3. A 0.406 g sample of magnesium reacts with oxygen, producing 0.674 g of magnesium oxide as the only product. What mass of oxygen was consumed in the reaction?

Since we know the mass of magnesium that went into making 0.674 g of magnesium oxide, we can find the mass of oxygen by subtracting the mass of magnesium from the mass of magnesium oxide.

mass of oxygen = 0.674 − 0.406 = 0.268 g

---

4. A 1.446 g sample of potassium reacts with 8.178 g of chlorine to produce potassium chloride as the only product. After the reaction, 6.867 g of chlorine remains unreacted. What mass of potassium chloride was formed?

If 6.867 g of chlorine remains ureacted, we can find the amount that reacted by subtracting the remaining amount from the initial amount.

mass of chlorine reacted = 8.178 − 6.867 = 1.311 g

Mass is conserved in a chemical reaction. Thus,

mass of reactant(s) = mass of product(s)

(mass of potassium reacted) + (mass of chlorine reacted) = (mass of potassium chloride produced)

1.446 + 1.311 = mass of potassium chloride produced

mass of potassium chloride produced = 2.757 g

5. When a solid mixture consisting of 10.500 g calcium hydroxide and 11.125 g ammonium chloride is strongly heated, gaseous products are evolved and 14.336 g of a solid residue remains. The gases are passed into 62.316 g water, and the mass of the resulting solution is 69.605 g. Within the limits of experimental error, show that these data conform to the law of conservation of mass.

Whatever happened in the reaction, whatever amounts of reactants remained unreacted, etc. we know that the total mass of the substances involved in the reaction will be the same before and after the reaction.

The water is not part of the reaction; it is just catching a gaseous product that's coming out. What we need is to calculate the mass added into the water (which would be the mass of the gaseous product)

$$\text{mass of gas} = \begin{pmatrix}\text{mass of}\\ \text{resulting solution}\end{pmatrix} - \begin{pmatrix}\text{mass of}\\ \text{water before rxn}\end{pmatrix}$$

$$= 69.605 - 62.316 = 7.289 \text{ g}$$

The other part of the reaction mixture at the end of the reaction is the solid residue with a mass of 14.336 g.

mass before reaction = 10.500 + 11.125 = 21.625 g

mass after reaction = 14.336 + 7.289 = 21.625 g

Data conform to the law of conservation of mass.

6. Within the limits of experimental error, show that the law of conservation of mass was obeyed in the following experiment: 10.00 g calcium carbonate (found in limestone) was dissolved in 100.0 mL hydrochloric acid ($d = 1.148$ g/mL). The products were 120.40 g solution (a mixture of hydrochloric acid and calcium chloride) and 2.22 L carbon dioxide gas ($d = 1.9769$ g/L).

mass before reaction = mass after reaction

We need to convert the amounts given as volume to mass using the corresponding density values:

$$m_{HCl} = d_{HCl} \cdot V_{HCl} = 1.148 \frac{g}{mL} \times 100.0\, mL = 114.8\, g$$

↑ m_{HCl}: mass of hydrochloric acid before reaction

↑ V_{HCl}: Volume of hydrochloric acid before reaction

total mass before reaction = 10.00 g + 114.8 g = 124.8 g

$$m_{CO_2} = d_{CO_2} \cdot V_{CO_2} = 1.9769 \frac{g}{L} \cdot 2.22\, L = 4.39\, g$$

↑ m_{CO_2}: mass of carbon dioxide gas (after reaction)

total mass after reaction = 120.40 g + 4.39 g = 124.79 g

Total mass before and after reaction are the same within the precision of the two numbers.

⇒ The law of conservation of mass is obeyed

7. In Example 2-1, we established that the mass ratio of magnesium to magnesium oxide is 0.455 g magnesium/ 0.755 g magnesium oxide.

(a) What is the ratio of oxygen to magnesium oxide, by mass?

(b) What is the mass ratio of oxygen to magnesium in magnesium oxide?

(c) What is the percent by mass of magnesium in magnesium oxide?

(a) Magnesium oxide is composed of just magnesium and oxygen (as its name implies)

mass of magnesium oxide = (mass of magnesium) + (mass of oxygen)

$\Rightarrow$ mass of oxygen = (mass of magnesium oxide) − (mass of magnesium)

$= 0.755\,g - 0.455\,g = 0.300\,g$

$$\text{mass \% of O} = \frac{\text{mass of O}}{\text{mass of magnesium oxide}} = \frac{0.300}{0.755} = 0.397$$

(b) $\frac{0.300}{0.455} = 0.659$

(c) $$\text{mass \% of magnesium} = \frac{\text{mass of magnesium}}{\text{mass of magnesium oxide}} \times 100$$

$$= \frac{0.455}{0.755} \times 100 = 60.3\%$$

8. Samples of pure carbon weighing 3.62, 5.91, and 7.07 g were burned in an excess of air. The masses of carbon dioxide obtained (the sole product in each case) were 13.26, 21.66, and 25.91 g, respectively.
(a) Do these data establish that carbon dioxide has a fixed composition?
(b) What is the composition of carbon dioxide, expressed in % C and % O, by mass?

