Molar Mass Worksheet

Molar mass, moles, grams & particles • 15 parts • 150 questions • Answer key at the back

Name: _____ Class: _____ Date: _____

How to calculate molar mass

1. Write the formula and list each element once.
2. Count the atoms of each element. A subscript after a bracket multiplies everything inside it.
3. Multiply each count by the element's atomic mass from the table below.
4. Add the results. The unit is grams per mole (g/mol).
5. For a hydrate, add the salt's molar mass to the number of H_2O × 18.02.

Example: $Ca(NO_3)_2$ has 1 Ca, 2 N and 6 O → 40.08 + 2(14.01) + 6(16.00) = **164.10 g/mol**

Mass, moles and particles

Mass (g) ÷ molar mass → ← × molar mass **Moles (mol)** × 6.022×10^{23} → ← ÷ 6.022×10^{23} **Particles**

Atomic masses to use (g/mol)

H 1.01	**He** 4.00	**Li** 6.94	**Be** 9.01	**B** 10.81	**C** 12.01	**N** 14.01	**O** 16.00
F 19.00	**Ne** 20.18	**Na** 22.99	**Mg** 24.31	**Al** 26.98	**Si** 28.09	**P** 30.97	**S** 32.07
Cl 35.45	**Ar** 39.95	**K** 39.10	**Ca** 40.08	**Sc** 44.96	**Ti** 47.87	**V** 50.94	**Cr** 52.00
Mn 54.94	**Fe** 55.85	**Co** 58.93	**Ni** 58.69	**Cu** 63.55	**Zn** 65.38	**Ga** 69.72	**Ge** 72.63
As 74.92	**Se** 78.97	**Br** 79.90	**Kr** 83.80	**Rb** 85.47	**Sr** 87.62	**Ag** 107.87	**Sn** 118.71
I 126.90	**Xe** 131.29	**Cs** 132.91	**Ba** 137.33	**Pt** 195.08	**Au** 196.97	**Hg** 200.59	**Pb** 207.20

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Part 1: Elements and Diatomic Molecules

Score: _____ / 10

Find the molar mass. Remember that some elements exist as molecules (O_2, Cl_2, P_4, S_8).

1. Na

Answer: _____

2. Fe

Answer: _____

3. Cu

Answer: _____

4. H_2

Answer: _____

5. O_2

Answer: _____

6. N_2

Answer: _____

7. Cl_2

Answer: _____

8. Br_2

Answer: _____

9. P_4

Answer: _____

10. S_8

Answer: _____

Part 2: Simple Compounds

Score: _____ / 10

Add up the atomic masses of all the atoms in each formula.

11. H_2O

Answer: _____

12. CO_2

Answer: _____

13. NaCl

Answer: _____

14. MgO

Answer: _____

15. NH_3

Answer: _____

16. CH_4

Answer: _____

17. HCl

Answer: _____

18. CaO

Answer: _____

19. SO_2

Answer: _____

20. Al_2O_3

Answer: _____

Part 3: Compounds with Polyatomic Ions

Score: _____ / 10

Count every atom carefully, including those in the polyatomic ion.

21. $NaOH$

Answer: _____

22. KNO_3

Answer: _____

23. $CaCO_3$

Answer: _____

24. H_2SO_4

Answer: _____

25. $NaHCO_3$

Answer: _____

26. $KMnO_4$

Answer: _____

27. Na_2SO_4

Answer: _____

28. NH_4Cl

Answer: _____

29. H_3PO_4

Answer: _____

30. $K_2Cr_2O_7$

Answer: _____

Part 4: Formulas with Brackets

Score: _____ / 10

A subscript after a bracket multiplies every atom inside the bracket.

31. $Ca(OH)_2$

Answer: _____

32. $Mg(NO_3)_2$

Answer: _____

33. $Al_2(SO_4)_3$

Answer: _____

34. $Ca_3(PO_4)_2$

Answer: _____

35. $(NH_4)_2SO_4$

Answer: _____

36. $Fe(OH)_3$

Answer: _____

37. $Pb(NO_3)_2$

Answer: _____

38. $Ba(OH)_2$

Answer: _____

39. $(NH_4)_3PO_4$

Answer: _____

40. $Fe_2(SO_4)_3$

Answer: _____

Part 5: Organic Compounds

Score: _____ / 10

Find the molar mass of each organic compound. Count C, H, O and N atoms in the whole formula.

