Molecular Formulas Worksheet

Empirical & molecular formulas • 10 parts • 100 questions • Answer key at the back

Name: _____ Class: _____ Date: _____

Finding a molecular formula

1. Change % or grams into moles of each element (if given %, assume a 100 g sample).
2. Divide every mole value by the smallest one.
3. If a ratio ends in about .25, .33, .5 or .67, multiply all ratios by 4, 3, 2 or 3 to get whole numbers.
4. Write the **empirical formula** and calculate its mass.
5. n = molar mass ÷ empirical formula mass. Multiply every subscript by n to get the **molecular formula**.

Example: 40.00% C, 6.71% H, 53.29% O, M = 180.16 g/mol. Moles: C 3.33, H 6.64, O 3.33 → ratio 1 : 2 : 1 → empirical CH_2O (30.03). n = 180.16 ÷ 30.03 = 6 → $\mathbf{C_6H_{12}O_6}$

Atomic masses to use (g/mol)

H 1.01	**B** 10.81	**C** 12.01	**N** 14.01	**O** 16.00	**Na** 22.99	**Mg** 24.31
Al 26.98	**P** 30.97	**S** 32.07	**Cl** 35.45	**K** 39.10	**Ca** 40.08	**Cr** 52.00
Mn 54.94	**Fe** 55.85	**Co** 58.93	**Cu** 63.55	**Zn** 65.38	**Sn** 118.71	**Ba** 137.33

What's inside

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Part 1: Counting Atoms in a Formula

Score: _____ / 10

Write the number of atoms of each element, then the total number of atoms. A number in front multiplies the whole formula.

1. $C_6H_{12}O_6$

Answer: _____

2. $Ca(OH)_2$

Answer: _____

3. $Al_2(SO_4)_3$

Answer: _____

4. $(NH_4)_3PO_4$

Answer: _____

5. $Mg_3(PO_4)_2$

Answer: _____

6. $C_{12}H_{22}O_{11}$

Answer: _____

7. $K_4Fe(CN)_6$

Answer: _____

8. $CuSO_4 \cdot 5H_2O$

Answer: _____

9. $3\ Ca(NO_3)_2$

Answer: _____

10. $2\ Fe_2(SO_4)_3$

Answer: _____

Part 2: Molar Mass

Score: _____ / 10

Calculate the molar mass in g/mol using the atomic masses on page 1.

11. H_2O

Answer: _____

12. CO_2

Answer: _____

13. $NaCl$

Answer: _____

14. $CaCO_3$

Answer: _____

15. H_2SO_4

Answer: _____

16. $C_6H_{12}O_6$

Answer: _____

17. $Ca_3(PO_4)_2$

Answer: _____

18. $Al_2(SO_4)_3$

Answer: _____

19. $(NH_4)_2SO_4$

Answer: _____

20. C_8H_{18}

Answer: _____

Part 3: Empirical Formula from a Molecular Formula

Score: _____ / 10

Write the empirical (simplest whole-number ratio) formula for each molecular formula.

21. $C_6H_{12}O_6$

Answer: _____

22. H_2O_2

Answer: _____

23. C_2H_4

Answer: _____

24. N_2O_4

Answer: _____

25. C_6H_6

Answer: _____

26. C_8H_{18}

Answer: _____

27. B_2H_6

Answer: _____

28. P_4O_{10}

Answer: _____

29. $C_2H_2O_4$

Answer: _____

30. $C_{12}H_{22}O_{11}$

Answer: _____

Part 4: Molecular Formula from Empirical Formula

Score: _____ / 10

Find the molecular formula from the empirical formula and the molar mass.

