

Moles, isotopes and chemical formulas

AP Chemistry · Test answers (mark scheme)

Marks reward method, correct moles and clear units. Accept answers within rounding of the values shown and award follow-through marks where an earlier value is reused correctly.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 1

Question 1 Moles of methane (2 marks)

- a. $n = 8.00/16.043 = \mathbf{0.499 \text{ mol}}$.
b. $N = 0.4987 \times 6.022 \times 10^{23} = \mathbf{3.00 \times 10^{23} \text{ molecules}}$.

Marking: 1 mark each part.

Question 2 Mass spectrum of an element (3 marks)

- a. **11 %** (peak at 26).
b. Average = $24(0.79) + 25(0.10) + 26(0.11) = 18.96 + 2.50 + 2.86 = \mathbf{24.32}$.
c. This is **magnesium**.

Marking: 1 mark for each part.

Question 3 Empirical formula (3 marks)

$K = 26.6/39.098 = 0.680$; $Cr = 35.4/51.996 = 0.681$; $O = 38.0/15.999 = 2.375$. Dividing by 0.680: 1 : 1 : 3.49. Multiply by 2: 2 : 2 : 7. **$K_2Cr_2O_7$** .

Marking: 1 mark for the moles; 1 mark for the ratio; 1 mark for the doubling and formula.

Question 4 Molecular formula (2 marks)

Empirical mass = $12.011 + 1.008 = 13.019$. $78.1/13.019 = 6.0$, so the formula is **C_6H_6** .

Marking: 1 mark for the factor 6; 1 mark for the formula.

Question 5 Iron in an ore (3 marks)

- a. $\%Fe = 2(55.845)/159.69 \times 100 = \mathbf{69.94 \%}$.
b. $m = 0.6994 \times 1.00 \text{ kg} = \mathbf{0.699 \text{ kg}}$ (699 g).

Marking: 1 mark for part (a); 1 mark for using the fraction; 1 mark for the answer with unit.

Question 6 Why a non-integer average? (2 marks)

The average is a weighted mean of the isotope masses, weighted by abundance. **No single atom has the average mass**; most atoms have one of the integer-like isotope masses.

Marking: 1 mark for weighted mean; 1 mark for the idea that individual atoms have whole-number masses.

Question 7 Limestone in a mixture (3 marks)

a. $n(\text{CO}_2) = 0.880/44.009 = \mathbf{0.0200 \text{ mol}}$.

b. 1 : 1 ratio, so $m(\text{CaCO}_3) = 0.0200 \times 100.09 = 2.00 \text{ g}$; percent = $2.00/5.00 \times 100 = \mathbf{40.0 \%}$.

Marking: 1 mark for the moles; 1 mark for the mole ratio; 1 mark for the percent.

Question 8 Spot the error (2 marks)

The student forgot the subscripts and the number of atoms: Al_2 has two atoms and $(\text{SO}_4)_3$ has three sulfur and twelve oxygen atoms. Correct value: $2(26.982) + 3(32.06) + 12(15.999) = 53.964 + 96.18 + 191.99 = \mathbf{342.13 \text{ g/mol}}$.

Marking: 1 mark for the error; 1 mark for the value.