41. CH_3OH (methanol)

Answer: _____

42. C_2H_5OH (ethanol)

Answer: _____

43. CH_3COOH (acetic acid)

Answer: _____

44. C_6H_6 (benzene)

Answer: _____

45. C_8H_{18} (octane)

Answer: _____

46. $C_6H_{12}O_6$ (glucose)

Answer: _____

47. $C_{12}H_{22}O_{11}$ (sucrose)

Answer: _____

48. $C_3H_8O_3$ (glycerol)

Answer: _____

49. $C_9H_8O_4$ (aspirin)

Answer: _____

50. $C_8H_{10}N_4O_2$ (caffeine)

Answer: _____

Part 6: Hydrates

Score: _____ / 10

Add the molar mass of the salt to the mass of the water molecules (H_2O = 18.02 g/mol).

51. $CuSO_4 \cdot 5H_2O$

Answer: _____

52. $MgSO_4 \cdot 7H_2O$

Answer: _____

53. $Na_2CO_3 \cdot 10H_2O$

Answer: _____

54. $CaCl_2 \cdot 2H_2O$

Answer: _____

55. $CoCl_2 \cdot 6H_2O$

Answer: _____

56. $FeSO_4 \cdot 7H_2O$

Answer: _____

57. $BaCl_2 \cdot 2H_2O$

Answer: _____

58. $Na_2SO_4 \cdot 10H_2O$

Answer: _____

59. $ZnSO_4 \cdot 7H_2O$

Answer: _____

60. $Al_2(SO_4)_3 \cdot 18H_2O$

Answer: _____

Part 7: Grams to Moles

Score: _____ / 10

moles = mass ÷ molar mass. Give answers to 3 significant figures.

61. How many moles are in 45.0 g of H_2O?

Answer: _____

62. How many moles are in 11.0 g of CO_2?

Answer: _____

63. How many moles are in 29.2 g of NaCl?

Answer: _____

64. How many moles are in 150. g of $CaCO_3$?

Answer: _____

65. How many moles are in 4.90 g of H_2SO_4?

Answer: _____

66. How many moles are in 90.0 g of $C_6H_{12}O_6$?

Answer: _____

67. How many moles are in 8.50 g of NH_3?

Answer: _____

68. How many moles are in 68.4 g of $Al_2(SO_4)_3$?

Answer: _____

69. How many moles are in 320. g of Fe_2O_3?

Answer: _____

70. How many moles are in 12.5 g of $CuSO_4 \cdot 5H_2O$?

Answer: _____

Part 8: Moles to Grams

Score: _____ / 10

mass = moles × molar mass. Give answers to 3 significant figures.

71. What is the mass in grams of 2.50 mol of O_2?

Answer: _____

72. What is the mass in grams of 0.400 mol of NaOH?

Answer: _____

73. What is the mass in grams of 3.00 mol of CH_4?

Answer: _____

74. What is the mass in grams of 0.0150 mol of $KMnO_4$?

Answer: _____

75. What is the mass in grams of 1.20 mol of $Ca(OH)_2$?

Answer: _____

76. What is the mass in grams of 0.750 mol of C_2H_5OH?

Answer: _____

77. What is the mass in grams of 0.0800 mol of $Mg(NO_3)_2$?

Answer: _____

78. What is the mass in grams of 5.00 mol of NH_4Cl?

Answer: _____

79. What is the mass in grams of 0.100 mol of $C_{12}H_{22}O_{11}$?

Answer: _____

80. What is the mass in grams of 0.0350 mol of $Ba(OH)_2$?

Answer: _____

Part 9: Moles and Particles

Score: _____ / 10

Use Avogadro's number: 1 mol = 6.022 × 10^{23} particles (atoms, molecules or formula units).

