

How atoms join to make molecules

Grade 8 science (Year 9 · Class 8) · Lab answers

The answers use the sample results printed in the table. Your own values will differ a little, but the pattern of balls matching the subscripts should be the same.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS1-1

Question 1 Atoms from formulas

Add the subscripts of the formula. CH₄: 1 + 4 = 5 balls. NH₃: 1 + 3 = 4 balls. These match the table, so **balls = total of the subscripts**.

Question 2 Mass per ball

H₂ 6.1 ÷ 2 = 3.05 g. O₂ 6.0 ÷ 2 = 3.00 g. H₂O 9.2 ÷ 3 = 3.07 g. CO₂ 8.9 ÷ 3 = 2.97 g. CH₄ 15.1 ÷ 5 = 3.02 g. NH₃ 12.0 ÷ 4 = 3.00 g. Mean = 18.11 ÷ 6 = **3.0 g per ball**.

Question 3 Spread of the results

Highest 3.07 g (water), lowest 2.97 g (carbon dioxide). Range = 3.07 – 2.97 = **0.10 g**. Differences come from the balls not being exactly the same size when rolled by hand.

Question 4 Sticks and valency

Carbon has 4 sticks touching it, hydrogen 1, oxygen 2 and nitrogen 3 (a double bond counts as two sticks). **C 4, H 1, O 2, N 3**.

Question 5 Predict ethanol

Balls = 2 + 6 + 1 = 9. Sticks: the 9 atoms form one connected group with no rings, so 9 – 1 = 8 sticks. Mass = 9 × 3.0 = **27 g** (9 balls, 8 sticks).

Question 6 Limits of the model

Real atoms are not coloured and are not solid balls; the sticks do not exist as objects; the sizes of the balls do not show the real relative sizes of atoms. **Two limits: colour and shape, and size.**

Question 7 Improving the lab

Weigh every ball before use and discard any outside 3.0 ± 0.1 g. Repeat each model twice and average. **Weigh balls first, repeat and average.**