

Thermochemistry

How much energy does a substance have?

Death of a gummy bear - DEMO

obj: I can identify and give examples of kinetic energy and potential energy

Thermochemistry

Energy -- the ability to do work

Potential energy-stored energy, energy of position or condition

stone at the top of the hill

battery with a full charge

chemical that can burn (bond energy)

Kinetic energy-energy of motion, heat, light

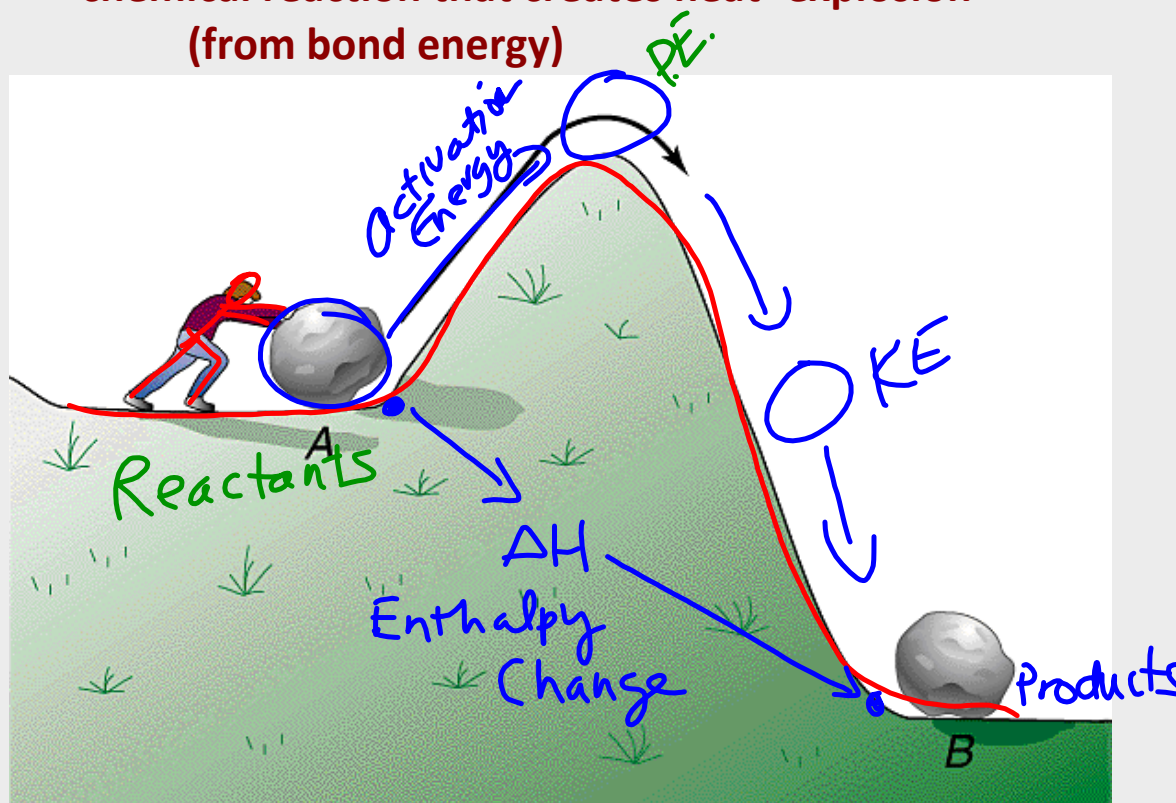
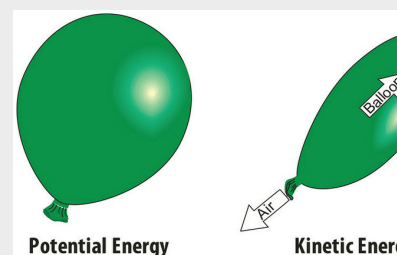
stone rolling down the hill

use of battery to run a toy car

toy car moving

chemical reaction that creates heat -explosion

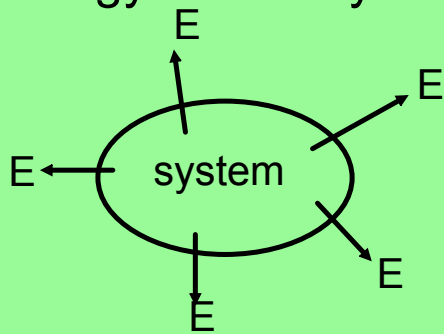
(from bond energy)



Where does energy come from?

