1. This is not balanced (the number of green spheres is one on the reactant side, and two on the product side). Of the four bullet points that Dalton wrote, this violates the fact that atoms should be re-arranged in a reaction, not created or lost!

11. a. +1 atomic number, \( Z = 55 \) (#p\(^+\)), defines the atom. \( \text{Cs}^+ \ldots \)

   Mass \# (A) = 133 (#p\(^+\) & n\(^0\)). \( ^{113}\text{Cs}^+ \)

b. ion 54 e\(^-\), 53 p\(^+\) (Z; defines the atom)… \( \text{I}^- \)… there are more electrons than protons… \( \text{I}^- \ldots 74 \, \text{n}^0 \) \( ^{127}\text{I}^- \) (53p\(^+\) + 74n\(^0\) = 127)

c. ion atomic number, \( Z = 15 \) (#p\(^+\)), defines the atom. \( \text{P}^+ \ldots \)

   A = 31 (p\(^+\) & n\(^0\)), negative three charge, \( \text{P}^3^- \ldots \) \( ^{31}\text{P}^3^- \)

d. ion 24 e\(^-\), 30 n\(^0\), +3 charge, so missing three electrons… \( \text{X}^3+ \ldots \)

   if it were neutral, it would have 27 e\(^-\) (24 + 3) and 27 p\(^+\). \( Z = 27, \text{Co}^3+ \)

   (27p\(^+\) + 30n\(^0\) = 57); \( ^{57}\text{Co}^3+ \)

17. a. \( Z = 26 \) (#p\(^+\)), so Fe, iron

   A = 58 (#p\(^+\) & n\(^0\)), charge = 2+ (so missing two electrons), # p\(^+\) = #n\(^0\) if neutral.

   \( 26 - 2 = 24 \, \text{e}^- \)

   58 #p\(^+\) & n\(^0\) – 26 #p\(^+\) = 32 n\(^0\)

b. \( Z = 53 \) (#p\(^+\)), so I, iodine

   A = 127 (#p\(^+\) & n\(^0\)), charge = 1– (so one extra electron), # p\(^+\) = #n\(^0\) if neutral.

   \( 53 + 1 = 54 \, \text{e}^- \)

   127 #p\(^+\) & n\(^0\) – 53 #p\(^+\) = 74 n\(^0\)

19. #p\(^+\), e\(^-\) and n\(^0\) if neutral

   a. \( ^7\text{Li} \ldots 7 \) (#p\(^+\) & n\(^0\)) – 3 (#p\(^+\)) = 4 n\(^0\)

   \( 3 \, \text{p}^+ = 3 \, \text{e}^- \)

   b. \( ^{125}\text{Te} \ldots 125 \) (#p\(^+\) & n\(^0\)) – 52 (#p\(^+\)) = 73 n\(^0\)

   \( 52 \, \text{p}^+ = 52 \, \text{e}^- \)

   c. \( ^{109}\text{Ag} \ldots 109 \) (#p\(^+\) & n\(^0\)) – 47 (#p\(^+\)) = 62 n\(^0\)

   \( 47 \, \text{p}^+ = 47 \, \text{e}^- \)

   d. \( ^{15}\text{N} \ldots 15 \) (#p\(^+\) & n\(^0\)) – 7 (#p\(^+\)) = 8 n\(^0\)

   \( 7 \, \text{p}^+ = 7 \, \text{e}^- \)
e.  $^{31}\text{P} \quad 31 \, (\#p^+ \ & n^0) - 15 \, (\#p^+) = 16 \, n^0$  \hspace{1cm} 15 \, p^+ = 15 \, e^-

23. $^{79}\text{Br} \quad 78.9183 \, \text{amu}, \ 50.69\%$

$^{81}\text{Br} \quad 80.9163 \, \text{amu}, \ 49.31\%$

(Note: amu is unitless! Units are always preferred as they help solve problems (often) via unit analysis. Use g/mole instead of amu here):

\[ \left(78.9183 \, \text{g/mole}\right) \times (0.5069) + \left(80.9163 \, \text{g/mole}(0.4931)\right) = \text{79.90 g/mole} \]

(\#s limit sig figs).

