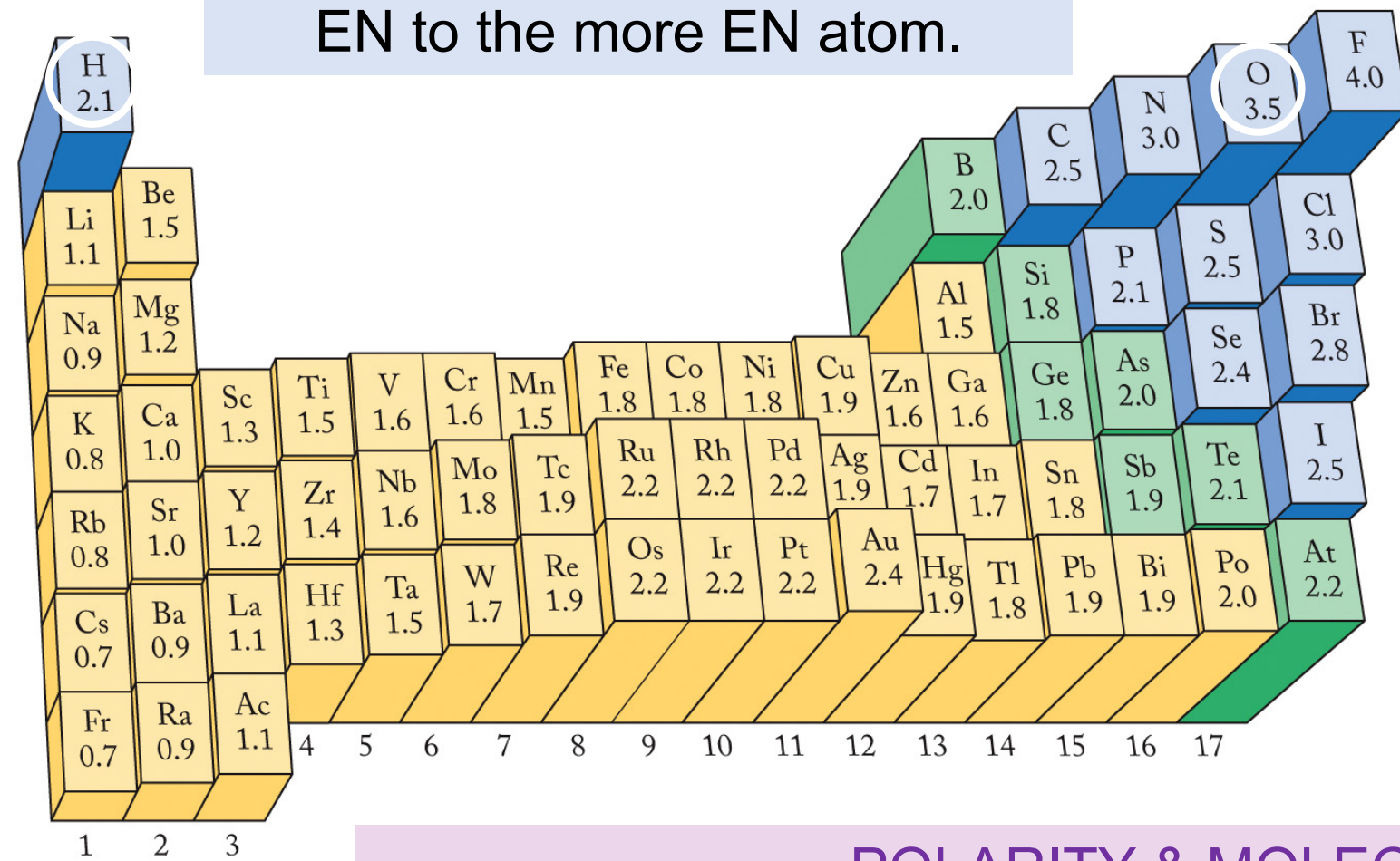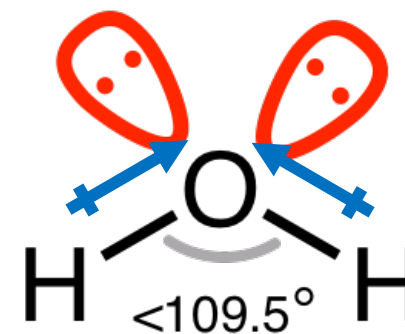

Draw the bond dipole for each:

