

Test Bank - Chapter 3
Mass Relationships in Chemical Reactions

- 1) One atomic mass unit (1 amu) is defined as:
- A. the mass of one proton
 - B. the mass of one hydrogen atom
 - C. one-twelfth the mass of a carbon-12 atom
 - D. the mass of one mole of atoms divided by Avogadro's number
 - E. the mass of one neutron
- 2) How many entities are in 0.100 mol of H₂O?
- A. 6.02×10^{24}
 - B. 6.02×10^{22}
 - C. 1.66×10^{23}
 - D. 1.00×10^{23}
 - E. 6.02×10^{20}
- 3) The mass (g) of 2.50 mol of carbon is:
- A. 120.1 g
 - B. 48.04 g
 - C. 2.50 g
 - D. 30.03 g
 - E. 0.208 g
- 4) Which statement about Avogadro's number is correct?
- A. the mass (in grams) of one atom of carbon-12
 - B. equals the number of atoms in 12.0 g of ¹²C
 - C. equals 1mole of electrons only
 - D. defined as 6.022×10^{22}
 - E. the number of grams in one mole of any substance
 - F. the amount of a substance having exactly 6.022×10^{23} constituent particles of that substance
 - G. both B and F
- 5) Which gives the correct molar mass unit?
- A. $\text{amu} \cdot \text{mol}^{-1}$
 - B. $\text{g} \cdot \text{mol}^{-1}$
 - C. $\text{mol} \cdot \text{g}^{-1}$
 - D. $\text{kg} \cdot \text{mol}^{-1}$
 - E. $\text{g} \cdot \text{atom}^{-1}$
- 6) Which quantity does a mass spectrometer directly measure for ions?
- A. mass only
 - B. charge only
 - C. mass-to-charge ratio (m/z)
 - D. number of electrons lost
 - E. percent abundance only

7) The molecular (molar) mass of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is closest to:

- A. $150.13 \text{ g}\cdot\text{mol}^{-1}$
- B. $180.16 \text{ g}\cdot\text{mol}^{-1}$
- C. $132.12 \text{ g}\cdot\text{mol}^{-1}$
- D. $360.32 \text{ g}\cdot\text{mol}^{-1}$
- E. $90.08 \text{ g}\cdot\text{mol}^{-1}$

8) A chemist observes peaks at m/z 35 and 37 for chlorine-containing ions. These peaks correspond to:

- A. ^{35}Cl and ^{37}Cl isotopes (different masses)
- B. different charge states of the same isotope only
- C. ^{36}Cl and ^{38}Cl isotopes
- D. fragments with different numbers of electrons only
- E. impurity peaks unrelated to chlorine

9) The molar mass ($\text{g}\cdot\text{mol}^{-1}$) of CaCO_3 is closest to:

- A. $84.01 \text{ g}\cdot\text{mol}^{-1}$
- B. $100.09 \text{ g}\cdot\text{mol}^{-1}$
- C. $56.08 \text{ g}\cdot\text{mol}^{-1}$
- D. $40.08 \text{ g}\cdot\text{mol}^{-1}$
- E. $64.06 \text{ g}\cdot\text{mol}^{-1}$

10) Percent carbon in ethanol ($\text{C}_2\text{H}_6\text{O}$, atomic masses $\text{C}=12.01$, $\text{H}=1.008$, $\text{O}=16.00$) is approximately:

- A. 40.0%
- B. 52.1%
- C. 66.7%
- D. 12.0%
- E. 27.3%

11) A compound is found to be 40.00% C, 6.71% H, and 53.29% O by mass. The empirical formula is:

- A. CHO
- B. $\text{C}_2\text{H}_4\text{O}_2$
- C. CH_2O
- D. $\text{C}_4\text{H}_8\text{O}_4$
- E. $\text{C}_2\text{H}_2\text{O}$

12) If the empirical formula of a substance is CH_2 and its molar mass is $56.0 \text{ g}\cdot\text{mol}^{-1}$, the molecular formula is:

- A. CH_2
- B. C_2H_4
- C. C_4H_8
- D. C_8H_{16}
- E. C_3H_6

13) Which is the correct percent composition of carbon in glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)?

- A. $\approx 40.0\%$
- B. $\approx 66.7\%$
- C. $\approx 33.3\%$
- D. $\approx 25.0\%$
- E. $\approx 50.0\%$

14) Which of the following experimental results would be used to determine an empirical formula?

- A. Vapor density at STP
- B. Combustion products masses (CO_2 and H_2O) from a known mass of sample
- C. Color of compound in solution
- D. Conductivity of melted sample
- E. Boiling point elevation

15) A 1.00 g sample gives 2.20 g CO_2 and 0.900 g H_2O on combustion data. The empirical formula of the sample is closest to:

- A. $\text{C}_2\text{H}_6\text{O}$
- B. $\text{C}_3\text{H}_6\text{O}$
- C. $\text{C}_8\text{H}_{16}\text{O}_3$
- D. CH_2O
- E. $\text{C}_2\text{H}_4\text{O}_2$

16) Balance and interpret: combustion of propane, $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$. If 2.00 mol C_3H_8 are burned, how many moles of CO_2 are formed?

- A. 2.00 mol
- B. 3.00 mol
- C. 4.00 mol
- D. 6.00 mol
- E. 10.0 mol

17) How many grams of CO_2 are produced when 10.0 g of carbon ($\text{C} = 12.01$) is completely converted to CO_2 ?

- A. 9.09 g
- B. 22.01 g
- C. 36.64 g
- D. 44.01 g
- E. 12.01 g

18) For the reaction $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, what mass of H_2O is formed from 2.00 g H_2 (excess O_2)?