(a) According to the law of fixed composition the ratio of carbon amount to the amount of sample is fixed (constant) for a given compound

$$\frac{3.62}{13.26} = 0.273$$

$$\frac{5.91}{21.66} = 0.273$$

$$\frac{7.07}{25.91} = 0.273$$

carbon dioxide has a fixed (constant) composition ✓

(b) Let's convert the fraction of carbon in carbon dioxide and convert it to percent mass by multiplying it by 100:

mass % of carbon = (0.273)(100) = 27.3%

The remaining mass is due to oxygen
The mass percents must add up to 100%

(mass % of carbon) + (mass % of oxygen) = 100

mass % of oxygen = 100 − (mass % of carbon) = 100 − 27.3
= 72.7%

We could also subtract the mass of carbon from the mass of sample to find the mass of oxygen, and then calculate its mass %:

$$\text{mass of oxygen} = 25.91 - 7.07 = 18.84\,g$$

$$\text{mass \% of oxygen} = \frac{18.84}{25.91} \times 100 = 72.7\%$$

13. Sulfur forms two compounds with oxygen. In the first compound, 1.000 g sulfur is combined with 0.998 g oxygen, and in the second, 1.000 g sulfur is combined with 1.497 g oxygen. Show that these results are consistent with Dalton's law of multiple proportions.

We are looking for a ratio of simple integers when we divide the amount of one element in one compound with the amount of that element in the other compound, for a fixed amount of the second element.

It's simplest to consider the amount of oxygen per 1.000 g of sulfur for both compounds

$$\frac{1.497\text{ g oxygen in 2nd compound}}{0.998\text{ g oxygen in 1st compound}} = 1.5 = \frac{3}{2}$$

14. Phosphorus forms two compounds with chlorine. In the first compound, 1.000 g of phosphorus is combined with 3.433 g chlorine, and in the second, 2.500 g phosphorus is combined with 14.308 g chlorine. Show that these results are consistent with Dalton's law of multiple proportions.

To make the quantities in both samples to correspond to the same amount of one of the elements, it's simplest to divide the amounts in the 2nd compound by 2.500 so that we have 1.000 g of phosphorus in both samples.

For 1.000 g of phosphorus

3.433 g chlorine in the first compound

$\frac{14.308}{2.500} = 5.723$ g chlorine in the second compound

$\frac{3.433}{5.723} = 1.667 \simeq 1\frac{2}{3} = \frac{5}{3}$ ratio of small integers

23. The following radioactive isotopes have applications in medicine. Write their symbols in the form $^{A}_{Z}E$. **(a)** cobalt-60; **(b)** phosphorus-32; **(c)** iron-59; **(d)** radium-226.

(a) $Z = 27$ for cobalt (Co)
$A = 60$ for cobalt-60 $\Rightarrow$ $^{60}_{27}Co$

(b) $Z = 15$ for phosphorus (P)
$A = 32$ for phosphorus-32 $\Rightarrow$ $^{32}_{15}P$

(c) $Z = 26$ for iron (Fe)
$A = 59$ for iron-59 $\Rightarrow$ $^{59}_{26}Fe$

(d) $Z = 88$ for radium (Ra)
$A = 226$ for radium-226 $\Rightarrow$ $^{226}_{88}Ra$

27. For the atom ^{108}Pd with mass 107.90389 u, determine
(a) the numbers of protons, neutrons, and electrons in the atom;
(b) the ratio of the mass of this atom to that of an atom of $^{12}_{6}C$.

(a) $Z = 46$ for Pd

$A = 108$ for ^{108}Pd

$p = Z$ $\quad$ $p = 46$

$p + n = A$ $\quad$ $46 + n = 108$

$n = 108 - 46 = 62$

For a neutral atom, $e = p$

$e = 46$

p = no. of protons
n = no. of neutrons
e = no. of electrons

(b) mass of $^{12}_{6}C$ is exactly 12 u

$$\frac{107.90389}{12} = 8.9919908$$

28. For the ion $^{228}Ra^{2+}$ with a mass of 228.030 u, determine **(a)** the numbers of protons, neutrons, and electrons in the ion; **(b)** the ratio of the mass of this ion to that of an atom of ^{16}O (refer to page 47).

