(**Q1**) The atomic masses of $^{35}_{17}Cl$ (75.53 percent) and $^{37}_{17}Cl$ (24.47 percent) are 34.968 amu and 36.956 amu, respectively. Calculate the average atomic mass of chlorine. The percentages in parentheses denote the relative abundances.

Average atomic mass of = (0.7553)(34.968 amu) + (0.2447)(36.956 amu)

(**Q2**) The atomic masses of $^{6}_{3}Li$ and $^{7}_{3}Li$ are 6.0151 amu and 7.0160 amu, respectively. Calculate the natural abundances of these two isotopes. The average atomic mass of Li is 6.941 amu.

6.941 = (X)(6.0151) + (1−X)(7.0160)

7.59% and 92.51%

(**Q3**) (a) What is the mass in grams of 13.2 amu?

(b) How many amu are there in 8.4 g?

1 g = 6.022×10^{23} amu

1 amu = 1.661×10^{-24} g

(**Q4**) The mole is:

(a) Avogadro's number

(b) The quantity of matter containing unit mass of its particles

(c) The quantity of matter containing Avogadro's number of its particles

(d) The mass of matter containing Avogadro's number of its particles

(**Q5**) How many moles of cobalt (Co) atoms are there in 6.00×10^{9} (6 billion) Co atoms?

9.96×10^{-15} mol Co

(**Q6**) How many atoms are there in 5.10 moles of sulfur (S)?

(**Q7**) How many moles of calcium (Ca) atoms are in 77.4 g of Ca?

(**Q8**) How many grams of gold (Au) are there in 15.3 moles of Au?
3.01×10^{3} g Au

(**Q9**) What is the mass in grams of a single atom of each of the following elements?
(a) As: 1.244×10^{-22} g
(b) Ni: 9.746×10^{-23} g

(**Q10**) What is the mass in grams of 1.00×10^{12} lead (Pb) atoms?

(**Q11**) How many atoms are present in 3.14 g of copper (Cu)?
2.98×10^{22} Cu atoms

(**Q12**) Which of the following has more atoms:
1.10 g of hydrogen atoms or 14.7 g of chromium atoms?

(**Q13**) Which of the following has a greater mass:
2 atoms of lead (Pb) or 5.1×10^{-23} mole of helium.
Pb

(**Q14**) Calculate the molar mass of the following substances:
(a) Li_2CO_3,
(b) CS_2,
(c) $CHCl_3$ (chloroform),
(d) $C_6H_8O_6$ (ascorbic acid, or vitamin C),
(e) KNO_3,
(f) Mg_3N_2.

(**Q15**) How many molecules of ethane (C_2H_6) are present in 0.334 g of C_2H_6?
6.69×10^{21} C_2H_6 molecules

(**Q16**) Urea [$(NH_2)_2CO$] is used for fertilizer and many other things. Calculate the number of N, C, O, and H atoms in 1.68×10^4 g of urea.

N: 3.37×10^{26} atoms

C: 1.69×10^{26} atoms

O: 1.69×10^{26} atoms

H: 6.74×10^{26} atoms

(**Q17**) The density of water is 1.00 g/mL at 4°C. How many water molecules are present in 2.56 mL of water at this temperature?

8.56×10^{22} molecules

(**Q18**) For many years chloroform ($CHCl_3$) was used as an inhalation anesthetic in spite of the fact that it is also a toxic substance that may cause severe liver, kidney, and heart damage. Calculate the percent composition by mass of this compound.

The molar mass of $CHCl_3$ = 119.37 g.

C: 12.01 / 119.37 * 100% = 10.06%

H: 1.008 / 119.37 * 100% = 0.8442%

Cl: (3*35.45) / 119.37 * 100% = 89.07%

(**Q19**) All of the substances listed below are fertilizers that contribute nitrogen to the soil. Which of these is the richest source of nitrogen on a mass percentage basis?