- A. 1.00 g
- B. 9.00 g
- C. 17.87 g
- D. 36.00 g
- E. 2.00 g

19) How many grams of NaCl are present in 0.250 mol NaCl ? ($\text{Na} \approx 22.99$, $\text{Cl} \approx 35.45$)

- A. 9.22 g
- B. 14.61 g
- C. 29.22 g
- D. 58.44 g
- E. 0.250 g

20) Combustion of ethane: $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$. How many grams of O_2 are needed to burn 10.0 g of C_2H_6 ?

- A. 12.0 g
- B. 24.5 g
- C. 37.2 g
- D. 49.6 g
- E. 74.4 g

21) If 5.00 g H_2 ($M = 2.016$) reacts with 50.0 g O_2 ($M = 32.00$) according to $2H_2 + O_2 \rightarrow 2H_2O$, the limiting reagent is:

- A. H_2
- B. O_2
- C. Both are limiting equally
- D. Neither; reaction is at equilibrium
- E. Cannot be determined without temperature

22) A reaction has a theoretical yield of 25.0 g but actual yield is 18.5 g. Percent yield is:

- A. 74.0%
- B. 18.5%
- C. 140%
- D. 46.5%
- E. 7.5%

23) Which description of atom economy is correct?

- A. $(\text{mass of waste})/(\text{mass of products}) \times 100$
- B. $(\text{mass of desired product})/(\text{mass of all reactants}) \times 100$
- C. $(\text{actual yield})/(\text{theoretical yield}) \times 100$
- D. $(\text{number of atoms in product})/(\text{number of atoms in reactants}) \times 100$
- E. $(\text{mass of reactants})/(\text{mass of products}) \times 100$

24) For the Haber process: $N_2 + 3H_2 \rightarrow 2NH_3$, the atom economy for making NH_3 (desired product) is:

- A. 50%
- B. 67%
- C. 75%
- D. 100%
- E. 200%

25) Which is conserved in a balanced chemical equation (and thus in a chemical reaction)?

- A. Mass of each element
- B. Number of atoms of each element

- C. Both mass and number of atoms of each element
- D. Neither mass nor atoms — only charge is conserved
- E. Energy only

26) A 0.2000-g sample of an organic compound on combustion produced 0.2931 g CO₂ and 0.1200 g H₂O. What is the empirical formula of the compound?

- A. C₂H₄O
- B. CHO
- C. CH₂O
- D. C₂H₆O₂
- E. C₃H₆O

27) Consider the reaction: $2 \text{Al} + 3 \text{CuCl}_2 \rightarrow 2 \text{AlCl}_3 + 3 \text{Cu}$. If you start with 10.0 g Al and 50.0 g CuCl₂, which is the limiting reagent?

- A. Al
- B. CuCl₂
- C. Both in exact stoichiometric amounts
- D. Neither (both are in large excess)
- E. Cannot be determined without temperature

28) What is the percent by mass of sulfur in Al₂(SO₄)₃?

- A. 12.0%
- B. 28.11%
- C. 32.0%
- D. 7.25%
- E. 42.5%

29) A compound has empirical formula CH₂ and measured molar mass $\approx 84.12 \text{ g}\cdot\text{mol}^{-1}$. What is its molecular formula?

- A. CH₂
- B. C₂H₄
- C. C₃H₆
- D. C₄H₈
- E. C₆H₁₂

30) Two lab routes to make product X:

Route 1: A (100 g) + B (50 g) $\rightarrow$ X (90 g) + waste (60 g)

Route 2: C (120 g) $\rightarrow$ X (110 g) + waste (10 g)

Which route has the higher atom economy?

- A. Route 1
- B. Route 2
- C. Both equal
- D. Impossible to tell without percent yield
- E. Atom economy is the same as percent yield so compare actual yields

31) Reaction: $2 \text{Fe} + 3 \text{Cl}_2 \rightarrow 2 \text{FeCl}_3$. Start with 10.0 g Fe and 15.0 g Cl₂. If the actual isolated mass of FeCl₃ is 18.0 g, what is the percent yield?

- A. 54.3%
- B. 78.7%
- C. 88.2%
- D. 95.0%
- E. 102%

32) A mass spectrum of element Z shows two isotopes at m/z 35 (relative abundance 75%) and 37 (relative abundance 25%). The average atomic mass on the periodic table you'd expect (amu) is closest to:

- A. 35.0
- B. 35.25
- C. 35.50
- D. 36.00
- E. 37.00

33) A synthesis reports 90% yield for the desired product but an atom economy of only 30%. Which statement best explains this?

- A. The process is efficient and generates little waste.
- B. Most of the mass of reactants ends up in by-products even though the desired product forms efficiently.
- C. The theoretical yield is wrong.
- D. The reaction must be reversible.
- E. Percent yield and atom economy are identical metrics.

34) A student uses an outdated atomic mass table giving chlorine atomic mass 35.50 instead of the modern 35.45 and uses it in all stoichiometric calculations. This will cause:

- A. Random error in results
- B. Systematic error (bias) in calculated masses and yields
- C. Improved precision but worse accuracy
- D. No effect because atomic masses are exact
- E. Only affect results involving hydrogen

Answer Key:

1) C	2) B	3) D	4) G	5) B	6) C
7) B	8) A	9) B	10) B	11) C	12) C
13) A	14) B	15) C	16) D	17) C	18) C
19) B	20) C	21) A	22) A	23) B	24) D
25) C	26) C	27) B	28) B	29) E	30) B
31) B	32) C	33) B	34) B		