

Heat in and out of reactions

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These twenty problems train you to classify reactions as exothermic or endothermic, read reaction profiles, use bond energies to find ΔH and turn temperature changes into energy in kJ. They move from simple recall to multi-step calculations with several data sets. They suit GCSE and IGCSE chemistry, O Level, CBSE Class 9-10 science and NGSS high school chemistry. Always write the unit and the sign of ΔH in your answer.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-4

Problem 1 Classify the changes (easy)

Write exothermic or endothermic for each change.

1. A camp fire burning wood
2. Calcium carbonate decomposing when heated strongly
3. Acid neutralising alkali so that the beaker gets warm
4. A plant making glucose in sunlight

Problem 2 Thermometer evidence (easy)

Wanjiru in Nairobi mixes citric acid with sodium hydrogencarbonate in a cup. The temperature falls from 24.0 °C to 17.5 °C.

1. Calculate the temperature change.
2. State whether the reaction is exothermic or endothermic.
3. State the sign of ΔH .

Problem 3 Hand warmers and cold packs (easy)

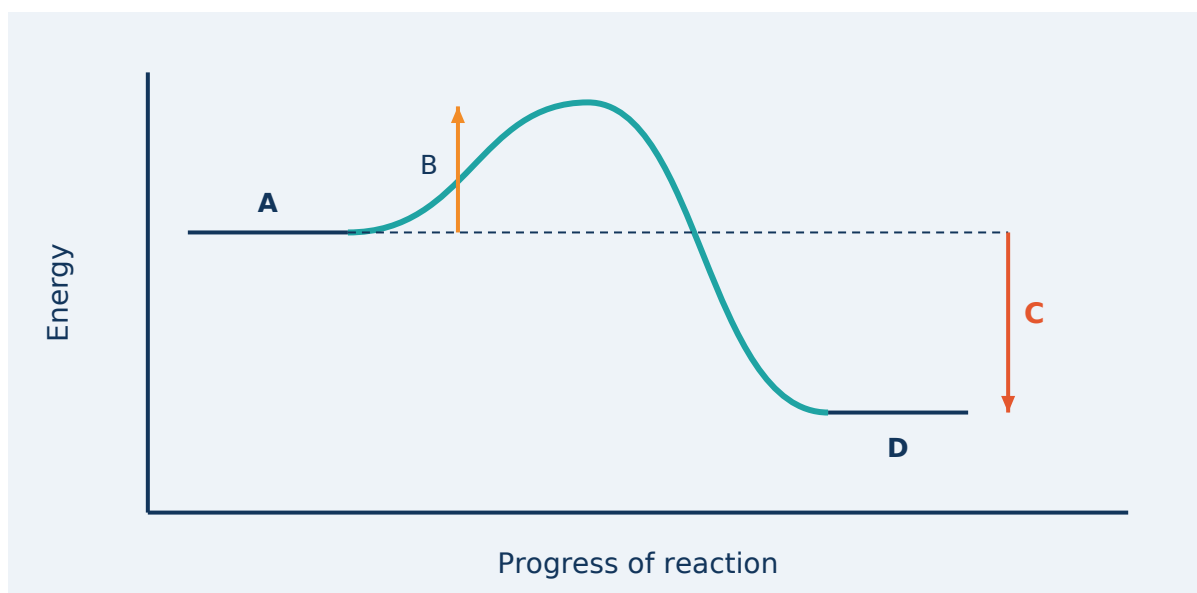
A hand warmer feels hot when activated. An instant cold pack feels cold.

1. State the type of reaction in each.
2. Explain where the energy goes in the hand warmer.
3. Suggest one situation for each.

Problem 4 Labelling a profile (easy)

The reaction profile shows a reaction.

1. Name the energy level labelled A and the one labelled D.
2. Name the quantity shown by arrow B.
3. Name the quantity shown by arrow C and state its sign.
4. State whether the reaction is exothermic or endothermic.



A reaction profile with four labels.

Problem 5 Breaking and making (easy)

State whether each process is endothermic or exothermic.

1. Breaking an H-H bond
2. Forming an O-H bond
3. Breaking a C=O bond
4. Forming an N≡N bond

Problem 6 Signs of ΔH (easy)

Complete each sentence.

1. In an exothermic reaction the temperature of the surroundings ____ and ΔH is ____.
2. In an endothermic reaction the products have ____ energy than the reactants.
3. The minimum energy to start a reaction is the ____ energy.

Problem 7 Heat from magnesium (medium)

Aarav in Pune adds magnesium ribbon to 50 g of dilute acid in a cup. The temperature rises by 11.0 °C ($c = 4.2 \text{ J/g/}^\circ\text{C}$).