31. Empirical formula CH, molar mass 78.12 g/mol

Answer: _____

32. Empirical formula CH_2O, molar mass 180.18 g/mol

Answer: _____

33. Empirical formula CH_2, molar mass 56.12 g/mol

Answer: _____

34. Empirical formula NO_2, molar mass 92.02 g/mol

Answer: _____

35. Empirical formula HO, molar mass 34.02 g/mol

Answer: _____

36. Empirical formula C_2H_5, molar mass 58.14 g/mol

Answer: _____

37. Empirical formula CH_2O, molar mass 60.06 g/mol

Answer: _____

38. Empirical formula P_2O_5, molar mass 283.88 g/mol

Answer: _____

39. Empirical formula C_3H_4, molar mass 120.21 g/mol

Answer: _____

40. Empirical formula CH_4N, molar mass 60.12 g/mol

Answer: _____

Part 5: Empirical Formula from Percent Composition

Score: _____ / 10

Assume a 100 g sample, convert grams to moles, divide by the smallest, and find the empirical formula.

41. Fe 69.94%, O 30.06%

Answer: _____

42. Na 32.37%, S 22.58%, O 45.05%

Answer: _____

43. K 24.74%, Mn 34.76%, O 40.50%

Answer: _____

44. N 25.94%, O 74.06%

Answer: _____

45. Fe 72.36%, O 27.64%

Answer: _____

Part 5: Empirical Formula from Percent Composition (continued)

46. Na 43.38%, C 11.33%, O 45.29%

Answer: _____

47. K 26.58%, Cr 35.35%, O 38.07%

Answer: _____

48. C 52.13%, H 13.15%, O 34.72%

Answer: _____

49. C 19.99%, H 6.73%, N 46.65%, O 26.64%

Answer: _____

50. C 68.84%, H 4.96%, O 26.20%

Answer: _____

Part 6: Molecular Formula from Percent Composition

Score: _____ / 10

Find the empirical formula first, then use the molar mass to find the molecular formula.

51. C 39.99%, H 6.73%, O 53.28%; molar mass 60.06 g/mol

Answer: _____

52. C 92.24%, H 7.76%; molar mass 78.12 g/mol

Answer: _____

53. N 87.40%, H 12.60%; molar mass 32.06 g/mol

Answer: _____

54. C 40.91%, H 4.59%, O 54.50%; molar mass 176.14 g/mol

Answer: _____

55. C 93.70%, H 6.30%; molar mass 128.18 g/mol

Answer: _____

Part 6: Molecular Formula from Percent Composition (continued)

56. C 26.68%, H 2.24%, O 71.08%; molar mass 90.04 g/mol

Answer: _____

57. C 54.52%, H 9.17%, O 36.31%; molar mass 88.12 g/mol

Answer: _____

58. C 49.47%, H 5.20%, N 28.85%, O 16.48%; molar mass 194.22 g/mol

Answer: _____

59. C 85.60%, H 14.40%; molar mass 84.18 g/mol

Answer: _____

60. B 78.11%, H 21.89%; molar mass 27.68 g/mol

Answer: _____

Part 7: Empirical Formula from Mass Data

Score: _____ / 10

Convert each mass to moles and find the empirical formula.

61. A 2.500 g sample contains 1.508 g Mg and 0.992 g O.

Answer: _____

62. A 5.100 g sample contains 2.699 g Al and 2.401 g O.

Answer: _____

63. A 8.000 g sample contains 5.595 g Fe and 2.405 g O.

Answer: _____

64. A 3.580 g sample contains 3.180 g Cu and 0.400 g O.

Answer: _____

65. A 4.520 g sample contains 3.560 g Sn and 0.960 g O.

Answer: _____

Part 7: Empirical Formula from Mass Data (continued)

66. A 6.660 g sample contains 2.405 g Ca and 4.255 g Cl.

Answer: _____

67. A 3.900 g sample contains 2.298 g Na and 1.602 g S.

Answer: _____

68. A 7.100 g sample contains 3.098 g P and 4.002 g O.

Answer: _____

69. A 2.200 g sample contains 1.797 g C and 0.403 g H.

Answer: _____

70. A 1.700 g sample contains 1.398 g N and 0.302 g H.

Answer: _____

Part 8: Percent Composition from a Formula

Score: _____ / 10

Calculate the percentage by mass of each element. Your percentages should add up to about 100%.

