CHEM 101

Chapter 2 tutorial

2.7 The diameter of a helium atom is about 1 X 10^2 pm. Suppose that we could line up helium atoms side by side in contact with one another. Approximately how many atoms would it take to make the distance from end to end 1 cm?

First, convert 1 cm to picometers.

$$1 \text{ cm} \times \frac{0.01 \text{ m}}{1 \text{ cm}} \times \frac{1 \text{ pm}}{1 \times 10^{-12} \text{ m}} = 1 \times 10^{10} \text{ pm}$$

$$\textbf{? He atoms} = (1 \times 10^{10} \text{ pm}) \times \frac{1 \text{ He atom}}{1 \times 10^{2} \text{ pm}} = \mathbf{1 \times 10^{8}\ He\ atoms}$$

2.16 Indicate the number of protons, neutrons, and electrons in each of the following species:

Isotope	$^{15}_{7}N$	$^{33}_{16}S$	$^{63}_{29}Cu$	$^{84}_{38}Sr$	$^{130}_{56}Ba$	$^{186}_{74}W$	$^{202}_{80}Hg$
No. Protons	7	16	29	38	56	74	80
No. Neutrons	8	17	34	46	74	112	122
No. Electrons	7	16	29	38	56	74	80

2.17 Write the appropriate symbol for each of the following isotopes: (a) Z = 11, A = 23; (b) Z = 28, A = 64.

(a) $^{23}_{11}\mathrm{Na}$ **(b)** $^{64}_{28}\mathrm{Ni}$

2.18 Write the appropriate symbol for each of the following isotopes: (a) Z = 74, A = 186; (b) Z = 80; A = 201.

(a) $^{186}_{74}\mathrm{W}$ **(b)** $^{201}_{80}\mathrm{Hg}$

2.63 One isotope of a metallic element has mass number 65 and 35 neutrons in the nucleus. The cation derived from the isotope has 28 electrons. Write the symbol for this cation.

The number of protons = 65 − 35 = 30. The element that contains 30 protons is zinc, Zn. There are two fewer electrons than protons, so the charge of the cation is +2. The symbol for this cation is $\mathbf{Zn^{2+}}$.

2.64 One isotope of a nonmetallic element has mass number 127 and 74 neutrons in the nucleus. The anion derived from the isotope has 54 electrons. Write the symbol for this anion

Atomic number = 127 − 74 = 53. This anion has 53 protons, so it is an iodide ion. Since there is one more electron than protons, the ion has a −1 charge. The correct symbol is $\mathbf{I^-}$.

2.33 Identify the following as elements or compounds: NH_3, N_2, S_8, NO, CO, CO_2, H_2, SO_2.

Elements: N_2, S_8, H_2

Compounds: NH_3, NO, CO, CO_2, SO_2

2.68 Which of the following are elements, which are molecules but not compounds, which are compounds but not molecules, and which are both compounds and molecules? (a) SO_2, (b) S_8, (c) Cs, (d) N_2O_5, (e) O, (f) O_2, (g) O_3, (h) CH_4, (i) KBr, (j) S, (k) P_4, (l) LiF

(a)	SO_2	molecule and compound
(b)	S_8	element and molecule
(c)	Cs	element
(d)	N_2O_5	molecule and compound
(e)	O	element
(f)	O_2	element and molecule
(g)	O_3	element and molecule
(h)	CH_4	molecule and compound
(i)	KBr	compound
(j)	S	element
(k)	P_4	element and molecule
(l)	LiF	compound

2.49 & 2.50 Which of the following compounds are likely to be ionic? Which are likely to be molecular? $SiCl_4$, LiF, $BaCl_2$, B_2H_6, KCl, C_2H_4, CH_4, NaBr, BaF_2, CCl_4, ICl, CsCl, NF_3

Ionic: LiF, $BaCl_2$, KCl

Molecular: $SiCl_4$, B_2H_6, C_2H_4

Ionic: NaBr, BaF_2, CsCl.

Molecular: CH_4, CCl_4, ICl, NF_3

2.35 & 2.36 Give the number of protons and electrons in each of the following common ions: K^+, Mg^{2+}, Fe^{3+}, Br^-, $Mn^{2}+$, C^{4-}, Cu^{2+} , Na^+ , Ca^{2+}, Al^{3+}, Fe^{2+}, I^-, F^-, S^{2-}, O^{2-}, and N^{3-}

Ion	K^+	Mg^{2+}	Fe^{3+}	Br^-	Mn^{2+}	C^{4-}	Cu^{2+}
No. protons	19	12	26	35	25	6	29
No. electrons	18	10	23	36	23	10	27

Ion	Na^+	Ca^{2+}	Al^{3+}	Fe^{2+}	I^-	F^-	S^{2-}	O^{2-}	N^{3-}
No. protons	11	20	13	26	53	9	16	8	7
No. electrons	10	18	10	24	54	10	18	10	10

2.69 Fill in the blanks in the following table:

Symbol		$^{54}_{26}Fe^{2+}$			
Protons	5			79	86
Neutrons	6		16	117	136
Electrons	5		18	79	
Net charge			−3		0

Symbol	$^{11}_{5}B$	$^{54}_{26}Fe^{2+}$	$^{31}_{15}P^{3-}$	$^{196}_{79}Au$	$^{222}_{86}Rn$
Protons	5	26	15	79	86
Neutrons	6	28	16	117	136
Electrons	5	24	18	79	86
Net Charge	0	+2	−3	0	0

2.75

The following table gives numbers of electrons, protons, and neutrons in atoms or ions of a number of elements. Answer the following: (a) Which of the species are neutral? (b) Which are negatively charged? (c) Which are positively charged? (d) What are the conventional symbols for all the species?