81. How many molecules are in 18.0 g of H_2O?

Answer: _____

82. How many molecules are in 2.50 mol of CO_2?

Answer: _____

83. How many atoms are in 5.00 g of Fe?

Answer: _____

84. What is the mass of 3.01 × 10^{23} molecules of O_2?

Answer: _____

85. How many moles are in 1.20 × 10^{24} atoms of Cu?

Answer: _____

86. How many molecules are in 100. g of glucose, $C_6H_{12}O_6$?

Answer: _____

87. How many atoms in total are in 0.500 mol of NH_3?

Answer: _____

88. What is the mass of 1.00 × 10^{22} molecules of CH_4?

Answer: _____

89. How many hydrogen atoms are in 9.00 g of H_2O?

Answer: _____

90. What is the mass of 4.50 × 10^{23} formula units of NaCl?

Answer: _____

Part 10: Molar Mass Challenge

Score: _____ / 10

These questions combine molar mass with identification, mass of an element and particles.

91. 0.500 mol of an element has a mass of 31.8 g. Find its molar mass and identify the element.

Answer: _____

92. 0.250 mol of a metal has a mass of 6.08 g. Find its molar mass and identify the metal.

Answer: _____

93. 0.200 mol of a gas has a mass of 8.80 g. Is the gas O_2, N_2, CO_2 or CH_4?

Answer: _____

94. What mass of oxygen is in 50.0 g of $CaCO_3$?

Answer: _____

95. What mass of iron can be obtained from 200. g of Fe_2O_3?

Answer: _____

96. What is the percentage by mass of water in $CuSO_4 \cdot 5H_2O$?

Answer: _____

97. Which contains more molecules: 10.0 g of H_2O or 10.0 g of CO_2? Show why.

Answer: _____

98. How many moles of oxygen atoms are in 2.00 mol of $Al_2(SO_4)_3$?

Answer: _____

99. A fertiliser bag contains 1.00 kg of NH_4NO_3. What mass of nitrogen does it supply?

Answer: _____

100. What is the mass in grams of one single molecule of H_2O?

Answer: _____

Part 11: Compounds of Other Elements

Score: _____ / 10

Use the full atomic mass table on page 1. Some of these elements are less common.

101. LiF

Answer: _____

102. SiO_2

Answer: _____

103. TiO_2

Answer: _____

104. $NiCl_2$

Answer: _____

105. $SnCl_4$

Answer: _____

106. $AgNO_3$

Answer: _____

107. KI

Answer: _____

108. Li_2CO_3

Answer: _____

109. $Sr(NO_3)_2$

Answer: _____

110. HgO

Answer: _____

Part 12: Acids and Bases

Score: _____ / 10

Find the molar mass of each acid or base.

111. HNO_3

Answer: _____

112. H_2CO_3

Answer: _____

113. $HClO_4$

Answer: _____

114. HF

Answer: _____

115. HBr

Answer: _____

116. HI

Answer: _____

117. KOH

Answer: _____

118. LiOH

Answer: _____

119. $Mg(OH)_2$

Answer: _____

120. $Al(OH)_3$

Answer: _____

Part 13: Large and Complex Formulas

Score: _____ / 10

Work through the formula part by part: brackets first, then hydrate water.

121. $K_4Fe(CN)_6$

Answer: _____

122. $K_3Fe(CN)_6$

Answer: _____

123. $(NH_4)_2Cr_2O_7$

Answer: _____

124. $Ca(H_2PO_4)_2$

Answer: _____

125. $Ba_3(PO_4)_2$

Answer: _____

126. $Cu(NH_3)_4SO_4$

Answer: _____

127. $C_{17}H_{35}COONa$ (sodium stearate, soap)

Answer: _____

128. $C_{27}H_{46}O$ (cholesterol)

Answer: _____

129. $KAl(SO_4)_2 \cdot 12H_2O$ (potash alum)

Answer: _____

130. $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$ (Mohr's salt)

Answer: _____

Part 14: Percent by Mass of an Element

Score: _____ / 10

% element = (number of atoms × atomic mass) ÷ molar mass × 100.

131. What is the percentage by mass of N in NH_4NO_3?

Answer: _____

132. What is the percentage by mass of C in $C_6H_{12}O_6$?

Answer: _____

133. What is the percentage by mass of Fe in Fe_2O_3?

Answer: _____

134. What is the percentage by mass of H in H_2O?

Answer: _____

135. What is the percentage by mass of Ca in $CaCO_3$?

Answer: _____

136. What is the percentage by mass of Cu in $CuSO_4 \cdot 5H_2O$?

Answer: _____

137. What is the percentage by mass of Na in NaCl?

Answer: _____

138. What is the percentage by mass of N in $(NH_4)_2SO_4$?

Answer: _____

139. What is the percentage by mass of C in C_8H_{18}?

Answer: _____

140. What is the percentage by mass of O in $KMnO_4$?

Answer: _____

Part 15: Mixed Review

Score: _____ / 10

Use everything from this worksheet: molar mass, moles, grams and particles.

