

IB Chemistry HL - S1.4

Counting particles by mass: The mole

Exercises + Practice questions

Official answers appended at the end

Exercise

- Q1.** Calculate how many hydrogen atoms are present in:
- (a) 0.020 moles of $\text{C}_2\text{H}_5\text{OH}$
 - (b) 2.50 moles of H_2O
 - (c) 0.10 moles of $\text{Ca}(\text{HCO}_3)_2$
- Q2.** Propane has the formula C_3H_8 . If a sample of propane contains 0.20 moles of C, how many moles of H are present?
- Q3.** Calculate the amount of sulfuric acid, H_2SO_4 , which contains 6.02×10^{23} atoms of oxygen.

Exercise

- Q4.** The two most common isotopes of chlorine are ^{35}Cl and ^{37}Cl . The A_r of chlorine is 35.45. What can you conclude about the relative abundance of these two isotopes? (no calculation required)
- Q5.** Calculate the M_r of the following compounds:
- (a) magnesium phosphate $\text{Mg}_3(\text{PO}_4)_2$
 - (b) ascorbic acid (vitamin C) $\text{C}_6\text{H}_8\text{O}_6$
 - (c) calcium nitrate $\text{Ca}(\text{NO}_3)_2$
 - (d) hydrated sodium thiosulfate $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$

Exercise

- Q6.** Calcium arsenate $\text{Ca}_3(\text{AsO}_4)_2$ is a poison which was widely used as an insecticide. What is the mass of 0.475 mol of calcium arsenate?
- Q7.** How many moles of carbon dioxide are there in 66 g of carbon dioxide, CO_2 ?
- Q8.** How many moles of chloride ions, Cl^- , are there in 0.50 g of copper(II) chloride, CuCl_2 ?
- Q9.** How many carbon atoms are there in 36.55 g of diamond (which is pure carbon)?
- Q10.** What is the mass in grams of a 0.500 mol sample of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$?
- Q11.** Which contains the greater number of particles, 10.0 g of water, H_2O , or 10.0 g of mercury, Hg ?
- Q12.** Put the following in descending order of mass.
- | | |
|-----------------------------------|---------------------------|
| I. 1.0 mol N_2H_4 | II. 2.0 mol N_2 |
| III. 3.0 mol NH_3 | IV. 25.0 mol H_2 |

Exercise

Q13. Give the empirical formulas of the following compounds:

(a) ethyne C_2H_2

(b) glucose $\text{C}_6\text{H}_{12}\text{O}_6$

(c) sucrose $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

(d) octane C_8H_{18}

(e) oct-1-yne C_8H_{14}

(f) ethanoic acid CH_3COOH

Q14. A sample of a compound contains only the elements sodium, sulfur and oxygen. It is found by analysis to contain 0.979 g Na, 1.365 g S and 1.021 g O. Determine its empirical formula.

Q15. A sample of a hydrated compound was analysed and found to contain 2.10 g Co, 1.14 g S, 2.28 g O and 4.50 g H_2O . Determine its empirical formula.

Q16. A street drug has the following composition: 83.89% C, 10.35% H, 5.76% N. Determine its empirical formula.

Q17. The following compounds are used in the production of fertilizers. Determine which has the highest percentage by mass of nitrogen: NH_3 , $\text{CO}(\text{NH})_2$, $(\text{NH}_4)_2\text{SO}_4$.

Q18. A compound has the formula M_3N where M is a metal and N is nitrogen. It contains 0.673 g of N per gram of the metal M. Determine the relative atomic mass of M and so its identity.

Q19. Compounds of cadmium are used in the construction of photocells. Show which of the following has the highest percentage by mass of cadmium: CdS, CdSe, CdTe.

Q20. Benzene is a hydrocarbon, a compound of carbon and hydrogen only. It is found to contain 7.74% H by mass. Its molar mass is 78.10 g mol^{-1} . Determine its empirical and molecular formulas.

Q21. A weak acid has a molar mass of 162 g mol^{-1} . Analysis of a 0.8821 g sample showed the composition by mass is 0.0220 g H, 0.3374 g P and the remainder oxygen. Determine its empirical and molecular formulas.

Q22. ATP is an important molecule in living cells. A sample with a mass of 0.8138 g was analysed and found to contain 0.1927 g C, 0.02590 g H, 0.1124 g N, and 0.1491 g P. The remainder was oxygen. Determine the empirical formula of ATP. Its formula mass was found to be 507 g mol^{-1} . Determine its molecular formula.

- Q23.** A 0.30 g sample of a compound that contains only carbon, hydrogen and oxygen was burned in excess oxygen. The products were 0.66 g of carbon dioxide and 0.36 g of water. Determine the empirical formula of the compound.
- Q24.** You are asked to write your name on a suitable surface, using a piece of chalk that is pure calcium carbonate, CaCO_3 . How could you calculate the number of carbon atoms in your signature?