1. Calculate the energy transferred to the solution in J.
2. Convert your answer to kJ.
3. State the type of reaction.

Problem 8 Hydrogen and bromine (medium)

$\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$. Bond energies (kJ/mol): H-H 436, Br-Br 193, H-Br 366.

1. Calculate the energy needed to break the bonds.
2. Calculate the energy released forming the bonds.
3. Calculate ΔH and state the type of reaction.

Problem 9 Making ammonia (medium)

$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$. Bond energies (kJ/mol): $\text{N}\equiv\text{N}$ 945, $\text{H}-\text{H}$ 436, $\text{N}-\text{H}$ 391.

1. Calculate the energy to break all the bonds.
2. Calculate the energy released making all the $\text{N}-\text{H}$ bonds (there are 6).
3. Calculate ΔH .

Problem 10 Sketch an endothermic profile (medium)

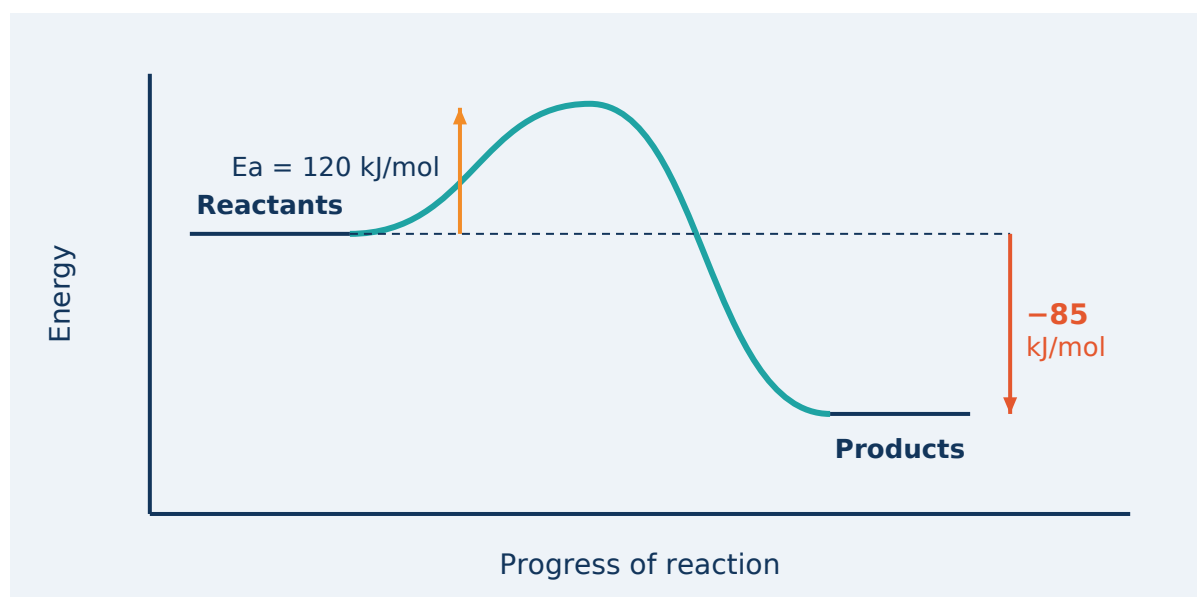
Describe how you would sketch the reaction profile of the thermal decomposition of calcium carbonate.

1. State where the reactants and the products are drawn.
2. State where you mark the activation energy and the energy change.
3. State the sign of ΔH .

Problem 11 Reading numbers from a profile (medium)

The profile shows a reaction with energies in kJ/mol.

1. State the activation energy of the forward reaction.
2. State ΔH for the forward reaction.
3. Calculate the activation energy of the reverse reaction.



Reactants at 0, hump at +120, products at -85.

Problem 12 Why light a match? (medium)

