

CHEMDU · COMMUNITY CHEMISTRY · LEVEL 1

LECTURE 8

Thermodynamics

Hot Packs, Cold Packs, and Engine Meltdowns: Where Does Heat Come From?

■ Duration: 50 minutes

Lecture script · with hooks, segments, demos, and key takeaways

Hook (opening 3 minutes)

Teacher holds up (or shows photos of):

A instant hand warmer (hot pack) — the kind you crack to activate

A instant cold pack — the kind you squeeze to activate for a sprained ankle

A car engine (overheating)

A microwave heating food

Teacher says: "You crack a hand warmer. It gets hot — but there's no fire. You squeeze a cold pack for a sprained ankle. It gets cold — but there's no ice.

Where does that heat come from? Where does the cold come from?

- Today's question: What makes some chemical reactions give off heat — and others take heat in? *

By the end of this session, you will be able to:

Explain why some reactions feel hot and some feel cold

Know whether a cold pack or hot pack is safe for an injury

Understand why engines overheat and what to do about it"

SEGMENT 1: What Is Thermodynamics? (5 minutes)

Teacher says: "Let's start with the big word: thermodynamics (ther-moh-dy-NAM-iks).

Thermodynamics is the study of heat and how it moves during chemical reactions. "Thermo" means heat. "Dynamics" means movement.

Everyday example you already know: When you burn a match, the chemical reaction between wood and oxygen releases heat. That's thermodynamics. When you put an ice cube in your drink, heat moves from the drink into the ice (that's why the drink gets cold). That's also thermodynamics.

Teacher continues: "In chemistry, there are two kinds of reactions when it comes to heat:

Type of Reaction	What Happens to Heat	Feels...	Example
Exothermic (ex-oh-THE R-mik)	Gives OFF heat	Hot to the touch	Burning wood, hand warmers
Endothermic (en-doh-TH ER-mik)	Takes IN heat	Cold to the touch	Cold packs, melting ice

Memorization trick:

"Exo" means "exit" — heat exits the reaction (comes out)

"Endo" means "enter" — heat enters the reaction (goes in)

Quick poll (show hands): "Raise your hand if you've ever used a hand warmer on a cold day." "Raise your hand if you've ever used a cold pack on a sprained ankle."

Teacher: "You've used exothermic and endothermic reactions. You already know thermodynamics."

Physical action:

"Exothermic: Pretend your hands are on fire and you're blowing heat outward (whoosh)."

"Endothermic: Pretend your hands are sucking heat inward from the air (brrrr)."

SEGMENT 2: Exothermic Reactions — Heat Makers (10 minutes)

Teacher says: "Let's dive deeper into exothermic reactions."

An exothermic (ex-oh-THER-mik) reaction is a chemical reaction that releases heat. The products (what you end with) have less stored energy than the reactants (what you started with). The extra energy comes out as heat.

Everyday examples you already know: *

Exothermic Reaction	Where You See It	Why It's Useful (or Dangerous)
Burning wood or gas	Campfire, car engine	Heat for cooking, warmth, movement
Rusting iron	Old fence, bike chain	Slow heat (you can't feel it) — but still exothermic
Hand warmer (iron oxidation)	Disposable hand warmers	Heat for cold hands — no flame
Concrete curing (hardening)	Sidewalks, buildings	Cement gets warm as it hardens
Bleach + water	Cleaning with bleach	The bottle gets slightly warm
Battery discharging	Using your phone	Phone gets warm — that's exothermic

Teacher continues: "Let's look at the hand warmer in detail. A disposable hand warmer contains iron powder, salt, water, and activated carbon.

When you open the package, oxygen from the air enters. The iron reacts with oxygen to form iron oxide (rust). That reaction is exothermic — it releases heat. The same reaction that slowly rusts a fence over years happens in minutes inside the hand warmer."

Show this simplified reaction:

text



Real-world safety note (2 minutes): "Exothermic reactions can be dangerous if the heat builds up too fast. Examples:

Danger	What Happens	Prevention
Lithium battery fire	Battery discharges too fast → heat builds up → fire	Don't puncture or overcharge batteries
Pool chemical mixing	Some pool chemicals react exothermically with water → can boil or explode	Follow mixing instructions exactly
Grease fire	Cooking oil gets too hot → ignites	Never put water on a grease fire (use lid or baking soda)

Quick poll (show hands): "Raise your hand if you've ever felt a phone or laptop get warm while charging."

Teacher: "That's an exothermic reaction inside the battery. A little warmth is normal. Too much heat means something is wrong."