Atom or Ion of Element	A	B	C	D	E	F	G
Number of electrons	5	10	18	28	36	5	9
Number of protons	5	7	19	30	35	5	9
Number of neutrons	5	7	20	36	46	6	10

(a) Species with the same number of protons and electrons will be neutral. **A, F, G.**

(b) Species with more electrons than protons will have a negative charge. **B, E.**

(c) Species with more protons than electrons will have a positive charge. **C, D.**

(d) **A:** $^{10}_{5}B$ **B:** $^{14}_{7}N^{3-}$ **C:** $^{39}_{19}K^{+}$ **D:** $^{66}_{30}Zn^{2+}$ **E:** $^{81}_{35}Br^{-}$ **F:** $^{11}_{5}B$ **G:** $^{19}_{9}F$

2.45 What are the empirical formulas of the following compounds? (a) C_2N_2, (b) C_6H_6, (c) C_9H_{20}, (d) P_4O_{10}, (e) B_2H_6

(a) CN **(b)** CH **(c)** C_9H_{20} **(d)** P_2O_5 **(e)** BH_3

2.46 What are the empirical formulas of the following compounds? (a) Al_2Br_6, (b) $Na_2S_2O_4$, (c) N_2O_5, (d) $K_2Cr_2O_7$

(a) Dividing both subscripts by 2, the simplest whole number ratio of the atoms in Al_2Br_6 is $\mathbf{AlBr_3}$.

(b) Dividing all subscripts by 2, the simplest whole number ratio of the atoms in $Na_2S_2O_4$ is $\mathbf{NaSO_2}$.

(c) The molecular formula as written, $\mathbf{N_2O_5}$, contains the simplest whole number ratio of the atoms present. In this case, the molecular formula and the empirical formula are the same.

(d) The molecular formula as written, $\mathbf{K_2Cr_2O_7}$, contains the simplest whole number ratio of the atoms present. In this case, the molecular formula and the empirical formula are the same.

2.57 Name these compounds: (a) Na_2CrO_4, (b) K_2HPO_4, (c) HBr (gas), (d) HBr (in water), (e) Li_2CO_3, (f) $K_2Cr_2O_7$, (g) NH_4NO_2, (h) PF_3, (i) PF_5, (j) P_4O_6, (k) CdI_2, (l) $SrSO_4$, (m) $Al(OH)_3$, (n) Na_2CO_3 . 10H2O.

(a) sodium chromate
(b) potassium hydrogen phosphate
(c) hydrogen bromide (molecular compound)
(d) hydrobromic acid
(e) lithium carbonate
(f) potassium dichromate
(g) ammonium nitrite
(h) phosphorus trifluoride
(i) phosphorus pentafluoride
(j) tetraphosphorus hexoxide
(k) cadmium iodide
(l) strontium sulfate
(m) aluminum hydroxide
(n) sodium carbonate decahydrate

2.58 Name these compounds: (b) Ag_2CO_3, (c) $FeCl_2$, (d) $KMnO_4$, (e) $CsClO_3$, (f) HIO, (g) FeO, (h) Fe_2O_3, (i) $TiCl_4$, (j) NaH, (k) Li_3N, (l) Na_2O, (n) $FeCl_3.6H2O$

(b) silver carbonate

(c) This is an ionic compound in which the metal can form more than one cation. Use a Roman numeral to specify the charge of the Fe ion. Since the chloride ion has a −1 charge, the Fe ion has a +2 charge. The correct name is **iron(II) chloride**.

(d) potassium permanganate **(e) cesium chlorate** **(f) hypoiodous acid**

(g) This is an ionic compound in which the metal can form more than one cation. Use a Roman numeral to specify the charge of the Fe ion. Since the oxide ion has a −2 charge, the Fe ion has a +2 charge. The correct name is **iron(II) oxide**.

(h) iron(III) oxide

(i) This is an ionic compound in which the metal can form more than one cation. Use a Roman numeral to specify the charge of the Ti ion. Since each of the four chloride ions has a −1 charge (total of −4), the Ti ion has a +4 charge. The correct name is **titanium(IV) chloride**.

