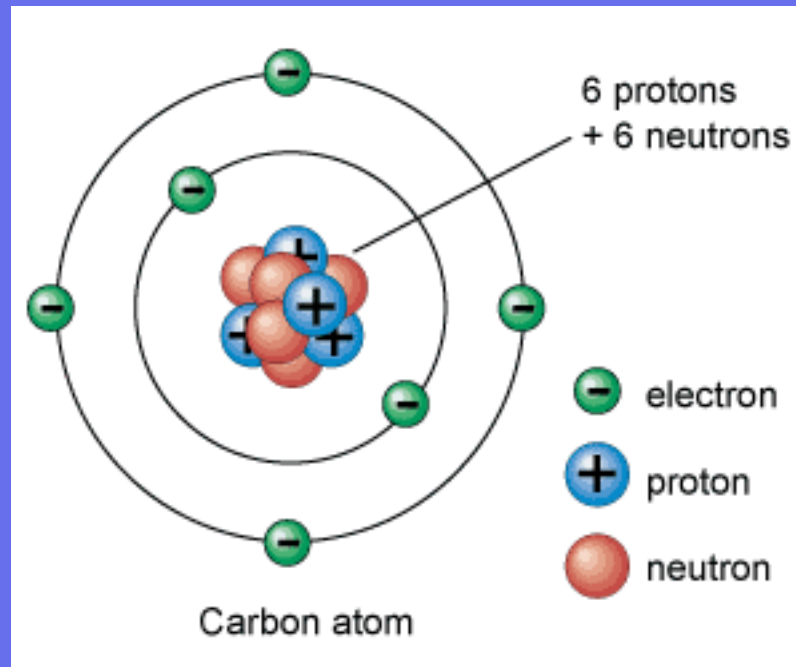


4.1 Atomic Theory and Bonding

- An atom is the smallest particle of an element that still has the properties of that element
 - ♦ 50 million atoms, lined up end to end = 1 cm
 - ♦ An atom = proton(s) + neutron(s) + electron(s)
 - ♦ Crash Course In Chemistry



See pages 168 - 169

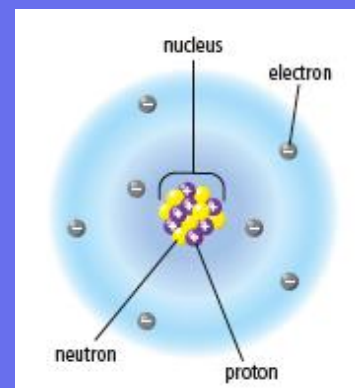
(c) McGraw Hill Ryerson 2007

- **Atoms join together to form compounds.**
 - ♦ **A compound is a pure substance that is composed of two or more atoms combined in a specific way.**
 - ♦ **Oxygen and hydrogen are atoms/elements; H₂O is a compound.**
- **A chemical change occurs when the arrangement of atoms in compounds changes to form new compounds.**

Atomic Theory

- Atoms are made up of smaller particles called subatomic particles.

Table 4.1 Subatomic Particles				
Name	Symbol	Electric Charge	Location in the Atom	Relative Mass
Proton	p	1+	Nucleus	1836
Neutron	n	0	Nucleus	1837
Electron	e	1-	Surrounding the nucleus	1



- The nucleus is at the centre of an atom.
 - The nucleus is composed of protons and neutrons.
 - Electrons exist in the space surrounding the nucleus.
 - # of protons = # of electrons in every atom, therefore atoms have **NO CHARGE**
 - Nuclear charge = charge on the nucleus = # of protons
 - Atomic number = # of protons = # of electrons

See page 170

- **How do I figure out how many protons an atom of carbon has?**
- **Electrons?**
- **Neutrons?**

Break

- **Pg 60 in workbook**

Organization of the Periodic Table

- In the periodic table elements are listed in order by their atomic number.
 - ♦ Metals are on the left (the transition metals range from group 3 to group 12), non-metals are on the right, and the metalloids form a “staircase” toward the right side.
 - ♦ Rows of elements (across) are called periods.
 - All elements in a period have their electrons in the same general area around their nucleus.
 - ♦ Columns of elements are called groups, or families.
 - All elements in a family have similar properties and bond with other elements in similar ways.
 - Group 1 = alkali metals
 - Group 2 = alkaline earth metals
 - Group 17 = the halogens
 - Group 18 = noble gases