SEGMENT 3: Endothermic Reactions — Heat Takers (10 minutes)

Teacher says: "Now let's talk about endothermic reactions."

An endothermic (en-doh-THER-mik) reaction is a chemical reaction that absorbs (takes in) heat. The products have more stored energy than the reactants. The reaction pulls heat from the surroundings — that's why it feels cold.

Everyday examples you already know: *

Endothermic Reaction	Where You See It	Why It Feels Cold
Melting ice	Ice cube in a drink	Heat from the drink goes into the ice
Evaporating sweat	Sweat drying on your skin	Heat from your skin goes into the sweat (cools you down)
Cold pack (ammonium nitrate + water)	First aid for sprains	Heat from your injury goes into the pack
Baking soda + vinegar	Volcano experiment	The container feels slightly cool
Photosynthesis	Plants making food	Plants absorb heat from the sun

Teacher continues: "Let's look at the cold pack in detail. A disposable cold pack contains ammonium nitrate (a salt) and a small inner bag of water.

When you squeeze the pack, the inner bag breaks. The ammonium nitrate dissolves in the water. That dissolving process is endothermic — it pulls heat from the surroundings. The pack gets cold — as low as

35°F (2°C).

Show this simplified reaction:

text

Ammonium nitrate (solid) + Water → Dissolved ammonium nitrate + COLD (heat absorbed)

Real-world safety note (2 minutes): "Cold packs are safe for sprains and bruises. But there are two important safety rules:

Rule	Why
Don't put directly on bare skin	Extreme cold can cause ice burn — wrap in a cloth or towel
Don't cut open or eat the contents	Ammonium nitrate is not food — it can be toxic if swallowed
Don't use on open wounds	The chemicals can irritate exposed tissue

Partner talk (1 minute): "Tell your partner: You sprain your ankle playing sports. Do you use a hot pack or a cold pack?"

Answer: Cold pack first — it reduces swelling by pulling heat out of the injury. Heat comes later (after 48 hours) to increase blood flow.

SEGMENT 4: The Cold Pack vs. Hot Pack Decision (8 minutes)

Teacher says: "Knowing when to use heat vs. cold can help you treat injuries at home. Here's the simple rule."

Show this table (read aloud and discuss):

Time After Injury	What to Use	Why	How Long
First 48 hours	COLD pack (endothermic)	Reduces swelling, numbs pain	15-20 minutes on, then 20 minutes off
After 48 hours	HEAT pack (exothermic)	Increases blood flow, relaxes tight muscles	15-20 minutes at a time

Teacher continues: "Wrong choice can make things worse:

If You Use...	When You Should Use...	Result
Heat on a fresh injury (first 48 hours)	Cold	Increases swelling — makes injury worse
Cold on a stiff muscle (after 48 hours)	Heat	Reduces blood flow — slows healing

What about a chemical burn from an exothermic reaction? *If a chemical reaction burns your skin (acid + base, or concentrated bleach), do NOT use a cold pack. Use lots of cool running water for 15+ minutes. Then call Poison Control.*

Quick check (show of hands): "You twist your knee jogging. It's swollen. It happened 2 hours ago. Raise your hand if you should use a cold pack." (Yes — within first 48 hours) "It's 3 days later. The swelling is down, but your knee is stiff. Raise your hand if you should use a heat pack." (Yes — after 48 hours)

SEGMENT 5: Thermodynamics in Your Car — Why Engines Overheat (6 minutes)

Teacher says: "Car engines run on exothermic reactions. Gasoline + oxygen → carbon dioxide + water + HEAT. That heat is what moves the pistons.

But too much heat is bad. That's why cars have a cooling system."

Show this simple diagram (draw or screen):

text

Engine (hot) → Coolant (water + antifreeze) → Radiator (cools coolant) → Engine (cools down)

Teacher explains: "The coolant flows through the engine, absorbs heat (endothermic for the coolant), then goes to the radiator where the heat is released into the air (exothermic for the radiator)."

What to do if your car temperature gauge goes into the red (overheating):

Step	Action	Why
1	Turn off the air conditioner	AC puts extra heat into the engine
2	Turn on the heater to full blast	Pulls heat away from the engine into the car cabin
3	Pull over safely as soon as possible	Continue driving = engine damage
4	Do NOT open the radiator cap while hot	Pressurized hot coolant can explode out and burn you badly
5	Wait 30+ minutes for engine to cool	Then check coolant level

Quick poll (show hands): "Raise your hand if you've ever seen a car's temperature gauge go into the red."