(a) Urea, $(NH_2)_2CO$

(b) Ammonium nitrate, NH_4NO_3

(c) Guanidine, $HNC(NH_2)_2$

(d) Ammonia, NH_3

(**Q20**) Peroxyacylnitrate (PAN) is one of the components of smog. It is a compound of C, H, N, and O. Determine the percent composition of oxygen and the empirical formula from the following percent composition by mass: 19.8 percent C, 2.50 percent H, 11.6 percent N. What is its molecular formula given that its molar mass is about 120 g?

O: 66.1 percent

$C_2H_3NO_5$

The molecular formula is the same as the empirical formula

(**Q21**) The formula for rust can be represented by Fe_2O_3. How many moles of Fe are present in 24.6 g of the compound?

$\mathcal{M}$ Fe_2O_3 = 159.69 g/mol

1 mole Fe_2O_3 contains 2 mole Fe

(**Q22**) How many grams of sulfur (S) are needed to react completely with 246 g of mercury (Hg) to form HgS?

$Hg + S \rightarrow HgS$

39.3 g S

(**Q23**) Tin(II) fluoride (SnF_2) is often added to toothpaste as an ingredient to prevent tooth decay. What is the mass of F in grams in 24.6 g of the compound?

$\mathcal{M}$ SnF_2 = 156.71 g/mol

1 mole SnF_2 contains 2 mole F

5.97 g F

(**Q24**) What are the empirical formulas of the compounds with the following compositions?

(a) 40.1 percent C, 6.6 percent H, 53.3 percent O: CH_2O

(b) 18.4 percent C, 21.5 percent N, 60.1 percent K: KCN

(**Q25**) The empirical formula of a compound is CH. If the molar mass of this compound is about 78 g, what is its molecular formula?

$\mathcal{M}$ CH = 13 g/mol

78 / 13 = 6

C_6H_6

(**Q26**) Monosodium glutamate (MSG), a food-flavor enhancer, has been blamed for “Chinese restaurant syndrome”, the symptoms of which are headaches and chest pains. MSG has the following composition by mass: 35.51 percent C, 4.77 percent H, 37.85 percent O, 8.29 percent N, and 13.60 percent Na. What is its molecular formula if its molar mass is about 169 g?

$C_5H_8O_4NNa$

(**Q27**) Balance the following equations:

(a) $N_2O_5 \rightarrow N_2O_4 + O_2$
(b) $KNO_3 \rightarrow KNO_2 + O_2$
(c) $NH_4NO_3 \rightarrow N_2O + H_2O$
(d) $NH_4NO_2 \rightarrow N_2 + H_2O$
(e) $NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$
(f) $P_4O_{10} + H_2O \rightarrow H_3PO_4$
(g) $HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$
(h) $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$
(i) $CO_2 + KOH \rightarrow K_2CO_3 + H_2O$
(j) $CH_4 + O_2 \rightarrow CO_2 + H_2O$
(k) $Be_2C + H_2O \rightarrow Be(OH)_2 + CH_4$
(l) $Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$
(m) $S + HNO_3 \rightarrow H_2SO_4 + NO_2 + H_2O$
(n) $NH_3 + CuO \rightarrow Cu + N_2 + H_2O$

(**Q28**) Silicon tetrachloride ($SiCl_4$) can be prepared by heating Si in chlorine gas:
$Si(s) + 2Cl_2(g) \rightarrow SiCl_4(l)$
In one reaction, 0.507 mole of $SiCl_4$ is produced. How many moles of molecular chlorine were used in the reaction?
1.01 mol

(**Q29**) Consider the combustion of butane (C_4H_{10}):
$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$
In a particular reaction, 5.0 moles of C_4H_{10} are reacted with an excess of O_2. Calculate the number of moles of CO_2 formed.
20 mol

(**Q30**) When baking soda (sodium bicarbonate or sodium hydrogen carbonate, $NaHCO_3$) is heated, it releases carbon dioxide gas, which is responsible for the rising of cookies, donuts and bread.
(a) Write a balanced equation for the decomposition of the compound (one of the products is Na_2CO_3).
(b) Calculate the mass of $NaHCO_3$ required to produce 20.5 g of CO_2.
(a) $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$
(b) 78.3 g

(**Q31**) Fermentation is a complex chemical process of wine making in which glucose is converted into ethanol and carbon dioxide:

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Starting with 500.4 g of glucose, what is the maximum amount of ethanol in grams and in liters that can be obtained by this process? (Density of ethanol = 0.789 g/mL).