(a) $Z = 88$ for Ra $\longrightarrow$ $p = 88$

$A = 228$ for ^{228}Ra $\longrightarrow$ $n = 228 - 88 = 140$

$e = p = 88$ for a neutral Ra atom

but 2 less for a Ra^{2+} cation

$e = 88 - 2 = 86$

(b) $\dfrac{228.030}{15.994914} = 14.2564$

32. The following ratios of masses were obtained with a mass spectrometer: ${}^{19}_{9}F/{}^{12}_{6}C = 1.5832$; ${}^{35}_{17}Cl/{}^{19}_{9}F = 1.8406$; ${}^{81}_{35}Br/{}^{35}_{17}Cl = 2.3140$. Determine the mass of a ${}^{81}_{35}Br$ atom in amu.

We know that ${}^{12}_{6}C$ mass is exactly 12u.

The ratios are conversion factors connecting the mass of one isotope to another.

We can have a chain of conversions to go from ${}^{12}_{6}C$ mass to ${}^{81}_{35}Br$ mass:

$$12\,u\ {}^{12}_{6}C \times \frac{1.5832\ u\ {}^{19}_{9}F}{1\ u\ {}^{12}_{6}C} \times \frac{1.8406\ u\ {}^{35}_{17}Cl}{1\ u\ {}^{19}_{9}F} \times \frac{2.3140\ u\ {}^{81}_{35}Br}{1\ u\ {}^{35}_{17}Cl}$$

$$= 80.917\ u\ {}^{81}_{35}Br$$

35. An isotope with mass number 44 has four more neutrons than protons. This is an isotope of what element?

$$A = p + n = 44$$

$$n = p + 4 \quad \text{(four more neutrons than protons)}$$

$$p + (p+4) = 44$$

$$2p + 4 = 44$$

$$2p = 40$$

$$p = 20 \Longrightarrow \text{Ca (calcium)}$$

38. Iodine-131 is a radioactive isotope that has important medical uses. Small doses of iodine-131 are used for treating hyperthyroidism (overactive thyroid) and larger doses are used for treating thyroid cancer. Iodine-131 is administered to patients in the form of sodium iodide capsules that contain $^{131}I^-$ ions. Determine the number of neutrons, protons, and electrons in a single $^{131}I^-$ ion.

$^{131}I^-$

$n + p = 131$

$p = 53$ (because iodine has the atomic number 53)

$n + 53 = 131$

$n = 131 - 53 = 78$

$e = p = 53$ for a neutral I atom

I^- has one extra electron. So,

$e = 53 + 1 = 54$ for $^{131}I^-$

39. Americium-241 is a radioactive isotope that is used in high-precision gas and smoke detectors. How many neutrons, protons, and electrons are there in an atom of americium-241?

Americium (Am) has $Z = 95$ $\Longrightarrow$ $p = 95$

$n + p = 241$

$n + 95 = 241$

$n = 241 - 95 = 146$

$e = p$ for a neutral atom

$e = 95$

40. Some foods are made safer to eat by being exposed to gamma rays from radioactive isotopes, such as cobalt-60. The energy from the gamma rays kills bacteria in the food. How many neutrons, protons, and electrons are there in an atom of cobalt-60?

$p = Z = 27$ for cobalt

$p + n = A = 60$ for cobalt-60

$n = 60 - p = 60 - 27 = 33$

$e = p$ for a neutral atom

$e = 27$

44. There are four naturally occurring isotopes of chromium. Their masses and percent isotopic abundances are 49.9461 u, 4.35%; 51.9405 u, 83.79%; 52.9407 u, 9.50%; and 53.9389 u, 2.36%. Calculate the weighted-average atomic mass of chromium.

$$\text{atomic mass} = \begin{pmatrix}\text{fractional}\\ \text{abundance}\\ 1\end{pmatrix}\begin{pmatrix}\text{isotopic}\\ \text{mass}\\ 1\end{pmatrix} + \begin{pmatrix}\text{fractional}\\ \text{abundance}\\ 2\end{pmatrix}\begin{pmatrix}\text{isotopic}\\ \text{mass}\\ 2\end{pmatrix} + \ldots\ldots$$

$$\text{fractional abundance} = \frac{\text{percent abundance}}{100}$$

$$\text{atomic mass} = (0.0435)(49.9461) + (0.8379)(51.9405) + (0.0950)(52.9407) + (0.0236)(53.9389)$$

$$= 51.99\underline{6}\ u$$

45. The two naturally occurring isotopes of silver have the following abundances: ^{107}Ag, 51.84%; ^{109}Ag, 48.16%. The mass of ^{107}Ag is 106.905092 u. What is the mass of ^{109}Ag?

$$\begin{pmatrix}\text{atomic mass}\\ \text{of Ag}\end{pmatrix} = \begin{pmatrix}\text{fractional}\\ \text{abundance}\\ \text{of } ^{107}Ag\end{pmatrix}\begin{pmatrix}\text{isotopic}\\ \text{mass of}\\ ^{107}Ag\end{pmatrix} + \begin{pmatrix}\text{fractional}\\ \text{abundance}\\ \text{of } ^{109}Ag\end{pmatrix}\begin{pmatrix}\text{isotopic}\\ \text{mass of}\\ ^{109}Ag\end{pmatrix}$$

✓ (look up) ✓ ✓ ✓ ?

$$107.87 = (0.5184)(106.905092) + (0.4816)\,x$$

$$x = 108.9\underline{1}\ u$$

46. Gallium has two naturally occurring isotopes. One of them, gallium-69, has a mass of 68.925581 u and a percent isotopic abundance of 60.11%. What must be the mass and percent isotopic abundance of the other isotope, gallium-71?