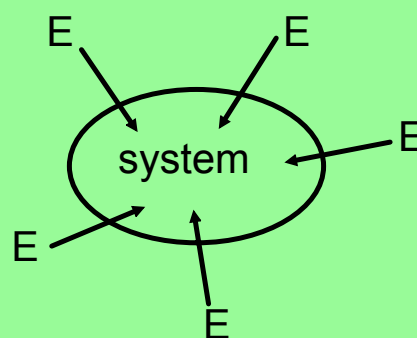
exothermic

energy exits a system

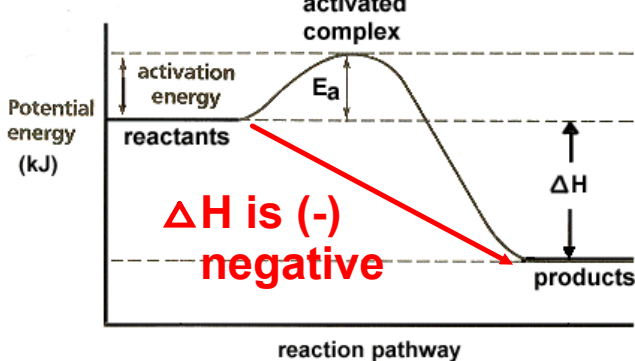


endothermic

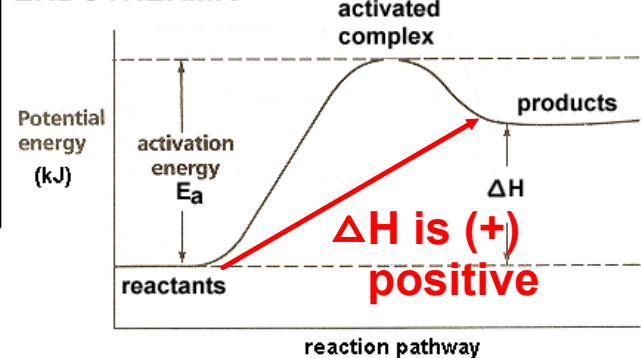
energy enters a system



EXOTHERMIC



ENDOTHERMIC



Enthalpy (H)-the amount of heat content used or released in a system
 ΔH = change in enthalpy

How do I quantify energy?

units:

Joule amount of energy needed to
metric move 1 kg 1 meter

calorie amount of energy to
English raise 1 g of water 1°C

$$1 \text{ cal} = 4.18 \text{ Joules}$$

$$1 \text{ food Calorie} = 1 \text{ kilocalorie} = 1000 \text{ cal}$$

upper case

$$1000 \text{ J} = 1 \text{ kJ}$$

lower case

Gummy Bear

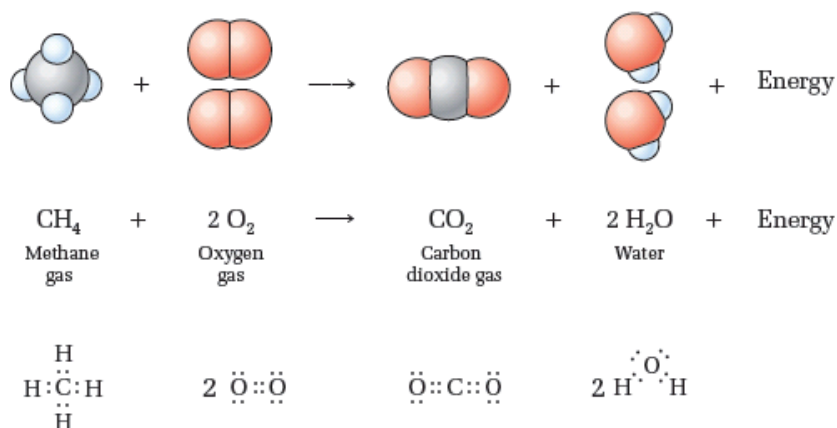
$$\frac{120 \text{ Calorie}}{1 \text{ Cal}} \times \frac{1000 \text{ cal}}{1 \text{ Cal}} \times \frac{4.18 \text{ J}}{1 \text{ cal}} \times \frac{1 \text{ kJ}}{1000 \text{ J}} = 501.6 \text{ kJ}$$