141. What is the mass of 0.125 mol of Ni?

Answer: _____

142. How many moles are in 25.0 g of TiO_2?

Answer: _____

143. How many atoms are in 1.00 g of gold (Au)?

Answer: _____

144. What is the mass of 2.00×10^{23} atoms of Ag?

Answer: _____

145. How many water molecules are in 1.00 L of water? (density = 1.00 g/mL)

Answer: _____

146. What is the mass in grams of one atom of gold?

Answer: _____

147. How many moles of ions are in 0.500 mol of $CaCl_2$?

Answer: _____

148. How many chloride ions are in 11.1 g of $CaCl_2$?

Answer: _____

149. How many moles of hydrogen atoms are in 3.00 mol of $C_6H_{12}O_6$?

Answer: _____

150. What is the mass of 0.0500 mol of potash alum, $KAl(SO_4)_2 \cdot 12H_2O$?

Answer: _____

Answer Key

Final answers in green, with working. Answers within about 1% are fine because of rounding.

Part 1: Elements and Diatomic Molecules

1. 22.99 = **22.99 g/mol**
2. 55.85 = **55.85 g/mol**
3. 63.55 = **63.55 g/mol**
4. 2(1.01) = **2.02 g/mol**
5. 2(16.00) = **32.00 g/mol**
6. 2(14.01) = **28.02 g/mol**
7. 2(35.45) = **70.90 g/mol**
8. 2(79.90) = **159.80 g/mol**
9. 4(30.97) = **123.88 g/mol**
10. 8(32.07) = **256.56 g/mol**

Part 2: Simple Compounds

11. 2(1.01) + 16.00 = **18.02 g/mol**
12. 12.01 + 2(16.00) = **44.01 g/mol**
13. 22.99 + 35.45 = **58.44 g/mol**
14. 24.31 + 16.00 = **40.31 g/mol**
15. 14.01 + 3(1.01) = **17.04 g/mol**
16. 12.01 + 4(1.01) = **16.05 g/mol**
17. 1.01 + 35.45 = **36.46 g/mol**
18. 40.08 + 16.00 = **56.08 g/mol**
19. 32.07 + 2(16.00) = **64.07 g/mol**
20. 2(26.98) + 3(16.00) = **101.96 g/mol**

Part 3: Compounds with Polyatomic Ions

21. 22.99 + 16.00 + 1.01 = **40.00 g/mol**
22. 39.10 + 14.01 + 3(16.00) = **101.11 g/mol**
23. 40.08 + 12.01 + 3(16.00) = **100.09 g/mol**
24. 2(1.01) + 32.07 + 4(16.00) = **98.09 g/mol**
25. 22.99 + 1.01 + 12.01 + 3(16.00) = **84.01 g/mol**
26. 39.10 + 54.94 + 4(16.00) = **158.04 g/mol**
27. 2(22.99) + 32.07 + 4(16.00) = **142.05 g/mol**
28. 14.01 + 4(1.01) + 35.45 = **53.50 g/mol**
29. 3(1.01) + 30.97 + 4(16.00) = **98.00 g/mol**
30. 2(39.10) + 2(52.00) + 7(16.00) = **294.20 g/mol**