⟵—⊢

C−Se   ΔEN = 2.5 − 2.4 = 0.1

⊢—⟶

C=O   ΔEN = 3.5 − 2.5 = 1.0

⟵—⊢

Cl−Br   ΔEN = 3.0 − 2.8 = 0.2

no bond dipole (nonpolar)

O=O   ΔEN = 3.5 − 3.5 = 0.0

⟵—⊢

N−H   ΔEN = 3.0 − 2.1 = 0.9

⟵—⊢

C−H   ΔEN = 2.5 − 2.1 = 0.4

BOND DIPOLE
An arrow pointing from the less EN to the more EN atom.

BOND POLARITY
An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

Draw the bond dipoles for water:

H
2.1

Li
1.1

Be
1.5

Na
0.9

Mg
1.2

K
0.8

Ca
1.0

Sc
1.3

Ti
1.5

V
1.6

Cr
1.6

Mn
1.5

Fe
1.8

Co
1.8

Ni
1.8

Cu
1.9

Zn
1.6

Ga
1.6

Ge
1.8

As
2.0

B
2.0

C
2.5

N
3.0

O
3.5

F
4.0

Al
1.5

Si
1.8

P
2.1

S
2.5

Cl
3.0

Se
2.4

Br
2.8

Rb
0.8

Sr
1.0

Y
1.2

Zr
1.4

Nb
1.6

Mo
1.8

Tc
1.9

Ru
2.2

Rh
2.2

Pd
2.2

Ag
1.9

Cd
1.7

In
1.7

Sn
1.8

Sb
1.9

Te
2.1

I
2.5

Cs
0.7

Ba
0.9

La
1.1

Hf
1.3

Ta
1.5

W
1.7

Re
1.9

Os
2.2

Ir
2.2

Pt
2.2

Au
2.4

Hg
1.9

Tl
1.8

Pb
1.9

Bi
1.9

Po
2.0

At
2.2

Fr
0.7

Ra
0.9

Ac
1.1

4   5   6   7   8   9   10   11   12   13   14   15   16   17

1   2   3

BOND DIPOLE
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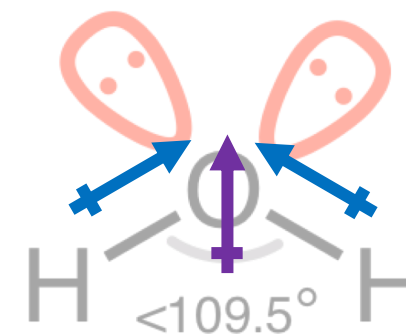
BOND POLARITY
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Draw the bond dipoles for water:

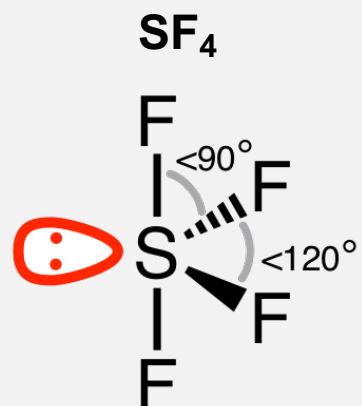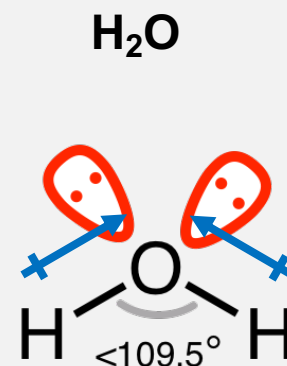*Use the <u>molecular geometry</u> not the Lewis structure!*

BOND DIPOLE
An arrow pointing from the less EN to the more EN atom.

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Draw the bond dipoles for water:

Use the <u>molecular geometry</u> not the Lewis structure!

Is water polar?