255.9 g; 0.324 L

(**Q32**) For many years the recovery of gold—that is, the separation of gold from other materials—involved the use of potassium cyanide:

$4Au + 8KCN + O_2 + 2H_2O \rightarrow 4KAu(CN)_2 + 4KOH$

What is the minimum amount of KCN in moles needed to extract 29.0 g (about an ounce) of gold?

0.294 mol

(**Q33**) Nitrous oxide (N_2O) is also called “laughing gas.” It can be prepared by the thermal decomposition of ammonium nitrate (NH_4NO_3). The other product is H_2O.

(a) Write a balanced equation for this reaction.

(b) How many grams of N_2O are formed if 0.46 mole of NH_4NO_3 is used in the reaction?

(a) $NH_4NO_3 \rightarrow N_2O + 2H_2O$

(b) 20 g N2O

(**Q34**) A common laboratory preparation of oxygen gas is the thermal decomposition of potassium chlorate ($KClO_3$). Assuming complete decomposition, calculate the number of grams of O_2 gas that can be obtained from 46.0 g of $KClO_3$. (The products are KCl and O_2).

$2KClO_3 \rightarrow 2KCl + 3O_2$

18 g

(**Q35**) The depletion of ozone (O_3) in the stratosphere has been a matter of great concern among scientists in recent years. It is believed that ozone can react with nitric oxide (NO) that is discharged from the high altitude jet plane, the SST. The reaction is

$O_3 + NO \rightarrow O_2 + NO_2$

If 0.740 g of O_3 reacts with 0.670 g of NO, which compound is the limiting reagent? How many grams of NO_2 will be produced? Calculate the number of moles of the excess reagent remaining at the end of the reaction.

O_3; 0.709 g NO_2; 6.9 x 10^{-3} mol NO

(**Q36**) Consider the reaction:

$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

If 0.86 mole of MnO_2 and 48.2 g of HCl react, which reagent will be used up first? How many grams of Cl_2 will be produced?

HCl; 23.4 g

(**Q37**) Nitroglycerin ($C_3H_5N_3O_9$) is a powerful explosive. Its decomposition may be represented by

$4C_3H_5N_3O_9 \rightarrow 6N_2 + 12CO_2 + 10H_2O + O_2$

This reaction generates a large amount of heat and many gaseous products. It is the sudden formation of these gases, together with their rapid expansion, that produces the explosion.

(a) What is the maximum amount of O_2 in grams that can be obtained from 2.00 x 10^2 g of nitroglycerin? 7.05 g

(b) Calculate the percent yield in this reaction if the amount of O_2 generated is found to be 6.55 g. 92.9%

(**Q38**) Ethylene (C_2H_4), an important industrial organic chemical, can be prepared by heating hexane (C_6H_{14}) at 800°C:

$C_6H_{14} \rightarrow C_2H_4$ + other products

If the yield of ethylene production is 42.5 percent, what mass of hexane must be reacted to produce 481 g of ethylene?

Theoretical mass of C_2H_4 = 481 / 0.425 = 1131.8 g

Mole of C_2H_2 = 1131.8 / 28 = 40.42 mol = mole of C_6H_{14}

Mass of C_6H_{14} = 40.42 x 86 = 3.48 x 10^3 g

(**Q39**) Disulfide dichloride (S_2Cl_2) is used in the vulcanization of rubber, a process that prevents the slippage of rubber molecules past one another when stretched. It is prepared by heating sulfur in an atmosphere of chlorine:

$S_8(l) + 4Cl_2(g) \rightarrow 4S_2Cl_2(l)$

What is the theoretical yield of S_2Cl_2 in grams when 4.06 g of S_8 are heated with 6.24 g of Cl_2? If the actual yield of S_2Cl_2 is 6.55 g, what is the percent yield?

8.55 g; 76.6%