Chemical Energy

Name: _____ Class: _____ Date: _____

Quick Reference: Understanding Chemical Energy

Chemical energy is a form of potential energy associated with the arrangement of atoms and electrons in substances, including their chemical bonds.

During a chemical reaction, existing bonds break and new bonds form.

- Breaking bonds requires energy.
- Forming bonds releases energy.
- An exothermic reaction releases more energy during bond formation than it absorbs during bond breaking.
- An endothermic reaction absorbs more energy during bond breaking than it releases during bond formation.

The overall energy change can be estimated using:

$$\Delta H \approx \text{Energy to break bonds} - \text{Energy released forming bonds}$$

A negative ΔH indicates an exothermic reaction. A positive ΔH indicates an endothermic reaction.

Part A: Multiple Choice (8 marks)

1. What is chemical energy?

A. Energy stored in the motion of objects
B. Energy associated with the arrangement of atoms and chemical bonds
C. Energy produced only by electricity
D. Energy stored only in hot objects

2. What happens when a chemical bond is broken?

A. Energy is always released.
B. No energy is involved.
C. Energy must be supplied.
D. The atoms disappear.

3. Which process is exothermic?

A. Burning natural gas
B. Photosynthesis
C. Thermal decomposition of calcium carbonate
D. Melting ice

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4. In an exothermic reaction, the surroundings usually:

A. Become colder
B. Become warmer
C. Remain at exactly the same temperature
D. Stop transferring energy

5. Which everyday object stores chemical energy?

A. An empty glass
B. A metal ruler
C. A charged battery
D. A stationary mirror

6. What happens when new chemical bonds form?

A. Energy is absorbed in every case.
B. Energy is released.
C. All chemical energy disappears.
D. No energy transfer occurs.

7. An endothermic chemical reaction:

A. Transfers energy to the surroundings overall.
B. Always produces a flame.
C. Absorbs energy from the surroundings overall.
D. Cannot form new bonds.

8. Why do chemical reactions involve energy changes?

A. Atoms are always destroyed during reactions.
B. Chemical reactions create energy from nothing.
C. Electrons stop moving during reactions.
D. Breaking and forming bonds involve energy transfers.

Part B: Chemical Energy in Everyday Life (10 marks)

1. Complete the table below. Identify the energy source and describe how chemical energy is transformed. (6 marks)

Example	Source of chemical energy	Useful energy transformation
A burning candle	_____	_____
A mobile phone battery powering a phone	_____	_____
A person running	_____	_____

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2. Explain why each example involves chemical energy. (4 marks)

a. A car engine burns petrol to move a vehicle. (2 marks)

b. A plant uses sunlight during photosynthesis to produce glucose. (2 marks)

Part C: Exothermic and Endothermic Reactions (10 marks)

1. Complete the table. State whether each process is exothermic or endothermic. (4 marks)

Process	Exothermic or endothermic?
Burning methane	_____
Photosynthesis	_____
Thermal decomposition of calcium carbonate	_____
Acid reacting with an alkali in a typical neutralisation reaction	_____

2. A student mixes two solutions. The temperature rises from 22°C to 31°C. (3 marks)

a. Calculate the temperature change. (1 mark)

b. Is the reaction exothermic or endothermic? (1 mark)

c. Explain your answer in terms of energy transfer. (1 mark)

3. During another reaction, the temperature decreases from 25°C to 18°C. Assume the reaction mixture exchanges energy with its surroundings. (3 marks)

a. Calculate the temperature change. (1 mark)

b. What type of reaction does this suggest? (1 mark)

c. Explain what happens to energy during this reaction. (1 mark)

Part D: Bond Energy and Chemical Reactions (12 marks)

1. Explain why breaking chemical bonds requires energy while forming bonds releases energy. (2 marks)

2. A reaction requires 450 kJ of energy to break bonds and releases 620 kJ when new bonds form. (4 marks)

a. Calculate the overall energy change. (2 marks)

b. Is the reaction exothermic or endothermic? (1 mark)

c. Explain your answer. (1 mark)