With only two naturally occurring isotopes, we can calculate the abundance of one isotope from the other:

% abundance of gallium-71 = 100 − 60.11 = 39.89%
because the abundances must add up to 100.

$$69.723 = (0.6011)(68.925581) + (0.3989)\,x$$

69.723: atomic mass of Ga, looked up from periodic table

x: isotopic mass of gallium-71

$x = 70.92$ u

48. Use the conventional atomic mass of boron to estimate the fractional isotopic abundances of the two naturally occurring isotopes, ^{10}B and ^{11}B. These isotopes have masses of 10.012937 u and 11.009305 u, respectively.

Remember that fractional abundances add up to 1

If the abundance of ^{10}B is x, then the abundance of ^{11}B is $1-x$

$$10.81 = x(10.012937) + (1-x)(11.009305)$$

atomic mass of boron (looked up)

$$10.81 = 10.012937x + 11.009305 - 11.009305x$$

$$-0.199305 = -0.996368x$$

$$x = 0.2000 \xrightarrow{\times 100} 20.\% \text{ (abundance of } ^{10}B)$$

$$1-x = 0.8000 \xrightarrow{\times 100} 80.\% \text{ (abundance of } ^{11}B)$$

51. Refer to the periodic table inside the front cover and identify

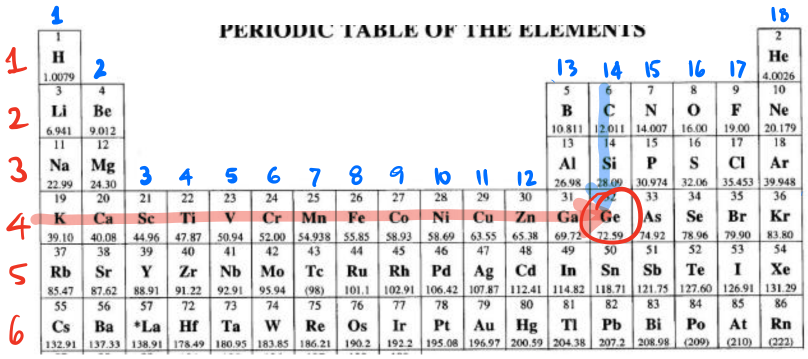
(a) the element that is in group 14 and the fourth period

(b) one element similar to and one unlike sulfur

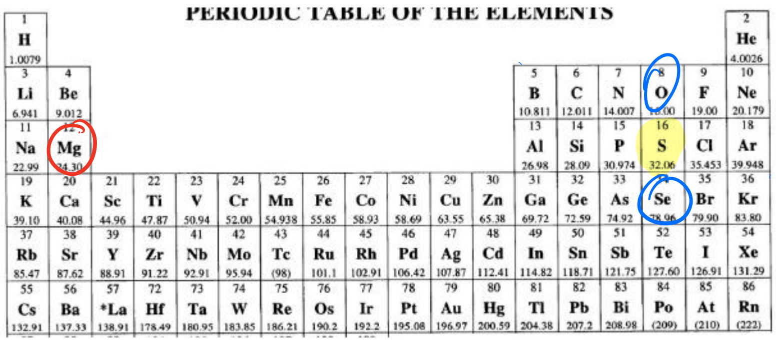
(c) the alkali metal in the fifth period

(d) the halogen element in the sixth period

(a)



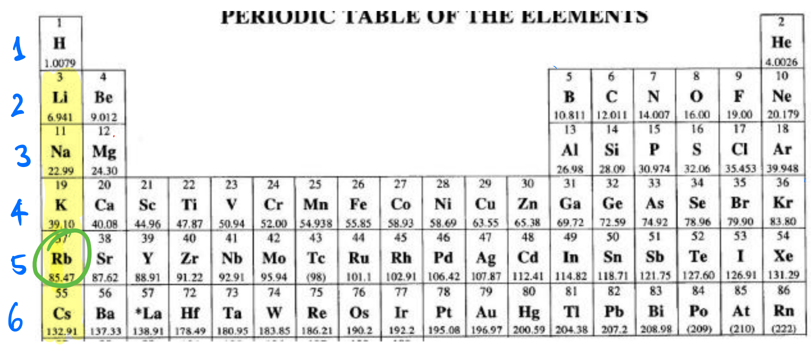
(b)