See page 171

The Periodic Table

Periodic Table of the Elements

1 H Hydrogen 1.0																	18 He Helium 4.0
3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
11 Na Sodium 23.0	12 Mg Magnesium 24.3											13 Al Aluminum 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulphur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 39.9
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 45.0	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.8	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Uub Ununbium (285)	113 Uut Ununtrium (284)	114 Uuq Ununquadium (289)	115 Uup Ununpentium (288)	116 Uuh Ununhexium (292)	117 Uus Ununseptium (?)	118 Uuo Ununoctium (294)

Where are the following?

- Atomic number
- Period
- Group/Family
- Metals
- Non-metals
- Transition metals
- Metalloids
- Alkali metals
- Alkaline earth metals
- Halogens
- Noble gases

Based on mass of C-12 at 12.00.

Any value in parentheses is the mass of the most stable or best known isotope for elements that do not occur naturally.

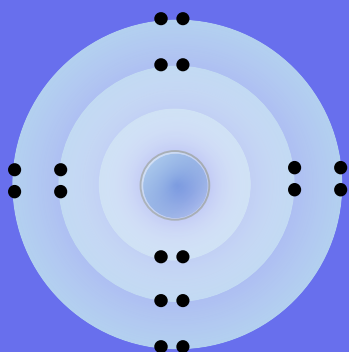
58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

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Colour Periodic Table

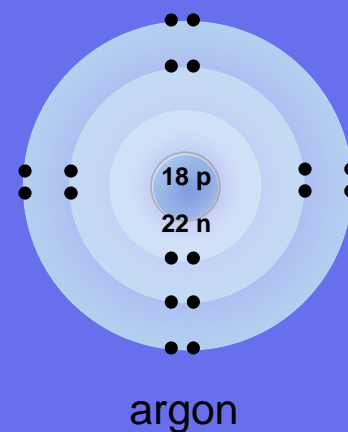
Bohr Diagrams

- Bohr diagrams show how many electrons appear in each electron shell around an atom.
 - Electrons in the outermost shell are called valence electrons.
 - Think of the shells as being 3-D like spheres, not 2-D like circles.



What element is this?

- It has $2 + 8 + 8 = 18$ electrons, and therefore, 18 protons.
- It has three electron shells, so it is in period 3.
- It has eight electrons in the outer (valence) shell.



See page 174

Patterns of Electron Arrangement in Periods and Groups

- Electrons appear in shells in a very predictable manner.
- There is a maximum of two electrons in the first shell, eight in the 2nd shell, and eight in the 3rd shell.
 - ♦ The period number = the number of shells in the atom.
 - ♦ Except for the transition elements, the last digit of the group number = the number of electrons in the valence shell.

	1								18
1	1 H								2 He
2	3 Li	4 Be		13 B	14 C	15 N	16 O	17 F	10 Ne
3	11 Na	12 Mg		13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca							

- ♦ The noble gas elements have full electron shells and are very stable.