Part 4: Formulas with Brackets

31. 40.08 + 2(16.00) + 2(1.01) = **74.10 g/mol**

32. 24.31 + 2(14.01) + 6(16.00) = **148.33 g/mol**

33. 2(26.98) + 3(32.07) + 12(16.00) = **342.17 g/mol**

34. 3(40.08) + 2(30.97) + 8(16.00) = **310.18 g/mol**

35. 2(14.01) + 8(1.01) + 32.07 + 4(16.00) = **132.17 g/mol**

36. 55.85 + 3(16.00) + 3(1.01) = **106.88 g/mol**

37. 207.20 + 2(14.01) + 6(16.00) = **331.22 g/mol**

38. 137.33 + 2(16.00) + 2(1.01) = **171.35 g/mol**

39. 3(14.01) + 12(1.01) + 30.97 + 4(16.00) = **149.12 g/mol**

40. 2(55.85) + 3(32.07) + 12(16.00) = **399.91 g/mol**

Part 5: Organic Compounds

41. 12.01 + 4(1.01) + 16.00 = **32.05 g/mol**

42. 2(12.01) + 6(1.01) + 16.00 = **46.08 g/mol**

43. 2(12.01) + 4(1.01) + 2(16.00) = **60.06 g/mol**

44. 6(12.01) + 6(1.01) = **78.12 g/mol**

45. 8(12.01) + 18(1.01) = **114.26 g/mol**

46. 6(12.01) + 12(1.01) + 6(16.00) = **180.18 g/mol**

47. 12(12.01) + 22(1.01) + 11(16.00) = **342.34 g/mol**

48. 3(12.01) + 8(1.01) + 3(16.00) = **92.11 g/mol**

49. 9(12.01) + 8(1.01) + 4(16.00) = **180.17 g/mol**

50. 8(12.01) + 10(1.01) + 4(14.01) + 2(16.00) = **194.22 g/mol**

Part 6: Hydrates

51. $CuSO_4$ 159.62 + 5(18.02) = **249.72 g/mol**

52. $MgSO_4$ 120.38 + 7(18.02) = **246.52 g/mol**

53. Na_2CO_3 105.99 + 10(18.02) = **286.19 g/mol**

54. $CaCl_2$ 110.98 + 2(18.02) = **147.02 g/mol**

55. $CoCl_2$ 129.83 + 6(18.02) = **237.95 g/mol**

56. $FeSO_4$ 151.92 + 7(18.02) = **278.06 g/mol**

57. $BaCl_2$ 208.23 + 2(18.02) = **244.27 g/mol**

58. Na_2SO_4 142.05 + 10(18.02) = **322.25 g/mol**

59. $ZnSO_4$ 161.45 + 7(18.02) = **287.59 g/mol**

60. $Al_2(SO_4)_3$ 342.17 + 18(18.02) = **666.53 g/mol**

Part 7: Grams to Moles

61. 45.0 g ÷ 18.02 g/mol → **2.50 mol**

62. 11.0 g ÷ 44.01 g/mol → **0.250 mol**

63. 29.2 g ÷ 58.44 g/mol → **0.500 mol**

64. 150. g ÷ 100.09 g/mol → **1.50 mol**

65. 4.90 g ÷ 98.09 g/mol → **0.0500 mol**

66. 90.0 g ÷ 180.18 g/mol → **0.500 mol**

67. 8.50 g ÷ 17.04 g/mol → **0.499 mol**

68. 68.4 g ÷ 342.17 g/mol → **0.200 mol**

69. 320. g ÷ 159.70 g/mol → **2.00 mol**

70. 12.5 g ÷ 249.72 g/mol → **0.0501 mol**

Part 8: Moles to Grams

71. 2.50 mol × 32.00 g/mol → **80.0 g**

72. 0.400 mol × 40.00 g/mol → **16.0 g**

73. 3.00 mol × 16.05 g/mol → **48.2 g**

74. 0.0150 mol × 158.04 g/mol → **2.37 g**

75. 1.20 mol × 74.10 g/mol → **88.9 g**

76. 0.750 mol × 46.08 g/mol → **34.6 g**

77. 0.0800 mol × 148.33 g/mol → **11.9 g**

78. 5.00 mol × 53.50 g/mol → **268 g**

79. 0.100 mol × 342.34 g/mol → **34.2 g**

80. 0.0350 mol × 171.35 g/mol → **6.00 g**

Part 9: Moles and Particles

81. 18.0 ÷ 18.02 = 0.9989 mol × 6.022×10^{23} → **6.02×10^{23} molecules**

82. 2.50 × 6.022×10^{23} → **1.51×10^{24} molecules**

83. 5.00 ÷ 55.85 = 0.08953 mol × 6.022×10^{23} → **5.39×10^{22} atoms**

84. ÷ 6.022×10^{23} = 0.4998 mol × 32.00 → **16.0 g**

85. $1.20 \times 10^{24} \div 6.022 \times 10^{23}$ → **1.99 mol**

86. 100. ÷ 180.18 = 0.5550 mol × 6.022×10^{23} → **3.34×10^{23} molecules**

87. 0.500 mol × 4 atoms per molecule × 6.022×10^{23} → **1.20×10^{24} atoms**

88. ÷ 6.022×10^{23} = 0.01661 mol × 16.05 → **0.267 g**

89. 9.00 ÷ 18.02 = 0.4994 mol × 2 × 6.022×10^{23} → **6.02×10^{23} H atoms**

90. ÷ 6.022×10^{23} = 0.7473 mol × 58.44 → **43.7 g**

Part 10: Molar Mass Challenge

91. 31.8 ÷ 0.500 = 63.6 g/mol → **Cu**

92. 6.08 ÷ 0.250 = 24.3 g/mol → **Mg**

93. 8.80 ÷ 0.200 = 44.0 g/mol → **CO_2** (44.01 g/mol)