29. Note: molecular formula is for all atoms, empirical formula is the lowest common denominator (simplified) formula.

<table>
<thead>
<tr>
<th>Molecular formula</th>
<th>empirical formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. CO$_3$</td>
<td>CO$_2$</td>
</tr>
<tr>
<td>b. C$_2$H$_2$</td>
<td>CH</td>
</tr>
<tr>
<td>c. C$_2$H$_4$</td>
<td>CH$_2$</td>
</tr>
<tr>
<td>d. H$_2$SO$_4$</td>
<td>H$_2$SO$_4$</td>
</tr>
</tbody>
</table>

37. a. U metal inner Transition metal (TM)

b. Br non-metal main

c. Sr metal main

d. Ne non-metal main

e. Au metal TM

f. Am metal inner TM

g. Rh metal TM

h. S non-metal main

i. C non-metal main

j. K metal main

39. Determine the lightest by looking at the smallest MM (g/mole) (or smallest Z)
a. He

b. Be

c. Li (H isn’t technically an alkali metal... it is the first atom on the Periodic Table and is a bit ‘odd’, kind of in its ‘own’ Group; its main isotope doesn’t have any neutrons).

d. C

41. Periods go across (horizontal), Groups go up and down (vertical).

44. KCl     NCl₃     ICl     MgCl₂     PCl₅     CCl₄

i. ionic,

metal + non-metal, OR metal and polyatomic ion OR polyatomic ion and polyatomic ion

c = covalent, non-metal and non-metal

47. a. NF₃ covalent (non-metal and non-metal)

b. BaO ionic (Ba²⁺; Group II), O²⁻… predictable charges on the Periodic Table

c. (NH₄)₂CO₃ ionic… careful! Looks like all non-metals (see answer to #45), but it is actually made up of polyatomic cation and polyatomic anion.

d. Sr(H₂PO₄)₂ ionic, (Sr²⁺, H₂PO₄⁻; need to memorize polyatomic ions).

e. IBr covalent
f. \( \text{Na}_2\text{O} \quad \text{Na}^+ \) (there are two of these- the subscript in the formula tells this).

\( \text{O}^{2-} \)… predictable charges on the Periodic Table

51. Ionic: element name + element name with –ide ending
   a. ionic cesium iodide
   b. ionic barium oxide
   c. ionic potassium sulfide
   d. ionic beryllium chloride
   e. ionic (and acid) hydrogen bromide (hydrobromic acid)
   f. ionic aluminum fluoride (Note: Roman numerals are not needed as the charges are predictable from the Periodic Table).

53. All ionic (metal and non-metal OR polyatomic species OR metal and polyatomic species), and all have predictable charges off the Periodic Table…
   a. \( \text{Rb}^+ \quad \text{Br}^- \rightarrow \text{RbBr} \)
   b. \( \text{Mg}^{2+} \quad \text{Se}^{2-} \rightarrow \text{MgSe} \)
   c. \( \text{Na}^+ \quad \text{O}^{2-} \rightarrow \text{Na}_2\text{O} \) (need two + to cancel the 2–)
   d. \( \text{Ca}^{2+} \quad \text{Cl}^- \rightarrow \text{CaCl}_2 \) (need two 1– to cancel the 2+)
   e. \( \text{H}^+ \quad \text{F}^- \rightarrow \text{HF} \)
   f. \( \text{Ga}^{3+} \quad \text{P}^{3-} \rightarrow \text{GaP} \)
g. \[ \text{Al}^{3+} \quad \text{Br}^- \quad \rightarrow \quad \text{AlBr}_3 \] (need three 1– to cancel the 3+)

h. \[ \text{NH}_4^+ \quad \text{SO}_4^{2–} \quad \rightarrow \quad (\text{NH}_4)_2\text{SO}_4 \] (need two + to cancel the 2–)

55. Use prefixes with covalent (non-metal and non-metal) (do NOT use prefixes with ionic)
   a. \(\text{ClO}_2\) covalent \((\text{di} = 2)\)
   b. \(\text{N}_2\text{O}_4\) covalent \((\text{di} = 2, \text{tetra} = 4)\)
   c. \(\text{K}^+, \text{P}^{3–}, \text{K}_3\text{P}\) ionic \((\text{cancel out charges, like #49 and #53})\)
   d. \(\text{Ag}^+, \text{S}^{2–}, \text{Ag}_2\text{S}\) ionic \((\text{cancel out charges})\)
   e. \(\text{Al}^{3+}, \text{F}^–, \text{AlF}_3\) ionic \((\text{cancel out charges})\) it is also a trihydrate, meaning it has three waters associated with it, so \(\text{AlF}_3\bullet3\text{H}_2\text{O}\)
   f. \(\text{SiO}_2\) covalent