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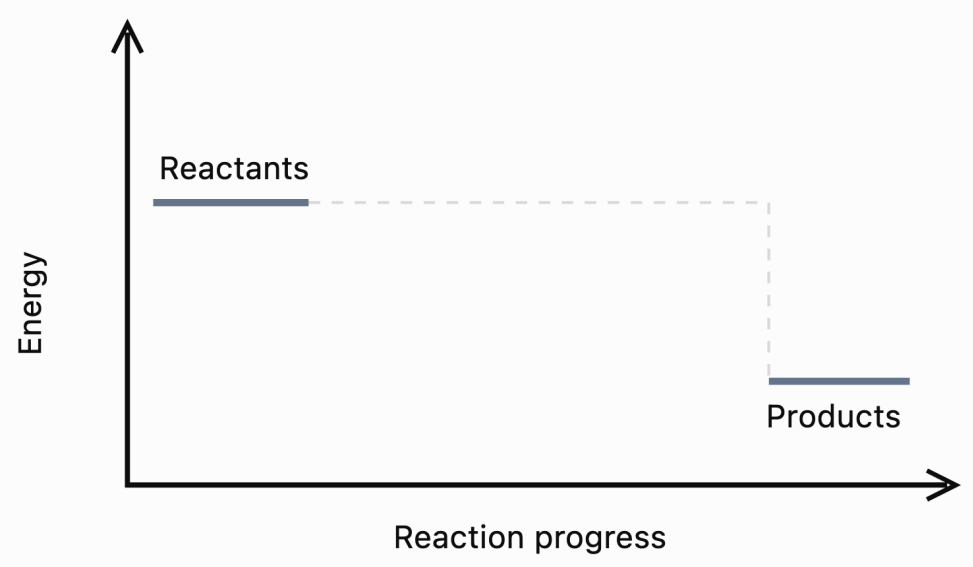
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3. A second reaction requires 700 kJ to break bonds and releases 540 kJ when new bonds form. (3 marks)

a. Calculate the overall energy change. (2 marks)

b. Identify the type of reaction. (1 mark)

4. Complete the energy profile diagram for an exothermic reaction. (3 marks)



Complete the reaction pathway with a curve rising to an activation-energy peak and then falling to the lower product energy level. Label the activation energy and overall energy change (ΔH).

a. Draw the reaction pathway. (1 mark)

b. Label the activation energy, Ea. (1 mark)

c. Show ΔH with an arrow indicating the energy difference between reactants and products. (1 mark)

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Part E: Applying Chemical Energy Concepts (10 marks)

1. Combustion of Methane (4 marks)

Methane burns in oxygen according to the equation:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

a. Identify the fuel. (1 mark)

b. State whether the reaction is exothermic or endothermic. (1 mark)

c. Explain why energy is released overall, referring to bond breaking and bond formation. (2 marks)

2. Instant Cold Packs (3 marks)

Some instant cold packs contain substances that dissolve in water through an endothermic process.

a. Explain why the cold pack becomes cold. (2 marks)

b. Give one practical use for an instant cold pack. (1 mark)

3. Food and Energy (3 marks)

Food contains chemical energy that the body can transfer to other energy stores through cellular respiration.

a. Identify one energy-rich nutrient in food. (1 mark)

b. Explain how chemical energy from food supports muscle movement. (2 marks)

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Teacher Answer Key

Part A (8 marks)

Question	Answer
1	B
2	C
3	A
4	B
5	C
6	B
7	C
8	D

Part B (10 marks)

1. Everyday examples

Example	Source	Transformation
Candle	Wax	Chemical → thermal and light
Mobile phone	Battery reactants	Chemical → electrical → light, sound and thermal
Running	Food molecules	Chemical → movement and thermal

2. Explanations

a. Petrol reacts with oxygen in combustion, releasing energy that the engine transfers into useful mechanical work and thermal energy.

b. Photosynthesis absorbs light energy and stores energy chemically in products such as glucose.

Part C (10 marks)

1. Classification: Burning methane — exothermic; photosynthesis — endothermic (requires energy input); thermal decomposition — endothermic; typical acid–alkali neutralisation — exothermic.

2. Temperature increase

a. 31 − 22 = 9°C.
b. Exothermic.
c. The reaction releases energy, warming the mixture.

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3. Temperature decrease

a. $18 - 25 = -7°C$ (a decrease of 7°C).
b. Endothermic.
c. The process absorbs energy from the surroundings, cooling the mixture.

Part D (12 marks)

1. Breaking bonds requires energy to overcome attractive forces between bonded atoms. Forming bonds releases energy as atoms move into a more stable, lower-energy arrangement.

2. $\Delta H \approx 450 - 620 = -170$ kJ. The reaction is exothermic because bond formation releases more energy than bond breaking requires.

3. $\Delta H \approx 700 - 540 = +160$ kJ. The reaction is endothermic.

4. Award marks for a reaction pathway with a peak, activation energy labelled from the reactant level to the peak, and a downward ΔH arrow from reactants to products.

Part E (10 marks)

1. Methane combustion

a. Methane (CH_4).
b. Exothermic.
c. Energy is required to break bonds in methane and oxygen. Forming the bonds in carbon dioxide and water releases more energy, giving a net release.

2. Cold packs

a. The dissolving process absorbs thermal energy from its surroundings, causing cooling.
b. Reducing swelling or providing temporary cooling after a minor injury.

3. Food energy

a. Carbohydrates or fats (proteins also accepted).
b. Cellular respiration transfers chemical energy from food into ATP, which powers muscle contraction and other cellular processes.

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