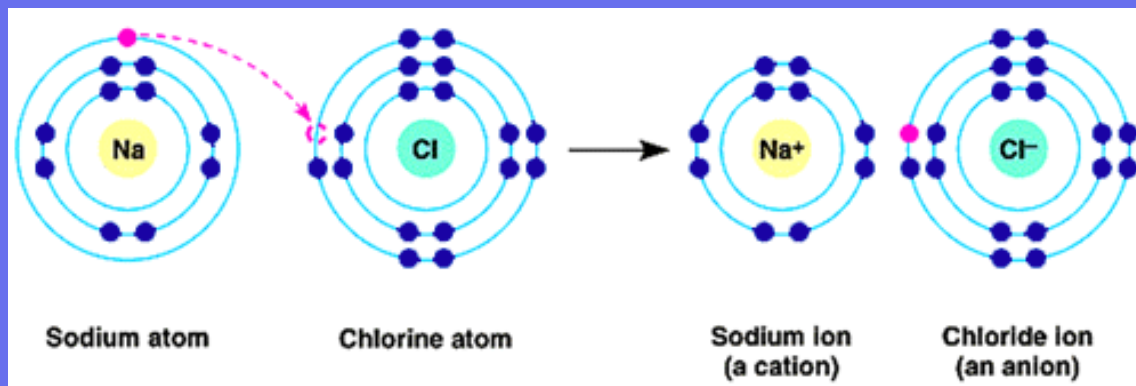
See page 175

Practice Drawing Bohr Diagrams

- **Bohr diagram worksheet**

Periodic Table and Ion Formation

- **Atoms gain and lose electrons to form bonds.**
 - ♦ The atoms become electrically charged particles called ions.
 - ♦ Metals lose electrons and become positive ions (cations).
 - Some metals (multivalent) lose electrons in different ways.
 - For example, iron, Fe, loses either two (Fe^{2+}) or three (Fe^{3+}) electrons
 - ♦ Non-metals gain electrons and become negative ions (anions).
 - ♦ Atoms gain and lose electrons in an attempt to have the same number of valence electrons (electrons farthest from the nucleus) as the nearest noble gas in the periodic table.

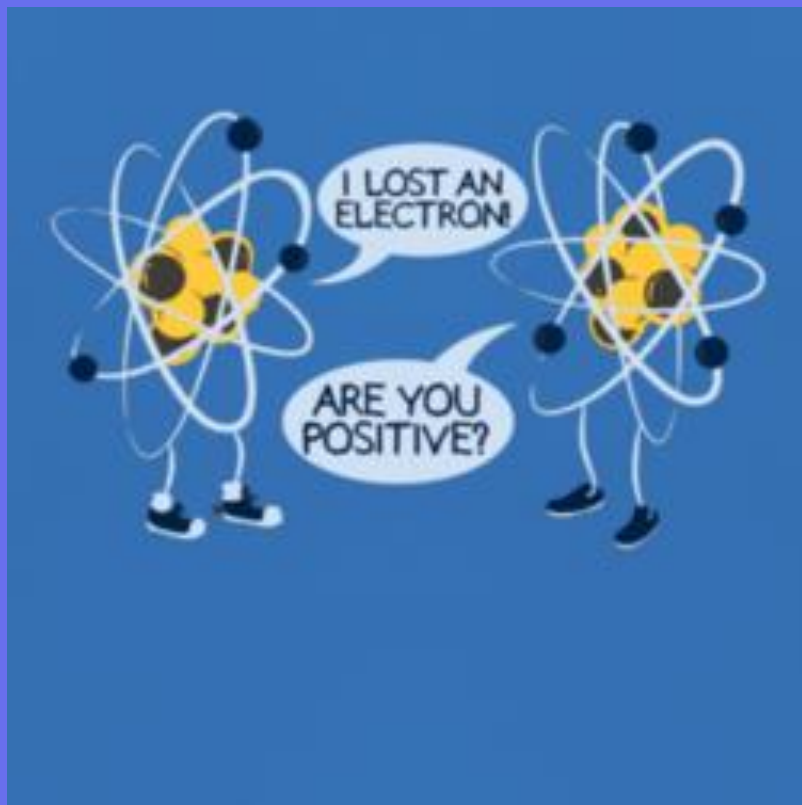


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Forming Compounds

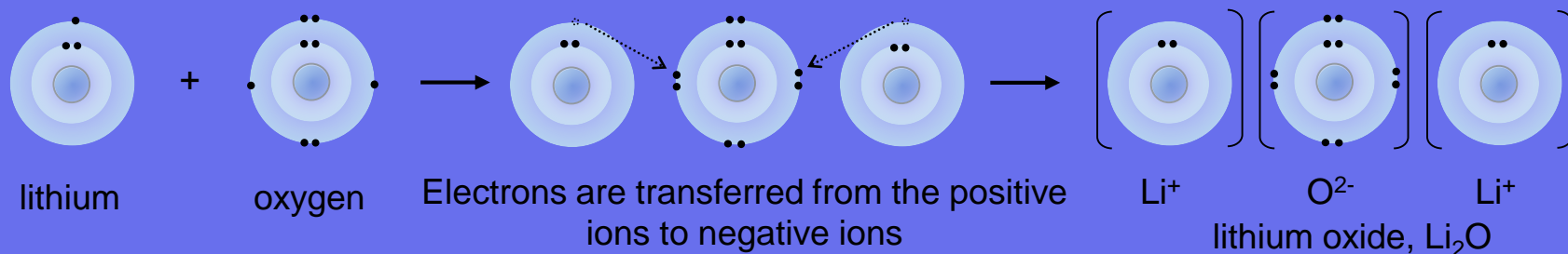
- **When two atoms get close together, their valence electrons interact.**
 - ♦ **If the valence electrons can combine to form a low-energy bond, a compound is formed.**
 - ♦ **Each atom in the compound attempts to have the stable number of valence electrons as the nearest noble gas.**
 - ♦ **Metals may lose electrons and non-metals may gain electrons (ionic bond), or atoms may share electrons (covalent bond).**
- **Ionic bonds form when electrons are transferred from positive ions to negative ions.**
- **Covalent bonds form when electrons are shared between two non-metals.**
 - ♦ **Electrons stay with their atom but overlap with other shells.**