94. 50.0 × (48.00 ÷ 100.09) → **24.0 g O**

95. 200. × (111.70 ÷ 159.70) → **140 g Fe**

96. 90.10 ÷ 249.72 × 100 → **36.1%**

97. H_2O 0.555 mol vs CO_2 0.227 mol → **10.0 g H_2O** (smaller molar mass, more moles)

98. 12 O atoms per formula unit × 2.00 → **24.0 mol O atoms**

99. 1000 g × (28.02 ÷ 80.06) → **350 g N**

100. 18.02 g/mol ÷ 6.022×10^{23} → **2.99×10^{-23} g**

Part 11: Compounds of Other Elements

101. 6.94 + 19.00 = **25.94 g/mol**

102. 28.09 + 2(16.00) = **60.09 g/mol**

103. 47.87 + 2(16.00) = **79.87 g/mol**

104. 58.69 + 2(35.45) = **129.59 g/mol**

105. 118.71 + 4(35.45) = **260.51 g/mol**

106. 107.87 + 14.01 + 3(16.00) = **169.88 g/mol**

107. 39.10 + 126.90 = **166.00 g/mol**

108. 2(6.94) + 12.01 + 3(16.00) = **73.89 g/mol**

109. 87.62 + 2(14.01) + 6(16.00) = **211.64 g/mol**

110. 200.59 + 16.00 = **216.59 g/mol**

Part 12: Acids and Bases

111. 1.01 + 14.01 + 3(16.00) = **63.02 g/mol**

112. 2(1.01) + 12.01 + 3(16.00) = **62.03 g/mol**

113. 1.01 + 35.45 + 4(16.00) = **100.46 g/mol**

114. 1.01 + 19.00 = **20.01 g/mol**

115. 1.01 + 79.90 = **80.91 g/mol**

116. 1.01 + 126.90 = **127.91 g/mol**

117. 39.10 + 16.00 + 1.01 = **56.11 g/mol**

118. 6.94 + 16.00 + 1.01 = **23.95 g/mol**

119. 24.31 + 2(16.00) + 2(1.01) = **58.33 g/mol**

120. 26.98 + 3(16.00) + 3(1.01) = **78.01 g/mol**

Part 13: Large and Complex Formulas

121. 4(39.10) + 55.85 + 6(12.01) + 6(14.01) = **368.37 g/mol**

122. 3(39.10) + 55.85 + 6(12.01) + 6(14.01) = **329.27 g/mol**

123. 2(14.01) + 8(1.01) + 2(52.00) + 7(16.00) = **252.10 g/mol**

124. 40.08 + 4(1.01) + 2(30.97) + 8(16.00) = **234.06 g/mol**

125. 3(137.33) + 2(30.97) + 8(16.00) = **601.93 g/mol**

126. 63.55 + 4(14.01) + 12(1.01) + 32.07 + 4(16.00) = **227.78 g/mol**

127. 18(12.01) + 35(1.01) + 2(16.00) + 22.99 = **306.52 g/mol**

128. 27(12.01) + 46(1.01) + 16.00 = **386.73 g/mol**

129. $KAl(SO_4)_2$ 258.22 + 12(18.02) = **474.46 g/mol**

130. $(NH_4)_2Fe(SO_4)_2$ 284.09 + 6(18.02) = **392.21 g/mol**

Part 14: Percent by Mass of an Element

131. 2 × 14.01 = 28.02; ÷ 80.06 × 100 → **35.0% N**

132. 6 × 12.01 = 72.06; ÷ 180.18 × 100 → **40.0% C**

133. 2 × 55.85 = 111.70; ÷ 159.70 × 100 → **69.9% Fe**

134. 2 × 1.01 = 2.02; ÷ 18.02 × 100 → **11.2% H**

135. 40.08; ÷ 100.09 × 100 → **40.0% Ca**

136. 63.55; ÷ 249.72 × 100 → **25.4% Cu**

137. 22.99; ÷ 58.44 × 100 → **39.3% Na**

138. 2 × 14.01 = 28.02; ÷ 132.17 × 100 → **21.2% N**

139. 8 × 12.01 = 96.08; ÷ 114.26 × 100 → **84.1% C**

140. 4 × 16.00 = 64.00; ÷ 158.04 × 100 → **40.5% O**

Part 15: Mixed Review

141. 0.125 × 58.69 → **7.34 g**

142. 25.0 ÷ 79.87 → **0.313 mol**

