LESSON MAKER PRO

Reaction Energy Tracker

Use energy models to tell whether reactions release or absorb energy.

HIGH SCHOOL · HS-PS1-4

HS-PS1-4 "Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy..."

NAME _____ DATE _____

PART 1: PRACTICE

Use ΔE = product energy - reactant energy. A positive ΔE means the chemical system absorbs energy, and a negative ΔE means it releases energy. The same energy is transferred between the system and its surroundings. Breaking reactant bonds requires energy; forming product bonds releases energy. The balance between these totals determines the net change. The supplied totals are simplified system-energy levels, not energies of individual bonds.

WORKED EXAMPLE

A reaction model gives reactants an energy of 180 kJ and products an energy of 120 kJ. Find ΔE and identify the energy transfer.

1. ΔE = product energy - reactant energy
2. ΔE = 120 kJ - 180 kJ
3. ΔE = -60 kJ, so the system releases energy

Answer: ΔE = -60 kJ. The reaction releases 60 kJ to the surroundings.

PRACTICE 5 problems

1 1. A reaction model lists 95 kJ for the reactants and 150 kJ for the products. Find ΔE.

ANSWER _____

2 2. Reactants have 230 kJ and products have 160 kJ. Find ΔE. Does the system release or absorb energy?

ANSWER _____

3 3. A reaction changes from 305 kJ in the reactants to 350 kJ in the products. Find ΔE. Does the system release or absorb energy?

ANSWER _____

4 4. A chemical system changes from 410 kJ in the reactants to 330 kJ in the products. How much energy moves to the surroundings?

ANSWER _____

5 5. A student says a reaction absorbs 90 kJ. The model shows 510 kJ for reactants and 600 kJ for products. Calculate ΔE and decide whether the student is correct.

ANSWER _____

_____

APPLY IT Show your work

1 Part 2: Apply 1. A student team testing a reusable heat pack models its reaction with 725 kJ in the reactants and 640 kJ in the products. Find ΔE and state what happens to the energy.

WORK SPACE

ANSWER _____

2 Part 2: Apply 2. A sports medicine club tests an instant cold-pack reaction. Its model shows 845 kJ for reactants and 920 kJ for products. How much energy must the system absorb?

WORK SPACE

ANSWER _____

CHALLENGE One step up

Part 3: Challenge. Reaction A has 1000 kJ in its reactants and 880 kJ in its products. Reaction B has 930 kJ in its reactants and 1010 kJ in its products. Find ΔE for each reaction. Then explain in one sentence how both reactions conserve energy. Then develop a qualitative energy model for each reaction on separate paper: show reactant and product energy levels, an upward arrow for energy required to break bonds and a downward arrow for energy released when new bonds form. Make their relative lengths consistent with the net change. Add an arrow to or from the surroundings and explain why A releases energy but B absorbs it. Do not calculate individual bond energies. Label this an energy-accounting model, not the actual sequence of reaction steps.

WORK SPACE AND ANSWER

ANSWER KEY

Reaction Energy Tracker

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	1. A reaction model lists 95 kJ for the reactants and 150 kJ for the products. Find ΔE.	**ΔE = +55 kJ.**
2	2. Reactants have 230 kJ and products have 160 kJ. Find ΔE. Does the system release or absorb energy?	**ΔE = -70 kJ. The system releases 70 kJ.**
3	3. A reaction changes from 305 kJ in the reactants to 350 kJ in the products. Find ΔE. Does the system release or absorb energy?	**ΔE = +45 kJ. The system absorbs 45 kJ.**
4	4. A chemical system changes from 410 kJ in the reactants to 330 kJ in the products. How much energy moves to the surroundings?	**80 kJ moves to the surroundings.**
5	5. A student says a reaction absorbs 90 kJ. The model shows 510 kJ for reactants and 600 kJ for products. Calculate ΔE and decide whether the student is correct.	**ΔE = +90 kJ. Yes, the system absorbs 90 kJ.**

PART 2 · APPLY IT

1. **ΔE = -85 kJ. The chemical system releases 85 kJ to the surroundings.** Subtract reactant energy from product energy: 640 - 725 = -85 kJ. The negative value shows energy leaves the system.
2. **The system absorbs 75 kJ.** Calculate 920 - 845 = +75 kJ. A positive ΔE means the system absorbs energy from its surroundings.

CHALLENGE

Reaction A: ΔE = -120 kJ, so it releases 120 kJ. Reaction B: ΔE = +80 kJ, so it absorbs 80 kJ. Energy lost or gained by each chemical system is transferred to or from the surroundings, so total energy is conserved. In A, products lie below reactants: the downward bond-formation release is greater than the upward bond-breaking requirement, so net energy goes to the surroundings. In B, products lie above reactants: breaking requires more than formation releases, so net energy enters from the surroundings. Both models must show breaking as energy input and formation as energy release; their relative arrow lengths must agree with their final levels.

Accept equivalent wording for release to surroundings and absorption from surroundings. Require the correct sign on ΔE when students are asked to calculate it. Require the learner-created qualitative models and explanations as well as the supplied-total arithmetic. These arrows compare total breaking/forming contributions without calculating any individual bond energy. Do not imply that breaking bonds releases energy or that the bookkeeping drawing is a reaction mechanism.