4.3 Three Ways to Represent a Reaction

Name: _____ Class: _____ Date: _____ **Total: 18 marks**

KEY WORDS particle diagram • macroscopic • particulate • limiting reactant • in excess • conservation of atoms • coefficient

Objective

Build the skills to answer exam questions on the **three ways to represent a reaction** : the balanced equation (symbolic), particle diagrams (particulate) and what we see (macroscopic).

You must be able to:

- link a balanced equation to a **particle diagram** before and after a reaction
- use a particle diagram to find the **limiting reactant** and the reactant left over
- describe the **macroscopic** observations that go with a reaction
- use the **conservation of atoms** to check a diagram or an equation

1 Key knowledge and worked examples

Three views of one reaction

view	what it shows	example: $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
symbolic	a balanced equation with states	the equation itself
particulate	particles before and after	2 H_2 molecules and 1 O_2 molecule make 2 H_2O molecules
macroscopic	what you can see and measure	a pop or flame; water droplets form when cooled

rule	
conservation	every atom before the reaction is still there after: count each kind
coefficients	give the ratio of particles (and of moles)
limiting reactant	the reactant that runs out first; the other is **in excess**

Worked example 1: a particle box. A box holds 3 N_2 and 6 H_2 molecules. They react: $N_2 + 3H_2 \rightarrow 2NH_3$.

1. 6 H_2 need 2 N_2; there are 3, so H_2 is limiting.
2. After: 4 NH_3 **and** 1 N_2 left over. Check: 6 N and 12 H on both sides.

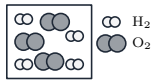
Worked example 2: macroscopic. Hydrogen gas is lit in air.

1. We hear a squeaky pop and see a flame.
2. Particulate: H_2 and O_2 molecules break apart and the atoms join as H_2O.

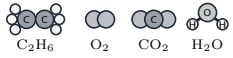
Answer shapes: count atoms of each element before and after; state which reactant is left over.

2 Practice

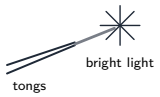
2.1 A box holds 4 H_2 molecules and 3 O_2 molecules. They react to form water: $2H_2 + O_2 \rightarrow 2H_2O$. State the number of water molecules formed and the molecules left over. [2]



2.2 Balance the equation ___ C_2H_6 + ___ O_2 → ___ CO_2 + ___ H_2O. [2]



2.3 Magnesium ribbon burns in air: $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$. Describe two things you would see. [2]



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3 Exam-style questions

3.1 The box shows the particles before nitrogen monoxide reacts with oxygen: $2NO(g) + O_2(g) \rightarrow 2NO_2($

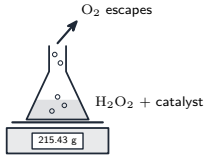
(a) State the number of each kind of molecule in the box after the reaction is complete. [2]



(b) Identify the limiting reactant, and show that atoms are conserved. [2]

3.2 Hydrogen peroxide decomposes when a catalyst is added: $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$. The flask stands on a balance with no stopper.

(a) 4 molecules of H_2O_2 decompose. State the number of each product molecule, and show that the atoms are conserved. [3]



(b) Describe two macroscopic observations, and give a test that shows the gas is oxygen. [3]

(c) The reading on the balance goes down. Explain why, using the particle view. [2]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

4 H_2O molecules; 1 O_2 molecule left over

2.2

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

2.3

a very bright white light (flame); a white powder (ash) forms

3.1

(a) 4 NO_2; 1 O_2 left over, 0 NO

(b) **NO** is limiting; before: 4 N and $4 + 6 = 10$ O; after: 4 N and $8 + 2 = 10$ O

3.2

(a) 4 H_2O; 2 O_2; before: 8 H and 8 O; after: 8 H and $4 + 4 = 8$ O

(b) bubbles of gas form; the flask may get warm (or froth forms); a glowing splint relights

(c) O_2 molecules escape from the open flask; the atoms are not destroyed, they leave the flask, so the mass on the balance falls

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