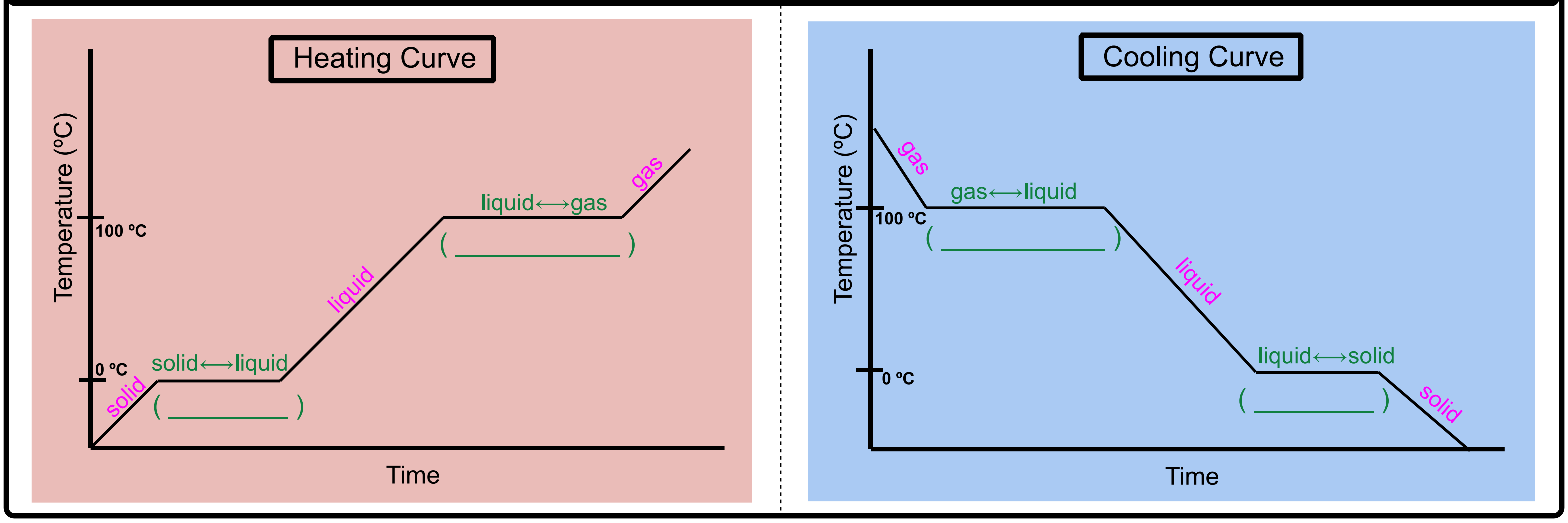
CONCEPT: HEATING AND COOLING CURVES

Introduction to Heating and Cooling Curves

● **Heating and Cooling Curves** represent amount of _____ absorbed or released by a substance during phase changes.

□ Heating Curve: endothermic process, _____ □ Cooling Curve: exothermic process, _____

Heating and Cooling Curves (Water)



● There are some significant _______________ between temperature and phase changes.

Temperature Changes	Phase Changes
□ Heat converted to _________ Energy	□ Heat converted to ___________ Energy
□ ___ Temp, ___ Kinetic Energy	□ Average Kinetic Energy is _________
	□ Temperature is _________
Specific Heat Capacity Formula	**Enthalpy Formula (Phase Change)**
$q = mc\Delta T$	$q = m$_____

EXAMPLE: Identify line segment on the diagram where specific heat of liquid water is used to calculate energy flow.

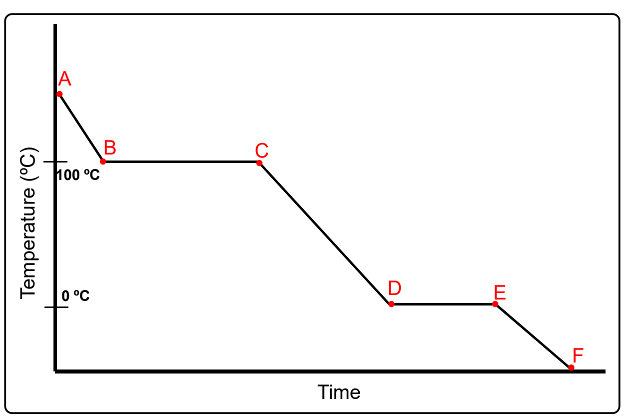
a) A - B

b) B - C

c) C - D

d) D - E

e) E - F



CONCEPT: HEATING AND COOLING CURVES

Calculations with Heating & Cooling Curves

● Recall the two formulas used to calculate heat at different parts of the curves.