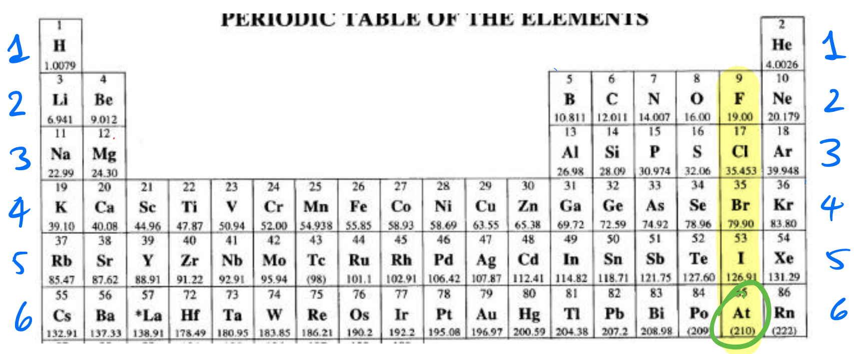
Se or O similar (in the same group)

Mg dissimilar (different group)

(c)

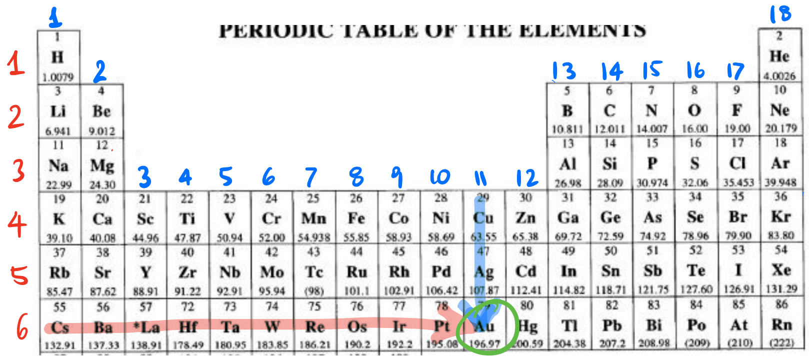


(d)

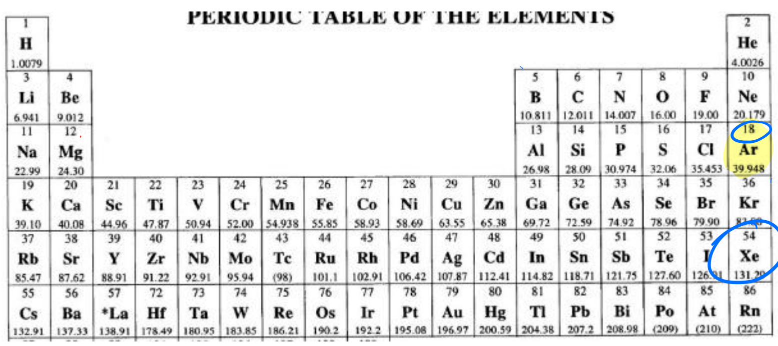


52. Refer to the periodic table inside the front cover and identify
(a) the element that is in group 11 and the sixth period
(b) an element with atomic number greater than 50 that has properties similar to the element with atomic number 18

(a)



(b)



We are looking for an element in the same group as Ar, but with $Z > 50$

Xe

55. What is the total number of atoms in **(a)** 15.8 mol Fe; **(b)** 0.000467 mol Ag; **(c)** 8.5×10^{-11} mol Na?

(a) $15.8 \text{ mol Fe} \times \frac{6.022\times10^{23} \text{ Fe atoms}}{1 \text{ mol Fe}} = 9.51\times10^{24}$ Fe atoms

(b) $0.000467 \text{ mol Ag} \times \frac{6.022\times10^{23} \text{ Ag atoms}}{1 \text{ mol Ag}} = 2.81\times10^{20}$ Ag atoms

(c) $8.5\times10^{-11} \text{ mol Na} \times \frac{6.022\times10^{23} \text{ Ag atoms}}{1 \text{ mol Na}} = 5.1\times10^{13}$ Na atoms

57. Determine
(a) the number of moles of Zn in a 415.0 g sample of zinc metal
(b) the number of Cr atoms in 147.4 kg chromium
(c) the mass of a one-trillion-atom (1.0×10^{12}) sample of metallic gold
(d) the average mass of a fluorine atom (in grams)

(a) mass of Zn $\xrightarrow{\text{molar mass of Zn}}$ moles of Zn

$$415.0\text{ g Zn} \times \frac{1\text{ mol Zn}}{65.38\text{ g Zn}} = 6.348\text{ mol Zn}$$