71. KNO_3

Answer: _____

72. C_2H_5OH

Answer: _____

73. $NaHCO_3$

Answer: _____

74. $Al_2(SO_4)_3$

Answer: _____

75. $CuSO_4$

Answer: _____

76. NH_4NO_3

Answer: _____

77. Fe_2O_3

Answer: _____

78. C_8H_{18}

Answer: _____

79. $Ca(OH)_2$

Answer: _____

80. H_3PO_4

Answer: _____

Part 9: Combustion Analysis

Score: _____ / 10

All C ends up in CO_2 and all H in H_2O. Find the mass of C and H, get O by subtraction, then find the formula.

81. A 2.000 g sample of a compound containing C, H only is burned, producing 5.986 g CO_2 and 3.268 g H_2O. Find the empirical formula.

Answer: _____

82. A 1.500 g sample of a compound containing C, H and O is burned, producing 2.865 g CO_2 and 1.760 g H_2O. Find the empirical formula.

Answer: _____

83. A 3.000 g sample of a compound containing C, H and O is burned, producing 4.397 g CO_2 and 1.800 g H_2O. Find the empirical formula.

Answer: _____

84. A 1.140 g sample of a compound containing C, H only is burned, producing 3.513 g CO_2 and 1.618 g H_2O. Find the empirical formula.

Answer: _____

85. A 0.780 g sample of a compound containing C, H only is burned, producing 2.637 g CO_2 and 0.540 g H_2O. Find the empirical formula.

Answer: _____

Part 9: Combustion Analysis (continued)

86. A 2.320 g sample of a compound containing C, H and O is burned, producing 5.273 g CO_2 and 2.159 g H_2O. Find the empirical formula.

Answer: _____

87. A 1.160 g sample of a compound containing C, H only is burned, producing 3.512 g CO_2 and 1.798 g H_2O. Find the empirical formula.

Answer: _____

88. A 1.850 g sample of a compound containing C, H and O is burned, producing 4.393 g CO_2 and 2.248 g H_2O. Find the empirical formula.

Answer: _____

89. A 1.200 g sample of a compound containing C, H and O is burned, producing 1.759 g CO_2 and 0.720 g H_2O. Its molar mass is 60.06 g/mol. Find the molecular formula.

Answer: _____

90. A 0.860 g sample of a compound containing C, H only is burned, producing 2.634 g CO_2 and 1.258 g H_2O. Its molar mass is 86.20 g/mol. Find the molecular formula.

Answer: _____

Part 10: Formulas of Hydrates

Score: _____ / 10

Find the mass of water lost, convert water and anhydrous salt to moles, and find the whole-number ratio.

91. A 5.00 g sample of hydrated $CuSO_4$ is heated until all water is removed. The anhydrous solid has a mass of 3.196 g. Find x in $CuSO_4 \cdot xH_2O$.

Answer: _____

92. A 4.93 g sample of hydrated $MgSO_4$ is heated until all water is removed. The anhydrous solid has a mass of 2.407 g. Find x in $MgSO_4 \cdot xH_2O$.

Answer: _____

93. A 2.44 g sample of hydrated $BaCl_2$ is heated until all water is removed. The anhydrous solid has a mass of 2.080 g. Find x in $BaCl_2 \cdot xH_2O$.

Answer: _____

94. A 5.72 g sample of hydrated Na_2CO_3 is heated until all water is removed. The anhydrous solid has a mass of 2.118 g. Find x in $Na_2CO_3 \cdot xH_2O$.

Answer: _____

95. A 3.57 g sample of hydrated $CoCl_2$ is heated until all water is removed. The anhydrous solid has a mass of 1.948 g. Find x in $CoCl_2 \cdot xH_2O$.

Answer: _____

Part 10: Formulas of Hydrates (continued)

96. A 2.78 g sample of hydrated $FeSO_4$ is heated until all water is removed. The anhydrous solid has a mass of 1.519 g. Find x in $FeSO_4 \cdot xH_2O$.