Chemical energy-stored energy (potential energy) in bonds

When fuel burns, **bonds break** and reactant atoms reorganize to **form new bonds** yielding products with a different and **more stable bonding** arrangements of atoms

Some energy is given off as heat (**thermal energy**) and light

Burning methane reaction example:

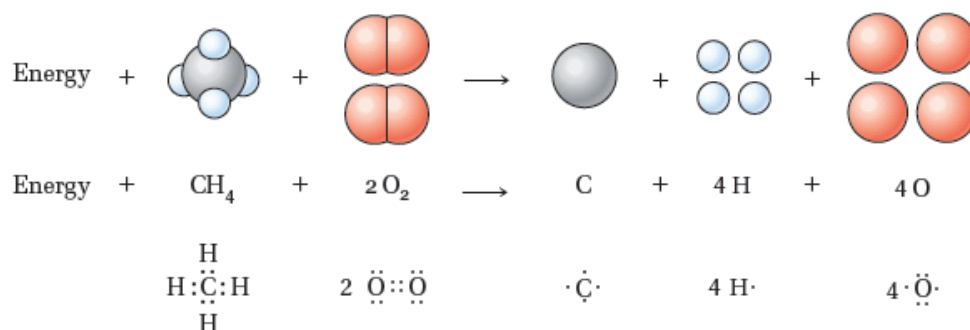


Does this reaction require energy to "start"?

Chemical Reaction--think of this as 2 steps

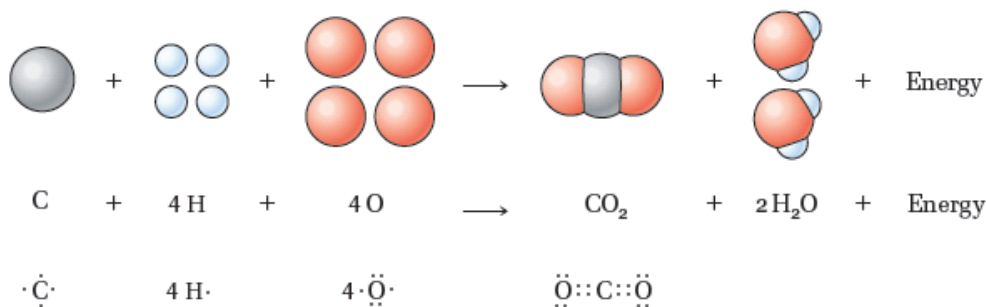
1. break bonds

Energy is always required to break bonds (endothermic)