(b) kg of Cr $\xrightarrow{k = kilo = 10^3}$ g of Cr $\xrightarrow{\text{molar mass of Cr}}$ moles of Cr $\xrightarrow{\text{Avogadro's Number}}$ no. of atoms of Cr

$$147.4\text{ kg Cr} \times \frac{10^3\text{ g Cr}}{1\text{ kg Cr}} \times \frac{1\text{ mol Cr}}{51.996\text{ g Cr}} \times \frac{6.022 \times 10^{23}\text{ Cr atoms}}{1\text{ mol Cr}} = 1.707 \times 10^{27}\text{ Cr atoms}$$

(c) no. of Au atoms $\xrightarrow{\text{Avogadro's number}}$ moles of Au $\xrightarrow{\text{molar mass of Au}}$ grams of Au

$$1.0 \times 10^{12}\text{ Au atoms} \times \frac{1\text{ mol Au}}{6.022 \times 10^{23}\text{ Au atoms}} \times \frac{196.97\text{ g Au}}{1\text{ mol Au}} = 3.3 \times 10^{-10}\text{ g Au}$$

(d)
$$1\text{ F atom} \times \frac{1\text{ mol F}}{6.022 \times 10^{23}\text{ F atoms}} \times \frac{18.998\text{ g F}}{1\text{ mol F}} = 3.155 \times 10^{-23}\text{ g F}$$

58. Determine

(a) the number of Kr atoms in a 5.25 mg sample of krypton

(b) the molar mass, *M*, and identity of an element if the mass of a 2.80×10^{22} atom sample of the element is 2.09 g

(c) the mass of a sample of phosphorus that contains the same number of atoms as 44.75 g of magnesium

(a) $5.25 \text{ mg Kr} \times \frac{10^{-3} \text{ g Kr}}{1 \text{ mg Kr}} \times \frac{1 \text{ mol Kr}}{83.798 \text{ g Kr}} \times \frac{6.022 \times 10^{23} \text{ Kr atoms}}{1 \text{ mol Kr}}$

$= 3.77 \times 10^{19}$ Kr atoms

(b) $\text{molar mass} = \frac{\text{mass}}{\text{moles}}$

We calculate moles from the number of atoms

$2.80 \times 10^{22} \text{ atoms} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} = 0.0465 \text{ mol}$

$\text{molar mass} = \frac{2.09 \text{ g}}{0.0465 \text{ mol}} = 44.9 \text{ g/mol}$

(c) To match the number of atoms, we need to match the number of moles

$44.75 \text{ g Mg} \times \frac{1 \text{ mol Mg}}{24.305 \text{ g Mg}} = 1.841 \text{ mol Mg}$

no. of moles of P = no. of moles of Mg = 1.841 mol

$\text{mass of P} = 1.841 \text{ mol P} \times \frac{30.974 \text{ g P}}{1 \text{ mol P}} = 57.02 \text{ g P}$

61. How many ^{204}Pb atoms are present in a piece of lead weighing 215 mg? The percent isotopic abundance of ^{204}Pb is 1.4%.

Percent abundance is on a mole basis. So we must convert the mass of the sample to moles, using the molar mass of element Pb (not just ^{204}Pb) and then take 1.4% of that.

$$215 \text{ mg Pb} \times \frac{10^{-3} \text{ g Pb}}{1 \text{ mg Pb}} \times \frac{1 \text{ mol Pb}}{207.2 \text{ g Pb}} = 1.038 \times 10^{-3} \text{ mol Pb}$$

$$\text{moles of } ^{204}Pb = (0.014)(1.038 \times 10^{-3}) = 1.453 \times 10^{-5} \text{ mol } ^{204}Pb$$

$$\text{no. of atoms of } ^{204}Pb = 1.453 \times 10^{-5} \text{ mol } ^{204}Pb \times \frac{6.022 \times 10^{23} \text{ Pb atoms}}{1 \text{ mol } ^{204}Pb}$$

$$= 8.75 \times 10^{18} \text{ Pb atoms}$$

62. A particular lead–cadmium alloy is 8.0% cadmium by mass. What mass of this alloy, in grams, must you weigh out to obtain a sample containing 7.25×10^{23} Cd atoms?

We first convert the no. of Cd atoms to grams:

$$7.25 \times 10^{23} \text{ Cd atoms} \times \frac{1 \text{ mol Cd}}{6.022 \times 10^{23} \text{ Cd atoms}} \times \frac{112.41 \text{ g Cd}}{1 \text{ mol Cd}} = 135.3 \text{ g Cd}$$

If 8.0% of the alloy sample amounts to 135.3 g, what is the mass of the sample (i.e. 100% of the sample)?

The whole sample has $\frac{100}{8.0} = 12.5$ times more mass than the Cd it contains. Therefore:

$(12.5)(135.3 \text{ g}) = 1691 \text{ g}$ is the sample mass

Or, using dimensional analysis:

$$135.3 \text{ g Cd} \times \frac{100 \text{ g sample}}{8.0 \text{ g Cd}} = 1691 \text{ g}$$

63. Medical experts generally believe a level of 30 μg Pb per deciliter of blood poses a significant health risk (1 dL = 0.1 L). Express this level **(a)** in the unit mol Pb/L blood; **(b)** as the number of Pb atoms per milliliter of blood.