Answer: _____

97. A 6.44 g sample of hydrated Na_2SO_4 is heated until all water is removed. The anhydrous solid has a mass of 2.839 g. Find x in $Na_2SO_4 \cdot xH_2O$.

Answer: _____

98. A 4.31 g sample of hydrated $ZnSO_4$ is heated until all water is removed. The anhydrous solid has a mass of 2.420 g. Find x in $ZnSO_4 \cdot xH_2O$.

Answer: _____

99. A 4.07 g sample of hydrated $MgCl_2$ is heated until all water is removed. The anhydrous solid has a mass of 1.906 g. Find x in $MgCl_2 \cdot xH_2O$.

Answer: _____

100. A 3.44 g sample of hydrated $CaSO_4$ is heated until all water is removed. The anhydrous solid has a mass of 2.720 g. Find x in $CaSO_4 \cdot xH_2O$.

Answer: _____

Answer Key

Final answers in green, with short working. Small differences in the last decimal place are fine.

Part 1: Counting Atoms in a Formula

1. C = 6, H = 12, O = 6; total = **24** atoms

2. Ca = 1, O = 2, H = 2; total = **5** atoms

3. Al = 2, S = 3, O = 12; total = **17** atoms

4. N = 3, H = 12, P = 1, O = 4; total = **20** atoms

5. Mg = 3, P = 2, O = 8; total = **13** atoms

6. C = 12, H = 22, O = 11; total = **45** atoms

7. K = 4, Fe = 1, C = 6, N = 6; total = **17** atoms

8. Cu = 1, S = 1, O = 9, H = 10; total = **21** atoms

9. Ca = 3, N = 6, O = 18; total = **27** atoms

10. Fe = 4, S = 6, O = 24; total = **34** atoms

Part 2: Molar Mass

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. 40.08 + 12.01 + 3(16.00) = **100.09 g/mol**

