Quantitative Chemistry

GCSE Science • **Combined and Triple** • Grades 4–7

WORKED SOLUTIONS

Name: worked example Class: _____ Total: 59 / 59

Show all your working. Marks are given for correct method as well as the final answer.

1. State the law of conservation of mass. **[2 marks]**

so the total mass of products equals the total mass of reactants

Answer: no atoms are lost or made in a reaction

2. 12 g of carbon reacts with 32 g of oxygen. Work out the mass of carbon dioxide formed. **[2 marks]**

12 + 32 = 44 g

Answer: 44 **g**

3. Explain why the mass appears to decrease when a metal carbonate is heated in an open container. **[3 marks]**

a gas is produced
it leaves the container
mass is conserved -- it just left

Answer: carbon dioxide gas escapes

4. Work out the relative formula mass of H_2O. A_r: H = 1, O = 16. **[2 marks]**

(2 × 1) + 16
= 18

Answer: 18

5. Work out the relative formula mass of $CaCO_3$. A_r: Ca = 40, C = 12, O = 16. **[2 marks]**

40 + 12 + (3 × 16)
= 40 + 12 + 48 = 100

Answer: 100

6. Work out the relative formula mass of $Ca(OH)_2$. A_r: Ca = 40, O = 16, H = 1. **[3 marks]**

the 2 applies to BOTH the O and the H
40 + 2(16 + 1)
= 40 + 34 = 74

Answer: 74

7. Write down the equation linking mass, moles and relative formula mass. **[1 mark]**

mass in grams

Answer: moles = mass ÷ M_r

8. Work out the number of moles in 36 g of water ($M_r = 18$). **[2 marks]**

36 ÷ 18 = 2 mol

Answer: 2 **mol**

9. Work out the mass of 0.5 mol of calcium carbonate ($M_r = 100$). **[2 marks]**

mass = moles × M_r
0.5 × 100 = 50 g

Answer: 50 **g**

10. Work out the number of moles in 8 g of magnesium ($A_r = 24$). **[3 marks]**

8 ÷ 24
= 0.33 mol (3 s.f.)

Answer: 0.333 **mol**

11. $CaCO_3 \rightarrow CaO + CO_2$. Work out the mass of calcium oxide from 50 g of calcium carbonate. M_r: $CaCO_3 = 100$, $CaO = 56$. **[4 marks]**

moles of $CaCO_3$ = 50 ÷ 100 = 0.5
the ratio is 1 : 1, so 0.5 mol of CaO
mass = 0.5 × 56
= 28 g

Answer: 28 **g**

12. Using the same equation, work out the mass of carbon dioxide released. M_r of $CO_2 = 44$. **[3 marks]**

0.5 mol of CO_2
0.5 × 44 = 22 g
check: 28 + 22 = 50 ✓

Answer: 22 **g**

13. $2Mg + O_2 \rightarrow 2MgO$. Work out the mass of magnesium oxide from 4.8 g of magnesium. A_r: Mg = 24, O = 16. **[4 marks]**

moles of Mg = 4.8 ÷ 24 = 0.2
the ratio Mg : MgO is 2 : 2, so 0.2 mol of MgO
M_r of MgO = 40
0.2 × 40 = 8 g

Answer: 8 **g**

14. Write down the equation linking concentration, mass and volume. **[1 mark]**

in g/dm^3

Answer: concentration = mass ÷ volume

15. 20 g of salt is dissolved in 0.5 dm^3 of water. Work out the concentration. **[2 marks]**

20 ÷ 0.5 = 40 g/dm^3

Answer: 40 **g/dm^3**

16. Convert 250 cm^3 into dm^3. **[2 marks]**

1 dm^3 = 1000 cm^3
this conversion costs more marks than the chemistry
250 ÷ 1000 = 0.25

Answer: 0.25 **dm^3**

17. Write down the equation for percentage yield. **[1 mark]**

both masses in the same units

Answer: actual ÷ theoretical × 100

18. A reaction should give 25 g but gives 20 g. Work out the percentage yield. **[2 marks]**

$\frac{20}{25} \times 100 = 80\%$

Answer: 80 %

19. Give two reasons why a yield is never 100%.

(a) Give two reasons. **[2 marks]**

some product is lost when transferred

the reaction may be reversible, or side reactions happen

(b) Explain why a high atom economy matters to industry. **[3 marks]**

a high atom economy means less waste

fewer raw materials are needed per tonne of product

which is cheaper and more sustainable

Answer: losses / reversible ; less waste and lower cost

20. $N_2 + 3H_2 \rightarrow 2NH_3$. A_r: N = 14, H = 1.

(a) Work out the relative formula mass of ammonia. **[2 marks]**

$14 + (3 \times 1)$

$= 17$

(b) Work out the atom economy for making ammonia. **[4 marks]**

useful product $= 2 \times 17 = 34$

total reactants $= 28 + 6 = 34$

$\frac{34}{34} \times 100 = 100\%$

addition reactions have 100% atom economy

Answer: 17 ; 100%

21. A student heats 10 g of copper carbonate. $CuCO_3 \rightarrow CuO + CO_2$. M_r: $CuCO_3 = 124$, $CuO = 80$.

(a) Work out the theoretical mass of copper oxide, to 1 d.p. **[4 marks]**

moles of $CuCO_3 = 10 \div 124 = 0.0806$

1 : 1 ratio, so 0.0806 mol of CuO

0.0806×80

$= 6.5$ g

(b) Only 5.2 g is made. Work out the percentage yield, to 1 d.p. **[3 marks]**

$\frac{5.2}{6.5} \times 100$

$= 80.0\%$

Answer: 6.5 g ; 80.0%

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