(a) $\frac{30\ \mu g\ \text{Pb}}{0.1\ L} \times \frac{10^{-6}\ g\ \text{Pb}}{1\ \mu g\ \text{Pb}} \times \frac{1\ \text{mol Pb}}{207.2\ g\ \text{Pb}} = 1.4 \times 10^{-6}\ \frac{\text{mol Pb}}{L}$

(b) $1.4 \times 10^{-6}\ \frac{\text{mol Pb}}{L} \times \frac{6.022 \times 10^{23}\ \text{Pb atoms}}{1\ \text{mol Pb}} \times \frac{10^{-3}\ L}{1\ mL} = 8.4 \times 10^{14}\ \frac{\text{Pb atoms}}{mL}$

64. During a severe episode of air pollution, the concentration of lead in the air was observed to be 3.11 μg Pb/m³. How many Pb atoms would be present in a 0.500 L sample of this air (the volume of air displaced in the lungs between inhaling and exhaling)?

To answer this question using dimensional analysis, we start with a quantity that is proportional to the quantity wanted. The more the volume, the more Pb atoms there would be.

$0.500\ L \times \frac{1\ dm^3}{1\ L} \times \frac{(10^{-1}\ m)^3}{(1\ dm)^3} \times \frac{3.11\ \mu g\ \text{Pb}}{m^3} \times \frac{10^{-6}\ g\ \text{Pb}}{1\ \mu g\ \text{Pb}} \times \frac{1\ \text{mol Pb}}{207.2\ g\ \text{Pb}} \times \frac{6.022 \times 10^{23}\ \text{Pb atoms}}{1\ \text{mol Pb}}$

↑ using the definition of "Liter"

↑ remember how we turn length conversions to volume conversions?

$= 4.52 \times 10^{12}$ Pb atoms

100. An attempt was made to determine the atomic mass of element X. If X forms a compound with oxygen that contains 46.7% X by mass and has the formula XO, what is the atomic mass of X?

x = molar mass of X

$$\text{mass \% of X} = \frac{x}{x + 15.999} \times 100 = 46.7$$

$$\frac{x}{x + 15.999} = 0.467$$

$$x = (0.467)(x + 15.999)$$

$$x = 0.467x + 7.472$$

$$0.533x = 7.472$$

$$x = 14.0 \text{ g/mol}$$

103. Which of the following have the same charge and approximately the same mass?
(a) an electron and a proton; **(b)** a proton and a neutron; **(c)** a hydrogen atom and a proton; **(d)** a neutron and a hydrogen atom; **(e)** an electron and an H^- ion

(a) Electrons and protons have opposite charges
A proton is ~2000 times heavier than an electron.

(b) proton & neutron have approximately the same mass but proton has a positive charge while neutrons are neutral

(c) A hydrogen atom (assuming ^1H isotope, which comprises the vast majority of hydrogen) and a proton have approximately the same mass but a proton is positively charged while a hydrogen atom is neutral

✓ (d) A hydrogen atom (assuming ^1H isotope, which comprises the vast majority of hydrogen) and a neutron have approximately the same mass and both are neutral (i.e. they both have a charge of zero)

(e) An electron and an H^- (hydride ion) have the same negative charge, but H^- is ~2000 times heavier than an electron

107. What is the correct symbol for the species that contains 18 neutrons, 17 protons, and 16 electrons?

17 protons $\Longrightarrow$ $Z = 17$ $\Longrightarrow$ $_{17}Cl$

$A = p + n = 17 + 18 = 35$ $\Longrightarrow$ $^{35}_{17}Cl$

16 electrons is one less than the number of protons, meaning there is a +1 net charge

$\Longrightarrow$ $^{35}_{17}Cl^+$

108. The properties of magnesium will most resemble those of which of the following? **(a)** cesium; **(b)** sodium; **(c)** aluminum; **(d)** calcium; **(e)** manganese.

PERIODIC TABLE OF THE ELEMENTS

1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 16.00	9 F 19.00	10 Ne 20.179
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.938	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.91	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 *La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.2	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)

Magnesium (Mg) will most resemble Ca (calcium) since they are in the same group (column)
The other elements are not in the same group.

110. The two species that have the same number of electrons as ^{32}S are **(a)** ^{32}Cl; **(b)** $^{34}S^{+}$; **(c)** $^{33}P^{+}$; **(d)** $^{28}Si^{2-}$; **(e)** $^{35}S^{2-}$; **(f)** $^{40}Ar^{2+}$; **(g)** $^{40}Ca^{2+}$.