57. a. \(\text{O}^{2–}\), three of them makes \(–6\), so \(\text{Cr}\) must contribute \(+6\) total
   (+6 to cancel out the \(–6\)… but there’s two \(\text{Cr}\) ions, so divide that by two. \(\text{Cr}^{3+}\)).
   chromium(III) oxide
   OR make the compound like a mathematical formula to solve for the unknown \((\text{Cr})\)…
   \[2\text{Cr} + (3)(–2) = 0\]
   \[2\text{Cr} \quad –6 = 0\]
   \[2\text{Cr} = +6\]
   \[\text{Cr} = +3\]
   b. \(\text{Cl}^- \times 2 = –2\), so \(\text{Fe}^{2+}\) iron(II) chloride
   OR \(\text{Fe} + (2)(–1) = 0\)
   \[\text{Fe} = +2\]
   \((\text{brush up on Roman numerals if you need to (esp.} \text{I-X (1-10))!})\)
   c. \(\text{O}^{2–} \times 3 = –6\), so \(\text{Cr} = +6\) chromium(VI) oxide
   OR \(\text{Cr} + (3)(–2) = 0\)
   \[\text{Cr} = +6\]
   d. \(\text{Ti} + (4)(–1) = 0\), so \(\text{Ti} = +4\) titanium(IV) chloride
e. Co + (2)(–1) = 0  \text{ cobalt(II) chloride hexahydrate}

Co = +2 and has six (hexa) waters associated with it

f. Mo + (2)(–2) = 0  \text{ molybdenum(VI) sulfide}

Mo = +4

59. use ionic naming rules (no prefixes). \textit{Know the polyatomic ions and their charges. Know the predictable charges from the Periodic Table.}

a. K\(^+\), PO\(^3–\) need three K\(^+\) to cancel out 3– from phosphate \(\rightarrow\) K\(_3\)PO\(_4\)

b. Cu\(^{2+}\), SO\(^2–\) \(\rightarrow\) CuSO\(_4\)

c. Ca\(^{2+}\), Cl\(^–\) need two Cl\(^–\) to cancel out 2+ from calcium ion \(\rightarrow\) CaCl\(_2\)

d. Bad name (don’t use prefixes for ionic), but it does tell the formula…

\[
\text{TiO}_2
\]

\((\text{O}^–)^2 = –4\) so Ti = +4

e. NH\(^4+\), NO\(^3–\) \(\rightarrow\) NH\(_4\)NO\(_3\)

f. Na\(^+\), HSO\(^4–\) \(\rightarrow\) NaHSO\(_4\)

61. \text{Note: the IUPAC (as of 2005) does not accept the altered names of transition metals as correct; you must name them as the transition metal followed by the Roman Numeral… BUT you may still see the ‘old’ (incorrect) names on-line or in older books…}

a. ionic: MnO\(_2\)… no prefixes with ionic compounds

\((\text{O}^–)^2 = –4, \text{ Mn} = +4\) \text{ manganese(IV) oxide}

b. mercurous (as opposed to the other, also incorrect, mercuric)

-ous is a ‘lower’ amount…
-ic is a ‘higher’ amount… (in this case charge)

Hg\(^{+1}\) as Hg\(_2^{2+}\) (that is, Hg\(^{+1}\)–Hg\(^{+1}\)… the two Hg are connected and together have a +2 charge or +1 each). \text{ mercury(I) chloride}

c. ferric (‘higher’ amount than ferrous… and, oh, so incorrect now).
Fe³⁺, NO₃⁻ (need three nitrate ions to cancel out the +3 from the iron ion).

Fe(NO₃)₃  **iron(III) nitrate**

d. TiCl₄  (no prefixes with ionic!)

4(Cl⁻) = –4, so Ti⁴⁺

*titanium(IV) chloride*

e. cupric  (‘higher’ amount than cuprous, and still not acceptable anymore)

Cu²⁺, so need two bromide anions, CuBr₂, **copper(II) bromide**

*Why no longer using –ic and –ous name ending with transition metals? Besides having to unnecessarily memorize names with charges, many transition metals form more than two charges. So what do you call something that isn’t +2 or +3 (say, +1 or +4…)?*