BOND DIPOLE
An arrow pointing from the less EN to the more EN atom.

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Is water polar?

POLARITY & MOLECULAR DIPOLE
The sum of the bond dipoles in a molecule determines if it is polar.

BOND DIPOLE
An arrow pointing from the less EN to the more EN atom.

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An <u>unequal</u> sharing of electrons in a bond when difference in EN (ΔEN) is large.

Draw the bond dipoles for water:

Use the <u>molecular geometry</u> not the Lewis structure!

Is water polar? YES!

POLARITY & MOLECULAR DIPOLE
The sum of the bond dipoles in a molecule determines if it is polar.

For each, draw the bond dipoles:

SF$_4$

SN = 5, see-saw

H$_2$O

SN = 4, bent

CH$_4$

SN = 4, tetrahedral

CO$_2$

SN = 2, linear

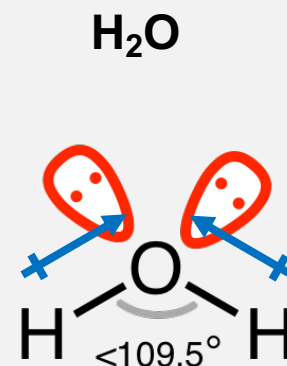**SO$_2$**

SN = 3, bent

CH$_2$Cl$_2$

SN = 4, tetrahedral

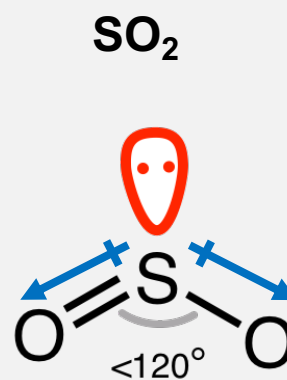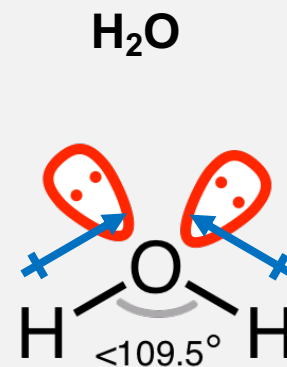For each, draw the bond dipoles:

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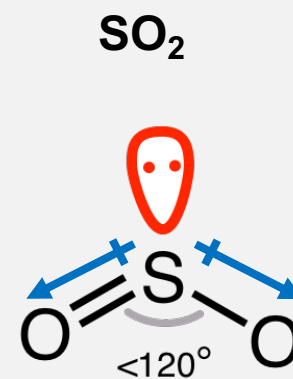
SF$_4$

SN = 5, see-saw

H$_2$O

SN = 4, bent

CH$_4$

SN = 4, tetrahedral

CO$_2$

180°

SN = 2, linear

SO$_2$

<120°

SN = 3, bent

CH$_2$Cl$_2$

109.5°

SN = 4, tetrahedral

For each, draw the bond dipoles:

SF$_4$

SN = 5, see-saw

H$_2$O

SN = 4, bent

CH$_4$

SN = 4, tetrahedral

CO$_2$

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CO$_2$

SN = 2, linear

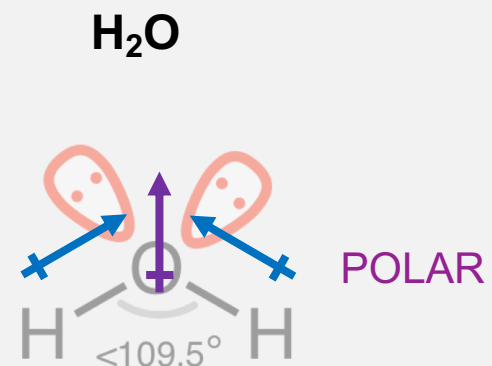**SO$_2$**

SN = 3, bent

CH$_2$Cl$_2$

SN = 4, tetrahedral

For each, determine if polar and draw the molecular dipoles:

SF$_4$

SN = 5, see-saw

H$_2$O

POLAR

SN = 4, bent

CH$_4$

SN = 4, tetrahedral

CO$_2$

SN = 2, linear

SO$_2$

SN = 3, bent

CH$_2$Cl$_2$

SN = 4, tetrahedral

For each, determine if polar and draw the molecular dipoles:

SF₄

SN = 5, see-saw — POLAR

H₂O

SN = 4, bent — POLAR
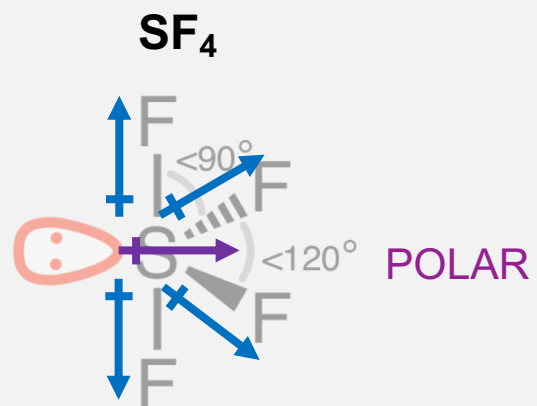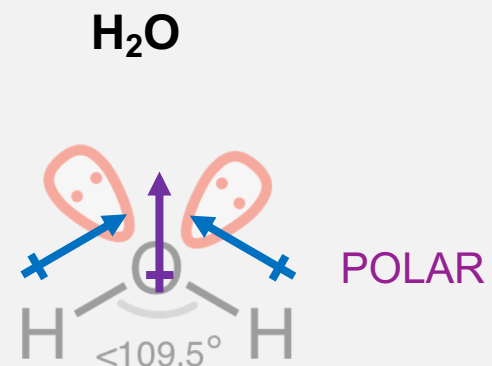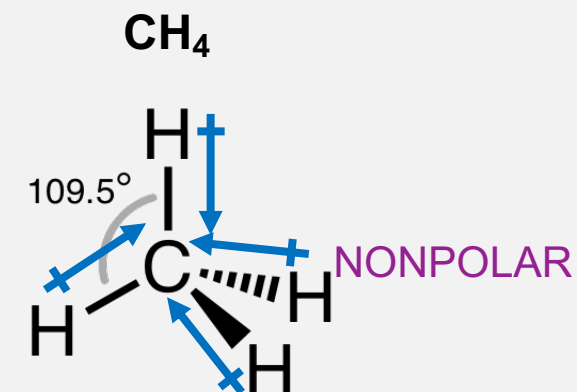
CH₄

SN = 4, tetrahedral

CO₂

SN = 2, linear

SO₂

SN = 3, bent

CH₂Cl₂

SN = 4, tetrahedral

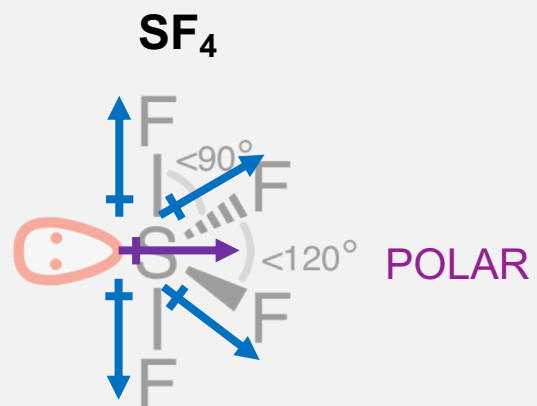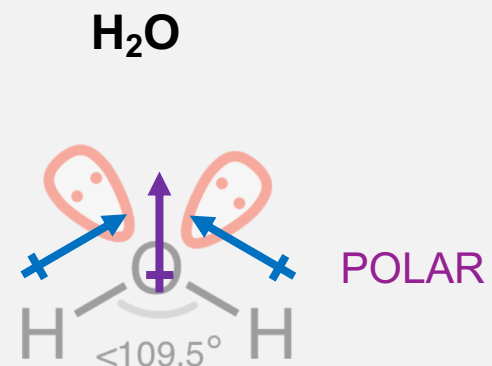For each, determine if polar and draw the molecular dipoles:

SF_4

SN = 5, see-saw

POLAR

H_2O

SN = 4, bent

POLAR

CH_4

SN = 4, tetrahedral

NONPOLAR

CO_2

SN = 2, linear

SO_2

SN = 3, bent

CH_2Cl_2

SN = 4, tetrahedral

For each, determine if polar and draw the molecular dipoles:

SF$_4$

<90°   <120°   POLAR
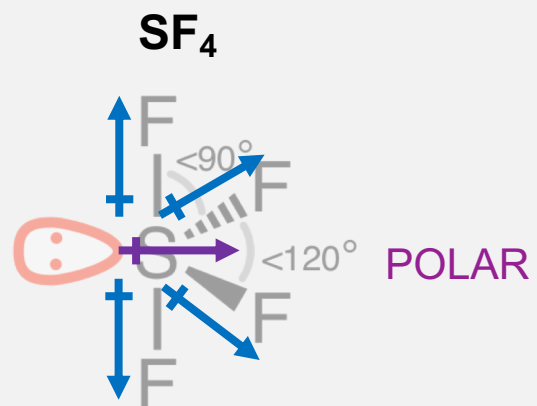
SN = 5, see-saw

H$_2$O

POLAR

<109.5°

SN = 4, bent

CH$_4$

109.5°   NONPOLAR

SN = 4, tetrahedral

CO$_2$

180°   NONPOLAR

SN = 2, linear

SO$_2$

<120°

SN = 3, bent

CH$_2$Cl$_2$

109.5°
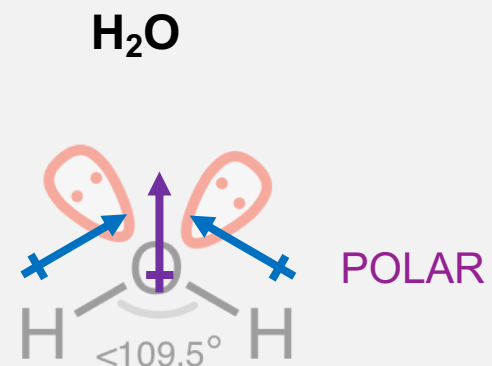
SN = 4, tetrahedral

For each, determine if polar and draw the molecular dipoles:

SF_4

POLAR

SN = 5, see-saw

H_2O

POLAR

SN = 4, bent

CH_4

NONPOLAR

SN = 4, tetrahedral

CO_2

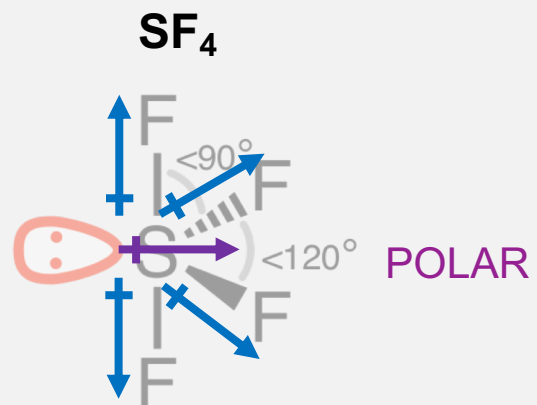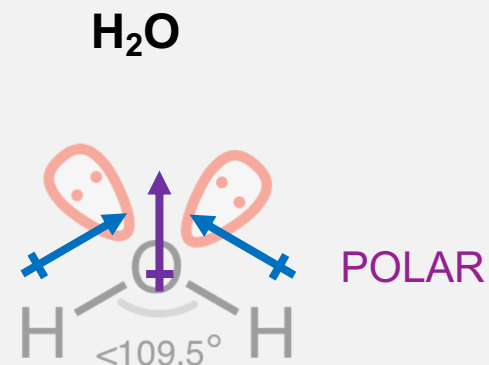NONPOLAR

SN = 2, linear

SO_2

POLAR

SN = 3, bent

CH_2Cl_2

SN = 4, tetrahedral

For each, determine if polar and draw the molecular dipoles:

SF$_4$

POLAR

SN = 5, see-saw

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SN = 4, tetrahedral