$^{32}S \Rightarrow Z = 16$ $\quad e = 16$ because ^{32}S is neutral

(a) $^{32}Cl \Rightarrow Z = 17$ $\quad e = 17 \neq 16$ ✗

(b) $^{34}S^{+} \Rightarrow Z = 16$ $\quad e = 16 - 1 = 15 \neq 16$ ✗

(c) $^{33}P^{+} \Rightarrow Z = 15$ $\quad e = 15 - 1 = 14 \neq 16$ ✗

(d) $^{28}Si^{2-} \Rightarrow Z = 14$ $\quad e = 14 + 2 = 16$ ✓

(e) $^{35}S^{2-} \Rightarrow Z = 16$ $\quad e = 16 + 2 = 18 \neq 16$ ✗

(f) $^{40}Ar^{2+} \Rightarrow Z = 18$ $\quad e = 18 - 2 = 16$ ✓

(g) $^{40}Ca^{2+} \Rightarrow Z = 20$ $\quad e = 20 - 2 = 18 \neq 16$ ✗

113. A 5.585-kg sample of iron (Fe) contains

(a) 10.0 mol Fe
(b) twice as many atoms as does 600.6 g C
(c) 10 times as many atoms as does 52.00 g Cr
(d) 6.022×10^{24} atoms

$$5.585 \text{ kg Fe} \times \frac{10^3 \text{ g Fe}}{1 \text{ kg Fe}} \times \frac{1 \text{ mol Fe}}{55.845 \text{ g Fe}} = 100.0 \text{ mol Fe}$$

(a) 10.0 mol Fe ✗

(b) $600.6 \text{ g C} \times \frac{1 \text{ mol C}}{12.011 \text{ g C}} = 50.00 \text{ mol C} \xrightarrow{\times 2} 100.00 \text{ mol C}$ ✓

(c) $52.00 \text{ g Cr} \times \frac{1 \text{ mol Cr}}{51.996 \text{ g Cr}} = 1.000 \text{ mol Cr} \xrightarrow{\times 10} 10.00 \text{ mol Cr}$ ✗

(d) $6.022 \times 10^{24} \text{ atoms} \times \frac{1 \text{ mol atoms}}{6.022 \times 10^{23} \text{ atoms}} = 1.000 \text{ mol atoms}$ ✗

114. A 91.84 g sample of Ti contains **(a)** 4.175 mol of Ti; **(b)** 6.022×10^{23} Ti atoms; **(c)** 1.155×10^{24} protons; **(d)** 2.542×10^{25} electrons; **(e)** none of these.

(a) $91.84\text{ g} \times \frac{1\text{ mol}}{47.867\text{ g}} = 1.9186\text{ mol} \neq 4.175\text{ mol}$ ✗

(b) $1.9186\text{ mol} \times \frac{6.022\times10^{23}\text{ atoms}}{1\text{ mol}} = 1.1554\times10^{24}\text{ atoms} \neq 6.022\times10^{23}\text{ atoms}$ ✗

(c) $1.1554\times10^{24}\text{ atoms} \times \frac{22\text{ protons}}{1\text{ atom}} = 2.542\times10^{25}\text{ protons} \neq 1.155\times10^{24}\text{ protons}$ ✗

Z=22

(d) $2.542\times10^{25}\text{ protons} \times \frac{1\text{ electron}}{1\text{ proton}} = 2.542\times10^{25}\text{ electrons}$ ✓

for a neutral atom (and a sample of the element is neutral, composed of neutral atoms)

117. Gold is present in seawater to the extent of 0.15 mg/ton. Assume the density of the seawater is 1.03 g/mL and determine how many Au atoms could conceivably be extracted from 0.250 L of seawater ($1 \text{ ton} = 2.000 \times 10^3 \text{ lb}$; $1 \text{ kg} = 2.205 \text{ lb}$).

seawater = "sw"

$$0.250\ \text{L} \times \frac{1\ \text{mL}}{10^{-3}\ \text{L}} \times \frac{1.03\ \text{g sw}}{1\ \text{mL}} \times \frac{1\ \text{kg sw}}{10^{3}\ \text{g sw}} \times \frac{2.205\ \text{lb sw}}{1\ \text{kg sw}} \times \frac{1\ \text{ton sw}}{2.000 \times 10^{3}\ \text{lb sw}} \times \frac{0.15\ \text{mg Au}}{1\ \text{ton sw}} \times \frac{10^{-3}\ \text{g Au}}{1\ \text{mg Au}} \times \frac{1\ \text{mol Au}}{196.97\ \text{g Au}} \times \frac{6.022 \times 10^{23}\ \text{Au atoms}}{1\ \text{mol Au}}$$

$$= 1.3 \times 10^{14}\ \text{Au atoms}$$

As an exercise, break down the dimensional analysis above into individual, conceptually distinct steps