(j) sodium hydride **(k) lithium nitride** **(l) sodium oxide**

(n) iron(III) chloride hexahydrate

2.59 Write the formulas for the following compounds: (a) rubidium nitrite, (b) potassium sulfide, (c) sodium hydrogen sulfide, (d) magnesium phosphate, (e) calcium hydrogen phosphate, (f) potassium dihydrogen phosphate, (g) iodine heptafluoride, (h) ammonium sulfate, (i) silver perchlorate, (j) boron trichloride

(a) $RbNO_2$ **(b)** K_2S **(c)** $NaHS$ **(d)** $Mg_3(PO_4)_2$ **(e)** $CaHPO_4$

(f) KH_2PO_4 **(g)** IF_7 **(h)** $(NH_4)_2SO_4$ **(i)** $AgClO_4$ **(j)** BCl_3

2.60 Write the formulas for the following compounds: (a) copper(I) cyanide, (b) strontium chlorite, (c) perbromic acid, (d) hydroiodic acid, (e) disodium ammonium phosphate, (f) lead(II) carbonate, (g) tin(II) fluoride, (h) tetraphosphorus decasulfide, (i) mercury(II) oxide, (j) mercury(I) iodide, (k) selenium hexafluoride

(a) The Roman numeral I tells you that the Cu cation has a +1 charge. Cyanide has a −1 charge. Since, the charges are numerically equal, no subscripts are necessary in the formula. The correct formula is **CuCN**.

(b) Strontium is an alkaline earth metal. It only forms a +2 cation. The polyatomic ion chlorite, ClO_2^-, has a −1 charge. Since the charges on the cation and anion are numerically different, the subscript of the cation is numerically equal to the charge on the anion, and the subscript of the anion is numerically equal to the charge on the cation. The correct formula is **$Sr(ClO_2)_2$**.

(c) Perbromic tells you that the anion of this oxoacid is perbromate, BrO_4^-. The correct formula is **$HBrO_4(aq)$**. Remember that (*aq*) means that the substance is dissolved in water.

(d) Hydroiodic tells you that the anion of this binary acid is iodide, I^-. The correct formula is **$HI(aq)$**.

(e) Na is an alkali metal. It only forms a +1 cation. The polyatomic ion ammonium, NH_4^+, has a +1 charge and the polyatomic ion phosphate, PO_4^{3-}, has a −3 charge. To balance the charge, you need 2 Na^+ cations. The correct formula is **$Na_2(NH_4)PO_4$**.

(f) The Roman numeral II tells you that the Pb cation has a +2 charge. The polyatomic ion carbonate, CO_3^{2-}, has a −2 charge. Since, the charges are numerically equal, no subscripts are necessary in the formula. The correct formula is **$PbCO_3$**.

(g) The Roman numeral II tells you that the Sn cation has a +2 charge. Fluoride has a −1 charge. Since the charges on the cation and anion are numerically different, the subscript of the cation is numerically equal to the charge on the anion, and the subscript of the anion is numerically equal to the charge on the cation. The correct formula is **SnF_2**.

(h) This is a molecular compound. The Greek prefixes tell you the number of each type of atom in the molecule. The correct formula is **P_4S_{10}**.

(i) The Roman numeral II tells you that the Hg cation has a +2 charge. Oxide has a −2 charge. Since, the charges are numerically equal, no subscripts are necessary in the formula. The correct formula is **HgO**.

(j) The Roman numeral I tells you that the Hg cation has a +1 charge. However, this cation exists as Hg_2^{2+}. Iodide has a −1 charge. You need two iodide ion to balance the +2 charge of Hg_2^{2+}. The correct formula is **Hg_2I_2**.

(k) This is a molecular compound. The Greek prefixes tell you the number of each type of atom in the molecule. The correct formula is **SeF_6**.

2.73 What is wrong with the name (in parentheses) for each of the following compounds: (a) $BaCl_2$ (barium dichloride), (b) Fe_2O_3 [iron(II) oxide], (c) $CsNO_2$ (cesium nitrate), (d) $Mg(HCO_3)_2$ [magnesium(II) bicarbonate]?

(a) This is an ionic compound. Prefixes are *not* used. The correct name is barium chloride.

(b) Iron has a +3 charge in this compound. The correct name is iron(III) oxide.

(c) NO_2^- is the nitrite ion. The correct name is cesium nitrite.

(d) Magnesium is an alkaline earth metal, which always has a +2 charge in ionic compounds. The roman numeral is not necessary. The correct name is magnesium bicarbonate.

2.74 What is wrong with the chemical formula for each of the following compounds: (a) $(NH_3)_2CO_3$ (ammonium carbonate), (b) CaOH (calcium hydroxide), (c) $CdSO_3$ (cadmium sulfide), (d) $ZnCrO_4$ (zinc dichromate)?

(a) Ammonium is NH_4^+, not NH_3^+. The formula should be $\mathbf{(NH_4)_2CO_3}$.

(b) Calcium has a +2 charge and hydroxide has a −1 charge. The formula should be $\mathbf{Ca(OH)_2}$.

(c) Sulfide is S^{2-}, not SO_3^{2-}. The correct formula is **CdS**.

(d) Dichromate is $Cr_2O_7^{2-}$, not $Cr_2O_4^{2-}$. The correct formula is $\mathbf{ZnCr_2O_7}$.