See pages 176 - 177

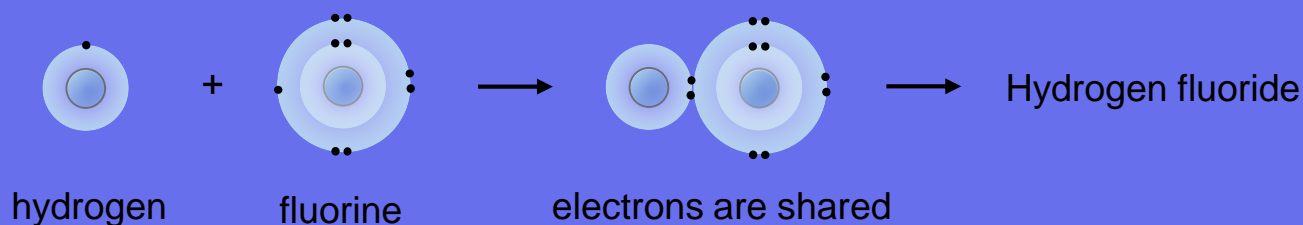


Forming Compounds (continued)

- **Ionic bonds are formed between positive ions and negative ions.**
 - ♦ Generally, this is a metal (+) and a non-metal (-) ion.
 - ♦ For example, lithium and oxygen form an ionic bond in the compound Li_2O .



- **Covalent bonds are formed between two or more non-metals.**
 - ♦ Electrons are shared between atoms.



See pages 176 - 177

Bohr Diagram

- In partners complete Bohr Bonding Worksheet
- As a class we will be going through them
 - ♦ Each partner will draw one and then together we will bond them

Lewis Diagrams

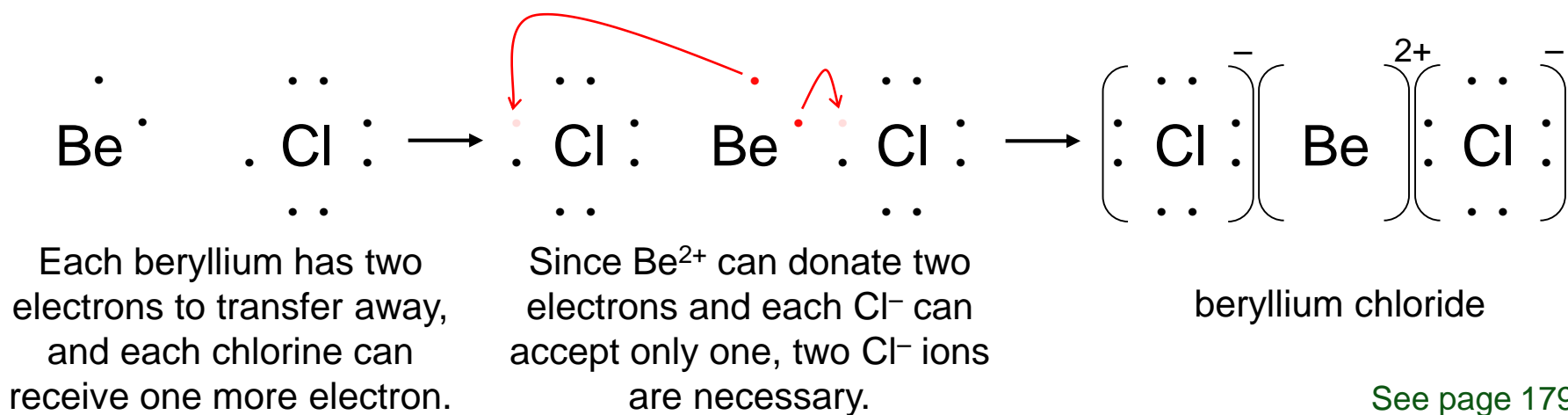
- Lewis diagrams illustrate chemical bonding by showing only an atom's valence electrons and the chemical symbol.
 - ♦ Dots representing electrons are placed around the element symbols at the points of the compass (north, east, south, and west).
 - ♦ Electron dots are placed singly until the fifth electron is reached then they are paired.