15. 2(1.01) + 32.07 + 4(16.00) = **98.09 g/mol**

16. 6(12.01) + 12(1.01) + 6(16.00) = **180.18 g/mol**

17. 3(40.08) + 2(30.97) + 8(16.00) = **310.18 g/mol**

18. 2(26.98) + 3(32.07) + 12(16.00) = **342.17 g/mol**

19. 2(14.01) + 8(1.01) + 32.07 + 4(16.00) = **132.17 g/mol**

20. 8(12.01) + 18(1.01) = **114.26 g/mol**

Part 3: Empirical Formula from a Molecular Formula

21. divide all subscripts by 6 → **CH_2O**

22. divide all subscripts by 2 → **HO**

23. divide all subscripts by 2 → **CH_2**

24. divide all subscripts by 2 → **NO_2**

25. divide all subscripts by 6 → **CH**

26. divide all subscripts by 2 → **C_4H_9**

27. divide all subscripts by 2 → **BH_3**

28. divide all subscripts by 2 → **P_2O_5**

29. divide all subscripts by 2 → **CHO_2**

30. already in simplest ratio → **$C_{12}H_{22}O_{11}$**

Part 4: Molecular Formula from Empirical Formula

31. empirical mass = 13.02; n = 78.12 ÷ 13.02 = 6 → **C_6H_6**

32. empirical mass = 30.03; n = 180.18 ÷ 30.03 = 6 → **$C_6H_{12}O_6$**

33. empirical mass = 14.03; n = 56.12 ÷ 14.03 = 4 → **C_4H_8**

34. empirical mass = 46.01; n = 92.02 ÷ 46.01 = 2 → **N_2O_4**

35. empirical mass = 17.01; n = 34.02 ÷ 17.01 = 2 → **H_2O_2**

36. empirical mass = 29.07; n = 58.14 ÷ 29.07 = 2 → **C_4H_{10}**

37. empirical mass = 30.03; n = 60.06 ÷ 30.03 = 2 → **$C_2H_4O_2$**

38. empirical mass = 141.94; n = 283.88 ÷ 141.94 = 2 → **P_4O_{10}**

39. empirical mass = 40.07; n = 120.21 ÷ 40.07 = 3 → **C_9H_{12}**

40. empirical mass = 30.06; n = 60.12 ÷ 30.06 = 2 → **$C_2H_8N_2$**

Part 5: Empirical Formula from Percent Composition

41. mol Fe 1.252, O 1.879; ratio 1.00 : 1.50; ×2 → **Fe_2O_3**

42. mol Na 1.408, S 0.704, O 2.816; ratio 2.00 : 1.00 : 4.00 → **Na_2SO_4**

43. mol K 0.633, Mn 0.633, O 2.531; ratio 1.00 : 1.00 : 4.00 → **$KMnO_4$**

44. mol N 1.852, O 4.629; ratio 1.00 : 2.50; ×2 → **N_2O_5**

45. mol Fe 1.296, O 1.728; ratio 1.00 : 1.33; ×3 → **Fe_3O_4**

46. mol Na 1.887, C 0.943, O 2.831; ratio 2.00 : 1.00 : 3.00 → **Na_2CO_3**

47. mol K 0.680, Cr 0.680, O 2.379; ratio 1.00 : 1.00 : 3.50; ×2 → **$K_2Cr_2O_7$**

48. mol C 4.341, H 13.020, O 2.170; ratio 2.00 : 6.00 : 1.00 → **C_2H_6O**

49. mol C 1.664, H 6.663, N 3.330, O 1.665; ratio 1.00 : 4.00 : 2.00 : 1.00 → **CH_4N_2O**

50. mol C 5.732, H 4.911, O 1.637; ratio 3.50 : 3.00 : 1.00; ×2 → **$C_7H_6O_2$**

Part 6: Molecular Formula from Percent Composition

51. mol C 3.330, H 6.663, O 3.330; ratio 1.00 : 2.00 : 1.00 → empirical CH_2O (30.03); n = 2 → **$C_2H_4O_2$**

52. mol C 7.680, H 7.683; ratio 1.00 : 1.00 → empirical CH (13.02); n = 6 → **C_6H_6**

53. mol N 6.238, H 12.475; ratio 1.00 : 2.00 → empirical NH_2 (16.03); n = 2 → **N_2H_4**

54. mol C 3.406, H 4.545, O 3.406; ratio 1.00 : 1.33 : 1.00; ×3 → empirical $C_3H_4O_3$ (88.07); n = 2 → **$C_6H_8O_6$**

55. mol C 7.802, H 6.238; ratio 1.25 : 1.00; ×4 → empirical C_5H_4 (64.09); n = 2 → **$C_{10}H_8$**

56. mol C 2.221, H 2.218, O 4.442; ratio 1.00 : 1.00 : 2.00 → empirical CHO_2 (45.02); n = 2 → **$C_2H_2O_4$**

57. mol C 4.540, H 9.079, O 2.269; ratio 2.00 : 4.00 : 1.00 → empirical C_2H_4O (44.06); n = 2 → **$C_4H_8O_2$**

58. mol C 4.119, H 5.149, N 2.059, O 1.030; ratio 4.00 : 5.00 : 2.00 : 1.00 → empirical $C_4H_5N_2O$ (97.11); n = 2 → **$C_8H_{10}N_4O_2$**

59. mol C 7.127, H 14.257; ratio 1.00 : 2.00 → empirical CH_2 (14.03); n = 6 → **C_6H_{12}**

60. mol B 7.226, H 21.673; ratio 1.00 : 3.00 → empirical BH_3 (13.84); n = 2 → **B_2H_6**