Teacher: "Now you know: don't open the radiator cap until it's cool. That pressurized coolant is an exothermic reaction waiting to burn you."

SEGMENT 6: Cooking Chemistry — Why Food Heats (4 minutes)

Teacher says: "Every time you cook, you're using thermodynamics."

Cooking Method	Type of Heat Transfer	Endothermic or Exothermic?
Microwave	Microwaves make water molecules spin — friction creates heat	Energy enters food (endothermic for food)
Oven baking	Hot air transfers heat to food	Heat enters food (endothermic for food)
Frying pan	Hot metal transfers heat to food	Heat enters food (endothermic for food)
Burning (charring)	Chemical reaction of food + heat	Exothermic (releases heat, but food is already hot)

Teacher: "Cooking is mostly endothermic — the food takes in heat. Burning is exothermic — the food releases heat (and turns to carbon). That's why burnt food keeps smoking even after you take it off the heat."

Safety rule for cooking (repeat together): "If you see smoke, turn off the heat. If you see flames, cover the pan with a lid — never use water."

Physical action:

"Pretend you're putting a lid on a flaming pan (covering motion)."

"Now pretend you're pouring water on it (shaking motion) — STOP. That's wrong."

CLOSING — The 30-Second Challenge (3 minutes)

Teacher says: "Pair up. Person A: 30 seconds — explain the difference between exothermic and endothermic, and give one example of each. Person B: 30 seconds — you sprain your ankle. When should you use a cold pack? When should you use a hot pack?"

Final takeaway table (show on screen / read aloud):

You learned...	So you can...
Exothermic = gives OFF heat (hand warmers, burning, batteries)	Understand why your phone gets warm; why engines need cooling
Endothermic = takes IN heat (cold packs, melting ice, sweat evaporating)	Treat sprains correctly (cold first, heat after 48 hours)
Hand warmer = iron + oxygen → rust + heat	Use safely without worrying it's a fire
Cold pack = ammonium nitrate + water → cold	Wrap in cloth — never directly on skin
Car overheating = coolant absorbs heat from engine	Pull over, turn on heater, never open hot radiator cap

You learned...	So you can...
Grease fire = exothermic reaction out of control	Cover with lid — never use water
Cold pack for 0-48 hours; heat pack after 48 hours	Treat injuries correctly

Final line (preview of next week): "Next week: Kinetics & Equilibrium — why food spoils faster in summer, why crushing medicine makes it work faster, and why you should never leave cooked rice out overnight. See you then."

SUPPLEMENTARY MATERIALS FOR LECTURE 8 (No Grade)

Resource	Source	Description	Link / Search Term
Video: "Endothermic and Exothermic Reactions"	Khan Academy	4-minute explanation with examples	Search "Khan Academy endothermic exothermic"
PhET "Reaction Rates" simulation	University of Colorado	Interactive — see how heat affects reactions	Search "PhET reaction rates"
Hand warmer chemistry article	ACS ChemMatters	How disposable hand warmers work	Search "ChemMatters hand warmers"
Cold pack safety information	Poison Control	What to do if someone eats cold pack contents	Search "poison control cold pack"
Car overheating guide	AAA / YouTube	What to do when your car overheats	Search "AAA car overheating"

OPTIONAL "NO-PRESSURE" ASSIGNMENT

"Between now and next session, find a hand warmer or cold pack in a store or online. Look at the ingredients label. Hand warmers often list 'iron powder.' Cold packs often list 'ammonium nitrate.' Next time, tell us what you found."

DEFINITIONS SUMMARY FOR LECTURE 8 (Student Handout)

Term	Simple Definition	Everyday Example
Thermodynamics	The study of heat and how it moves during chemical reactions	Burning wood, melting ice
Exothermic	A reaction that gives OFF heat (heat exits)	Hand warmer, burning match, phone battery
Endothermic	A reaction that takes IN heat (heat enters)	Cold pack, melting ice, sweat evaporating
Hand warmer	Iron + oxygen → rust + heat (exothermic)	Disposable warmers for cold hands
Cold pack	Ammonium nitrate + water → cold (endothermic)	First aid for sprains and bruises

Term	Simple Definition	Everyday Example
Coolant	A liquid that absorbs heat from an engine	Antifreeze + water in a car radiator
Grease fire	An exothermic reaction that gets out of control	Oil overheating in a pan
Heat transfer	Heat moving from a hotter thing to a colder thing	Spoon getting hot in a hot soup