	1								18
1	1 H •								2 He ••
2	3 Li •	4 Be •	5 B ••	6 C •• •	7 N •• •	8 O •• •	9 F •• •	10 Ne •• ••	
3	11 Na •	12 Mg •	13 Al ••	14 Si •• •	15 P •• •	16 S •• •	17 Cl •• •	18 Ar •• ••	

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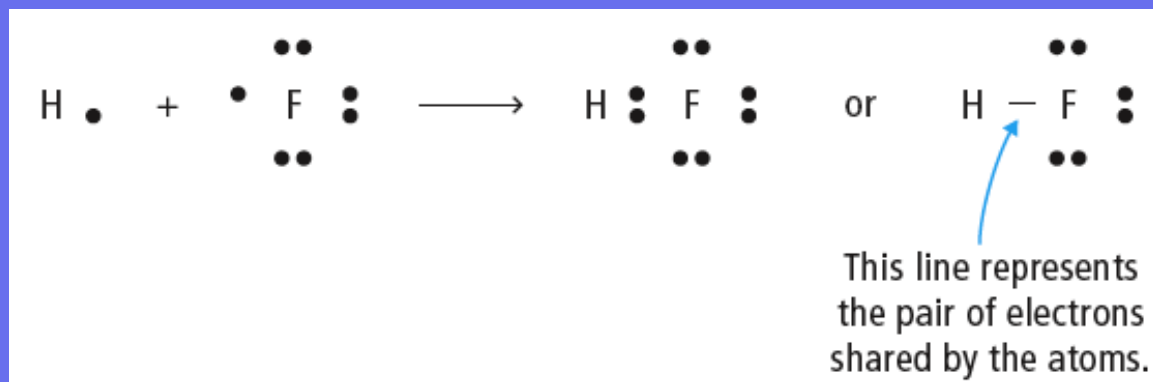
Lewis Diagrams of Ions

- **Lewis diagrams can be used to represent ions and ionic bonds.**
 - ♦ For positive ions, one electron dot is removed from the valence shell for each positive charge.
 - ♦ For negative ions, one electron dot is added to each valence shell for each negative charge.
 - ♦ Square brackets are placed around each ion to indicate transfer of electrons.



Lewis Diagrams of Covalent Bonds

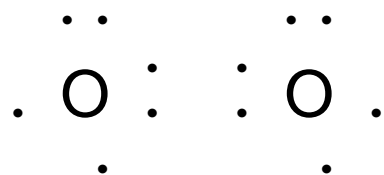
- Lewis diagrams can also represent covalent bonds.
 - ♦ Like Bohr diagrams, valence electrons are drawn to show sharing of electrons.
 - ♦ The shared pairs of electrons are usually drawn as a straight line.



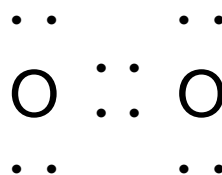
See page 179

Lewis Diagrams of Diatomic Molecules

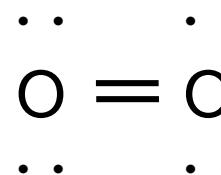
- Diatomic molecules, like O_2 , are also easy to draw as Lewis diagrams.



Several non-metals join to form diatomic molecules.



Valence electrons are shared, here in two pairs.



This is drawn as a double bond.

[Take the Section 4.1 Quiz](#)

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