2. make new bonds

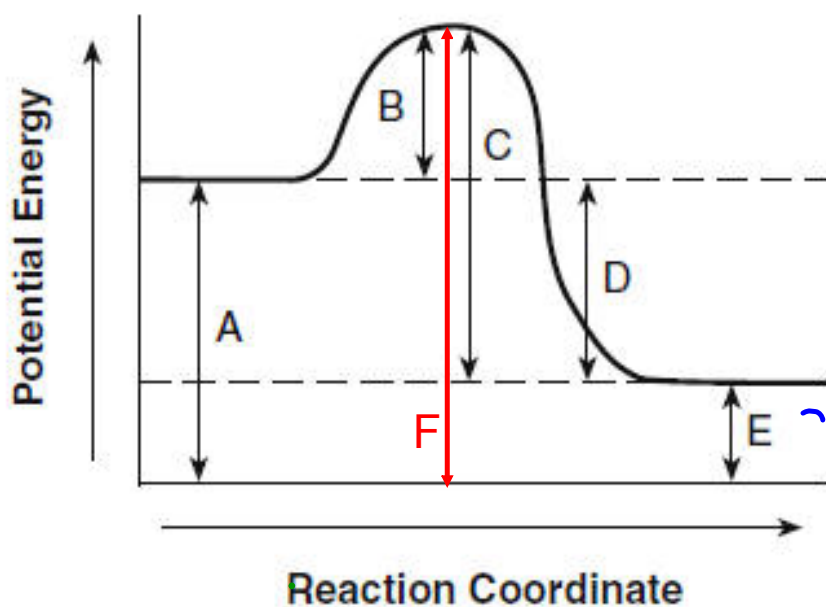
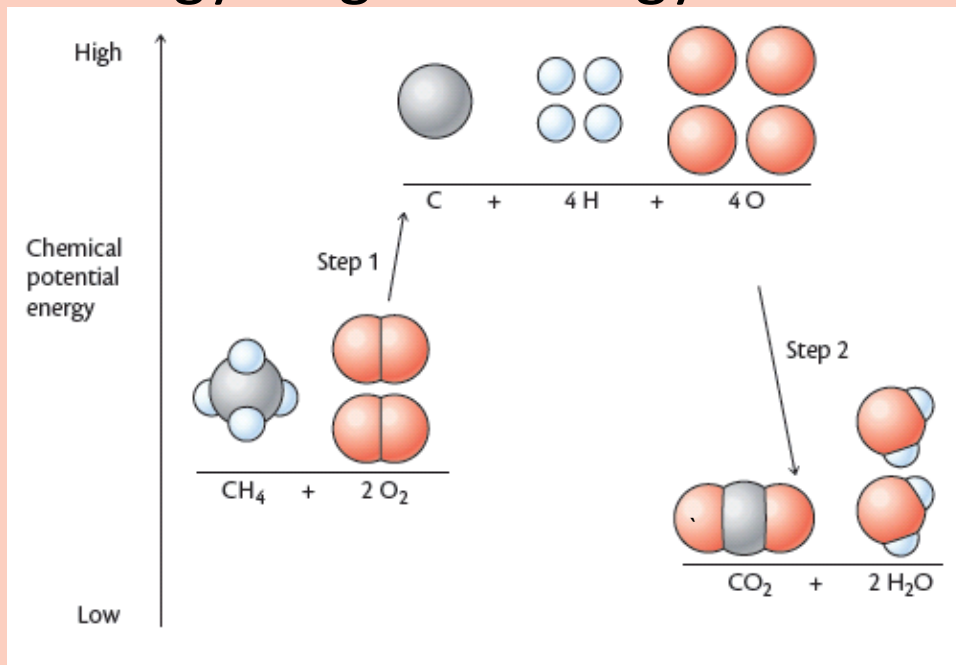
Energy is always given off to form bonds (exothermic)