Specific Heat Capacity Formula	Enthalpy Formula (Phase Change)
$q = mc\Delta T$	$q = m\Delta H$

□ We will use this formula to calculate the ________________ involved in a heating or cooling process.

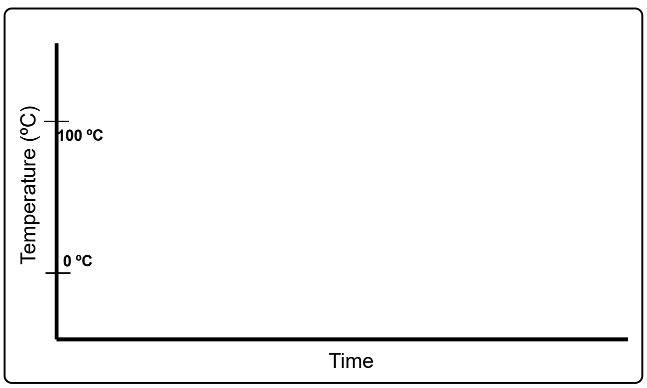
Total Energy Formula

$$q_{total} = q_1 + q_2 + q_3 + \ldots..$$

EXAMPLE: How much total energy (J) is required to convert 55.8 g of ice at -5 ºC to a gas at 100 ºC?

STEP 1: Draw the necessary curve and label all the changes.

STEP 2: Identify all the heats (q) involved along with necessary formulas.



Specific Heat of Ice (c)	$2.09 \frac{J}{g \cdot ºC}$
ΔH_{Fusion}	$334 \frac{J}{g}$
Specific Heat of Water (c)	$4.184 \frac{J}{g \cdot ºC}$
$\Delta H_{Vaporization}$	$2260 \frac{J}{g}$
Specific Heat of Steam (c)	$1.84 \frac{J}{g \cdot ºC}$

STEP 3: Calculate all the heats (q) involved using appropriate specific heats and enthalpies of a substance involved.

□ Pay attention to the signs of enthalpy: $+\Delta H_{Fusion} = -\Delta H_{Freezing}$

STEP 4: Calculate total energy involved by adding together all heats from **STEP 3**.

CONCEPT: HEATING AND COOLING CURVES

PRACTICE: How much energy (kJ) is required to convert a 76.4 g acetone (MM= 58.08 g/mol) as a liquid at -30 ºC to a solid at -115.0 ºC?

a) -11.406 kJ   b) -39.820 kJ   c) -22.811 kJ   d) -82.592 kJ

Specific Heat of Solid	$1.65 \frac{J}{g \cdot ^\circ C}$
ΔH_{Fusion}	$7.27 \frac{kJ}{mol}$
Specific Heat of Liquid	$2.16 \frac{J}{g \cdot ^\circ C}$
Specific Heat of Gas	$1.29 \frac{J}{g \cdot ^\circ C}$
$Temp_{Melting}$	-95.0 ºC

PRACTICE: If 53.2 kJ of heat are added to a 15.5 g ice cube at -5.00 ºC, what will be the resulting state and temperature of the substance?

a) 322.5 ºC, gas   b) -3.70 ºC, solid   c) 98.82 ºC, liquid   d) 222.5 ºC, gas

Specific Heat of Ice (c)	**$2.09 \frac{J}{g \cdot ^\circ C}$**
ΔH_{Fusion}	**$334 \frac{J}{g}$**
Specific Heat of Water (c)	**$4.184 \frac{J}{g \cdot ^\circ C}$**
$\Delta H_{Vaporization}$	**$2260 \frac{J}{g}$**