Part 7: Empirical Formula from Mass Data

61. mol Mg 0.062, O 0.062; ratio 1.00 : 1.00 → **MgO**

62. mol Al 0.100, O 0.150; ratio 1.00 : 1.50; ×2 → **Al_2O_3**

63. mol Fe 0.100, O 0.150; ratio 1.00 : 1.50; ×2 → **Fe_2O_3**

64. mol Cu 0.050, O 0.025; ratio 2.00 : 1.00 → **Cu_2O**

65. mol Sn 0.030, O 0.060; ratio 1.00 : 2.00 → **SnO_2**

66. mol Ca 0.060, Cl 0.120; ratio 1.00 : 2.00 → **$CaCl_2$**

67. mol Na 0.100, S 0.050; ratio 2.00 : 1.00 → **Na_2S**

68. mol P 0.100, O 0.250; ratio 1.00 : 2.50; ×2 → **P_2O_5**

69. mol C 0.150, H 0.399; ratio 1.00 : 2.67; ×3 → **C_3H_8**

70. mol N 0.100, H 0.299; ratio 1.00 : 3.00 → **NH_3**

Part 8: Percent Composition from a Formula

71. M = 101.11 g/mol; **K 38.67%**, **N 13.86%**, **O 47.47%**

72. M = 46.08 g/mol; **C 52.13%**, **H 13.15%**, **O 34.72%**

73. M = 84.01 g/mol; **Na 27.37%**, **H 1.20%**, **C 14.30%**, **O 57.14%**

74. M = 342.17 g/mol; **Al 15.77%**, **S 28.12%**, **O 56.11%**

75. M = 159.62 g/mol; **Cu 39.81%**, **S 20.09%**, **O 40.10%**

76. M = 80.06 g/mol; **N 35.00%**, **H 5.05%**, **O 59.96%**

77. M = 159.70 g/mol; **Fe 69.94%**, **O 30.06%**

78. M = 114.26 g/mol; **C 84.09%**, **H 15.91%**

79. M = 74.10 g/mol; **Ca 54.09%**, **O 43.18%**, **H 2.73%**

80. M = 98.00 g/mol; **H 3.09%**, **P 31.60%**, **O 65.31%**

Part 9: Combustion Analysis

81. g C = 1.634, g H = 0.366; mol C 0.136, H 0.363; ratio 1.00 : 2.67; ×3 → empirical **C_3H_8**

82. g C = 0.782, g H = 0.197; g O = 1.500 – 0.782 – 0.197 = 0.521; mol C 0.065, H 0.195, O 0.033; ratio 2.00 : 6.00 : 1.00 → empirical **C_2H_6O**

83. g C = 1.200, g H = 0.202; g O = 3.000 – 1.200 – 0.202 = 1.598; mol C 0.100, H 0.200, O 0.100; ratio 1.00 : 2.00 : 1.00 → empirical **CH_2O**

84. g C = 0.959, g H = 0.181; mol C 0.080, H 0.180; ratio 1.00 : 2.25; ×4 → empirical **C_4H_9**

85. g C = 0.720, g H = 0.061; mol C 0.060, H 0.060; ratio 1.00 : 1.00 → empirical **CH**

86. g C = 1.439, g H = 0.242; g O = 2.320 – 1.439 – 0.242 = 0.639; mol C 0.120, H 0.240, O 0.040; ratio 3.00 : 6.00 : 1.00 → empirical **C_3H_6O**

87. g C = 0.958, g H = 0.202; mol C 0.080, H 0.200; ratio 1.00 : 2.50; ×2 → empirical **C_2H_5**

88. g C = 1.199, g H = 0.252; g O = 1.850 – 1.199 – 0.252 = 0.399; mol C 0.100, H 0.250, O 0.025; ratio 4.00 : 10.00 : 1.00 → empirical **$C_4H_{10}O$**

89. g C = 0.480, g H = 0.081; g O = 1.200 – 0.480 – 0.081 = 0.639; mol C 0.040, H 0.080, O 0.040; ratio 1.00 : 2.00 : 1.00 → empirical **CH_2O**; n = 2 → molecular **$C_2H_4O_2$**

90. g C = 0.719, g H = 0.141; mol C 0.060, H 0.140; ratio 1.00 : 2.33; ×3 → empirical **C_3H_7**; n = 2 → molecular **C_6H_{14}**