Compare 2 steps to determine overall energy exchange

http://employees.oneonta.edu/viningwj/sims/bond_energy_dh_reaction_s.html

Energy diagram-energy summary



A= Energy of Reactants

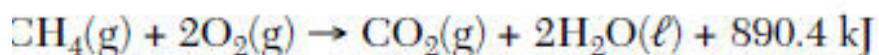
B= Activation energy, E_a

C= Activation energy, E_a of the reverse reaction

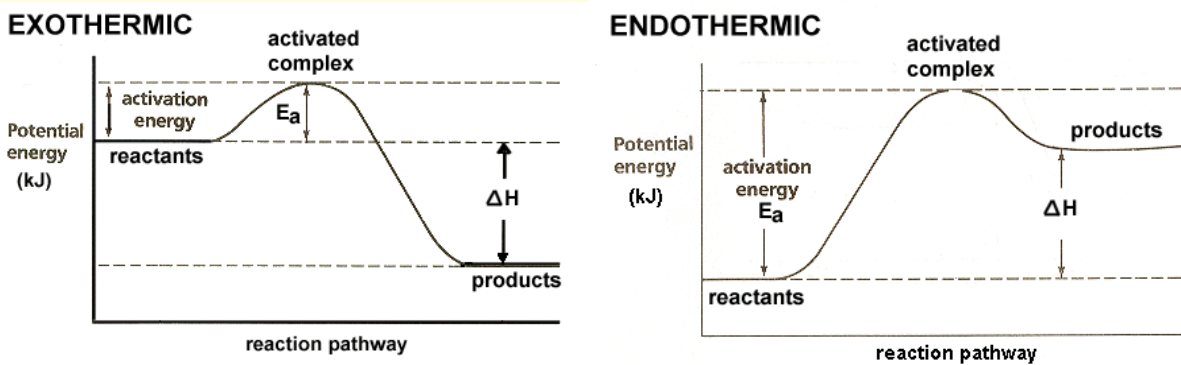
D= Energy of Enthalpy, ΔH

E= Energy of products

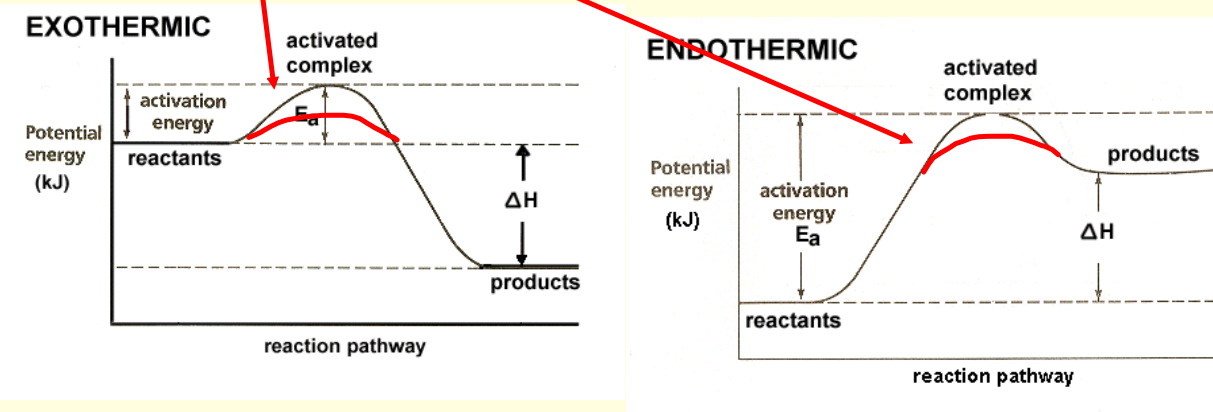
F=Energy of Activated Complex

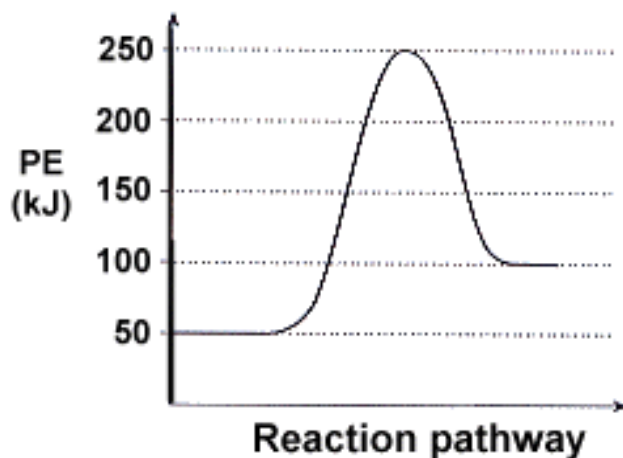


Energy diagrams for overall endothermic and exothermic reactions:

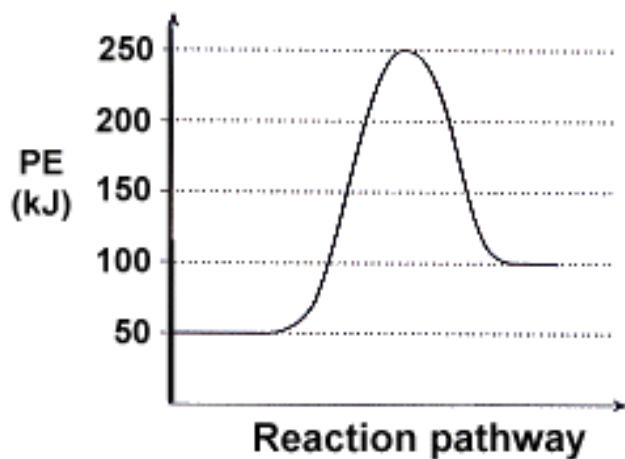


catalyst (enzyme) -lowers activation energy, E_a
 -speeds up a reaction,
 -is not used up