143. 1.00 ÷ 196.97 = 0.005077 mol × 6.022×10^{23} → **3.06×10^{21} atoms**

144. ÷ 6.022×10^{23} = 0.3321 mol × 107.87 → **35.8 g**

145. 1000 g ÷ 18.02 = 55.49 mol × 6.022×10^{23} → **3.34×10^{25} molecules**

146. 196.97 ÷ 6.022×10^{23} → **3.27×10^{-22} g**

147. 1 Ca^{2+} + 2 Cl^- = 3 ions; 0.500 × 3 → **1.50 mol ions**

148. 11.1 ÷ 110.98 = 0.1000 mol × 2 × 6.022×10^{23} → **1.20×10^{23} Cl^- ions**

149. 12 H per molecule × 3.00 → **36.0 mol H atoms**

150. 0.0500 × 474.46 → **23.7 g**

Notes: 15 Key Points to Remember

01	**What molar mass means** Molar mass is the mass of one mole of a substance, in grams per mole (g/mol). It equals the formula mass in atomic mass units.
02	**Use the periodic table values** Each element's molar mass is its relative atomic mass from the periodic table: Na = 22.99 g/mol, so 1 mol of Na weighs 22.99 g.
03	**Count every atom** List each element once, count its atoms, multiply by its atomic mass and add. Missing a single O is the most common mistake.
04	**Brackets multiply** A subscript after a bracket multiplies everything inside: $Al_2(SO_4)_3$ has 2 Al, 3 S and 12 O.
05	**Subscripts belong to the atom before them** In H_2SO_4, the 2 belongs to H and the 4 to O. S has no subscript, so there is 1 S.
06	**Diatomic elements** H_2, N_2, O_2, F_2, Cl_2, Br_2 and I_2 exist as molecules. The molar mass of O_2 is 32.00 g/mol, not 16.00.
07	**Hydrates include the water** $CuSO_4 \cdot 5H_2O$ includes 5 water molecules: 159.62 + 5(18.02) = 249.72 g/mol. The dot means “plus”, not “times”.
08	**A coefficient is not part of molar mass** 3 H_2O means 3 molecules (or moles) of water. The molar mass of H_2O is still 18.02 g/mol.
09	**Mass $\leftrightarrow$ moles** moles = mass ÷ molar mass, and mass = moles × molar mass. Check that the units cancel to what you want.
10	**Avogadro's number** 1 mol of anything contains 6.022×10^{23} particles: atoms, molecules, ions or formula units.
11	**Molecules vs atoms** 1 mol of H_2O contains 6.022×10^{23} molecules but $3 \times 6.022 \times 10^{23}$ atoms. Read the question carefully.
12	**Always go through moles** To change grams into particles (or back), always pass through moles: grams $\rightarrow$ moles $\rightarrow$ particles.
13	**Mass of an element in a sample** Mass of element = sample mass × (mass of that element in the formula ÷ molar mass).
14	**Identifying an unknown** Molar mass = mass ÷ moles. Compare the result with the periodic table or a list of possible formulas.
15	**Units and rounding** Write g/mol for molar mass. Keep 2 decimal places when adding atomic masses, and round final calculated answers to 3 significant figures.