Part 10: Formulas of Hydrates

91. water = 1.804 g = 0.1001 mol; $CuSO_4$ = 0.0200 mol; ratio 5.00 → **$CuSO_4·5H_2O$**

92. water = 2.523 g = 0.1400 mol; $MgSO_4$ = 0.0200 mol; ratio 7.00 → **$MgSO_4·7H_2O$**

93. water = 0.360 g = 0.0200 mol; $BaCl_2$ = 0.0100 mol; ratio 2.00 → **$BaCl_2·2H_2O$**

94. water = 3.602 g = 0.1999 mol; Na_2CO_3 = 0.0200 mol; ratio 10.00 → **$Na_2CO_3·10H_2O$**

95. water = 1.622 g = 0.0900 mol; $CoCl_2$ = 0.0150 mol; ratio 6.00 → **$CoCl_2·6H_2O$**

96. water = 1.261 g = 0.0700 mol; $FeSO_4$ = 0.0100 mol; ratio 7.00 → **$FeSO_4·7H_2O$**

97. water = 3.601 g = 0.1998 mol; Na_2SO_4 = 0.0200 mol; ratio 10.00 → **$Na_2SO_4·10H_2O$**

98. water = 1.890 g = 0.1049 mol; $ZnSO_4$ = 0.0150 mol; ratio 7.00 → **$ZnSO_4·7H_2O$**

99. water = 2.164 g = 0.1201 mol; $MgCl_2$ = 0.0200 mol; ratio 6.00 → **$MgCl_2·6H_2O$**

100. water = 0.720 g = 0.0400 mol; $CaSO_4$ = 0.0200 mol; ratio 2.00 → **$CaSO_4·2H_2O$**

Notes: 15 Key Points to Remember

01	**Empirical vs molecular formula** The empirical formula is the simplest whole-number ratio of atoms (CH_2O). The molecular formula is the actual number of atoms in one molecule ($C_6H_{12}O_6$).
02	**Molecular = n × empirical** The molecular formula is always a whole-number multiple of the empirical formula. n can be 1, so some formulas are both, such as H_2O or CO_2.
03	**Finding n** n = molar mass ÷ empirical formula mass. The answer should be very close to a whole number.
04	**Assume 100 g for percentages** With percent composition, assume a 100 g sample so each percentage becomes the same number of grams.
05	**Always work in moles** Formulas show ratios of atoms, which means ratios of moles, not masses. Convert grams to moles before comparing.
06	**Divide by the smallest** After finding moles, divide every value by the smallest mole value so that element gets a ratio of 1.
07	**Do not round too early** Keep at least 3 significant figures until the end. Rounding 1.33 down to 1 gives a wrong formula.
08	**Recognise common decimals** About .50 → multiply by 2; .33 or .67 → by 3; .25 or .75 → by 4; .20 → by 5. Multiply every element, not just one.
09	**Round only when very close** A ratio within about 0.1 of a whole number (1.98, 3.04) can be rounded. A ratio like 1.5 cannot.
10	**Counting atoms with brackets** A subscript after a bracket multiplies everything inside it: $Ca_3(PO_4)_2$ has 3 Ca, 2 P and 8 O.
11	**Percentages should total 100%** In percent composition, add your answers as a check. A total of 99.9–100.1% is fine because of rounding.
12	**Combustion analysis** All carbon ends up in CO_2 (g C = g CO_2 × 12.01/44.01) and all hydrogen in H_2O (g H = g H_2O × 2.02/18.02).
13	**Oxygen by subtraction** In combustion problems, oxygen in the sample = sample mass – mass of C – mass of H. Never use the O in CO_2 or H_2O.
14	**Hydrates** Mass of water = hydrate mass – anhydrous mass. Then x = moles of H_2O ÷ moles of anhydrous salt.
15	**Ionic compounds have no molecular formula** Salts such as NaCl or Fe_2O_3 are written as formula units, which are already empirical. Molecular formulas apply to covalent molecules.