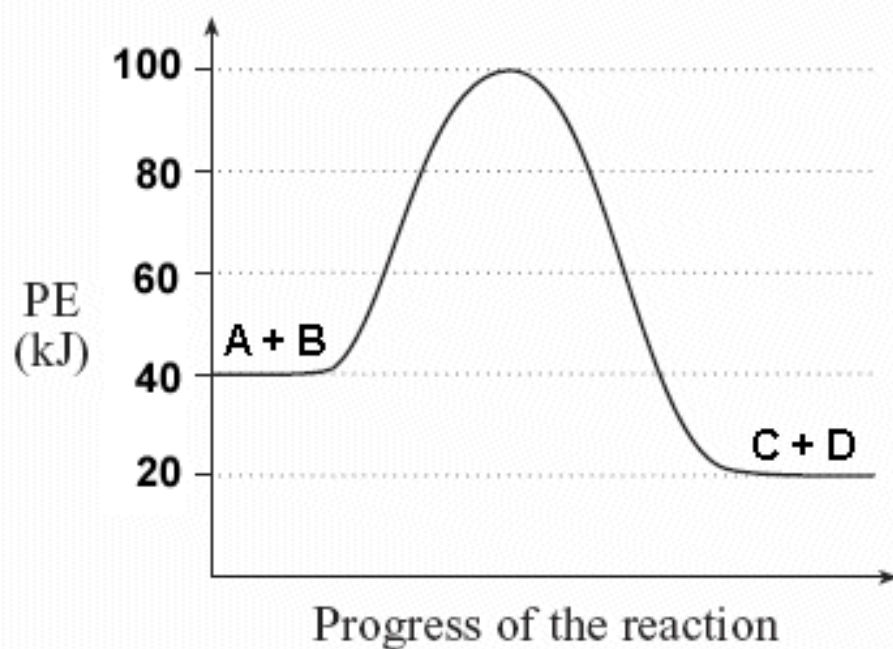




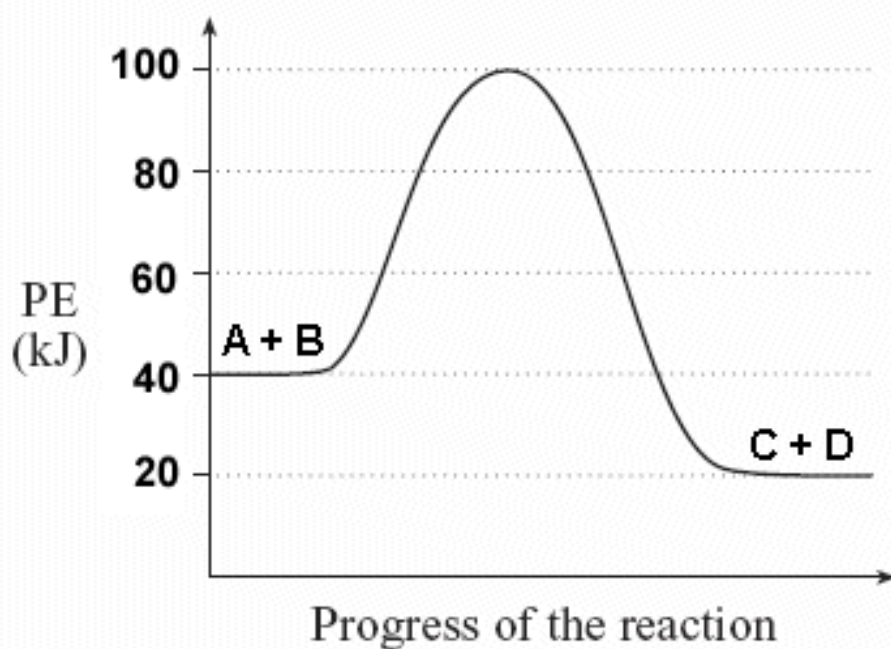
Question	Answer
Does the graph represent an endothermic or exothermic reaction?	
Determine the heat of reaction, ΔH , for this reaction.	
Determine the activation energy, E_a for this reaction.	
What is the energy of the activated complex for this reaction?	
Determine the reverse activation energy, E_a for this reaction.	



Question	Answer
Does the graph represent an endothermic or exothermic reaction?	endothermic
Determine the heat of reaction, ΔH , for this reaction.	+ 50 kJ
Determine the activation energy, E_a for this reaction.	200 kJ
What is the energy of the activated complex for this reaction?	250 kJ
Determine the reverse activation energy, E_a for this reaction.	150 kJ



Question	Answer
Does the graph represent an endothermic or exothermic reaction?	
Determine the heat of reaction, ΔH , for this reaction.	
Determine the activation energy, E_a for this reaction.	
What is the energy of the activated complex for this reaction?	
Determine the reverse activation energy, E_a for this reaction.	



Question	Answer
Does the graph represent an endothermic or exothermic reaction?	exothermic
Determine the heat of reaction, ΔH , for this reaction.	-20 kJ
Determine the activation energy, E_a for this reaction.	200 kJ
What is the energy of the activated complex for this reaction?	60 kJ
Determine the reverse activation energy, E_a for this reaction.	80 kJ