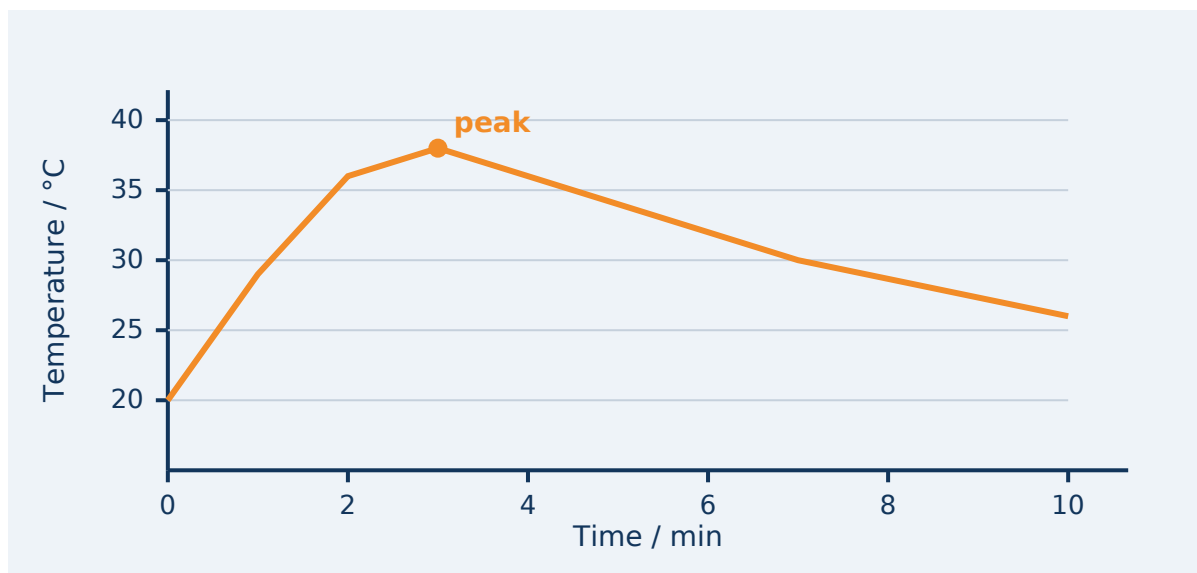
Burning methane in a cooker is exothermic, but the gas does not ignite by itself.

1. Explain this using activation energy.
2. Explain why the flame then keeps burning without the spark.

Problem 13 Reading a temperature graph (medium)

Kofi in Accra follows a reaction in a cup. The graph shows his temperature readings.

1. State the maximum temperature.
2. Calculate the greatest temperature rise.
3. Explain why the temperature falls after the peak.
4. State the type of reaction.



Temperature of the mixture against time.

Problem 14 Energy per gram of fuel (medium)

Energy given out on burning one mole: hydrogen 286 kJ ($M = 2$ g/mol), methane 890 kJ ($M = 16$ g/mol), ethanol 1367 kJ ($M = 46$ g/mol).

1. Calculate the energy released per gram for each fuel.
2. Rank the fuels from most to least energy per gram.
3. Suggest why hydrogen is still difficult to use as a car fuel.

Problem 15 Per mole from joules (medium)

A reaction in a cup releases 4500 J when 0.030 mol of a reactant is used up.

1. Convert 4500 J to kJ.
2. Calculate the energy released per mole.
3. Write the value of ΔH .

Problem 16 Burning ethanol under a can (hard)

Bilal in Lahore burns 0.50 g of ethanol ($M = 46$ g/mol) under a can containing 100 g of water. The water rises by 30 °C ($c = 4.2$ J/g/°C). The data book value is -1367 kJ/mol.

1. Calculate the energy absorbed by the water.
2. Calculate the moles of ethanol burned.
3. Calculate the energy per mole and compare with the data book value.

4. Suggest two reasons for the difference.

Problem 17 Burning methane (hard)

$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$. Bond energies (kJ/mol): C-H 413, O=O 498, C=O 805, O-H 464.

1. Calculate the energy to break all the bonds.
2. Calculate the energy released forming the bonds.
3. Calculate ΔH .
4. Calculate the energy released burning 8.0 g of methane ($M = 16 \text{ g/mol}$).

Problem 18 Hydrogen iodide (hard)

$2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$. Bond energies (kJ/mol): H-I 299, H-H 436, I-I 151.

1. Calculate the energy to break the bonds.
2. Calculate the energy released making the bonds.
3. Calculate ΔH and decide the type of reaction.
4. Sketch in words where the products lie on the profile.

Problem 19 Evaluate a claim (hard)

Diego says: 'The reaction has $\Delta H = -200 \text{ kJ/mol}$, so it must happen instantly when the reactants are mixed.' Its activation energy is 150 kJ/mol .

1. Explain why the claim is wrong.
2. State the activation energy of the reverse reaction.
3. Describe what Diego must do to start it.

Problem 20 Spot the errors (hard)

A student wrote: 'Bond making is endothermic. In an exothermic reaction the products have more energy than the reactants. $\Delta H = \text{bonds formed} - \text{bonds broken}$. The temperature falls in an exothermic reaction.' Correct all four errors.