Latent Heat

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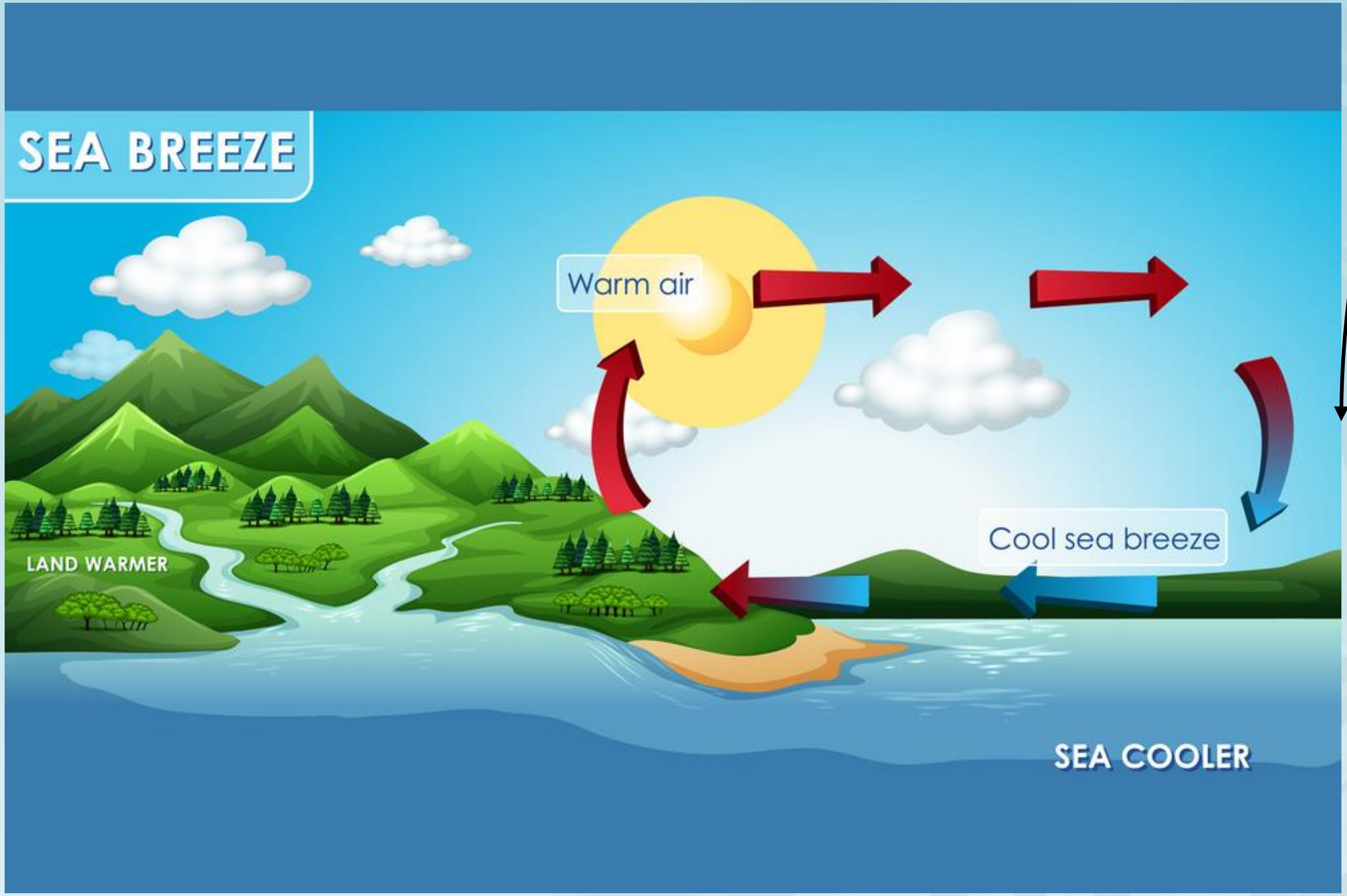
Latent Heat

- **Land breeze**
  - What is land breeze
- **Sea breeze**
  - What is sea breeze
- **Evaporation**
- **Difference between sea breeze and land breeze**
  - Defining evaporation
- **Boiling**
  - Defining boiling
- Difference between boiling and evaporation
- **Latent heat**
  - Defining latent heat
  - Calculating latent heat
- **Phase change**
  - Defining phase change



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Sea Breeze

During the day, the land heats up more rapidly than the sea. The air above the land is heated and expands; becomes less dense and rises. This causes the cool, denser air from the sea to flow from the sea towards the land.

Note: Land has a specific heat capacity of 800 $Jkg^{-1}K^{-1}$ and sea has a specific heat capacity of 4200 $Jkg^{-1}K^{-1}$

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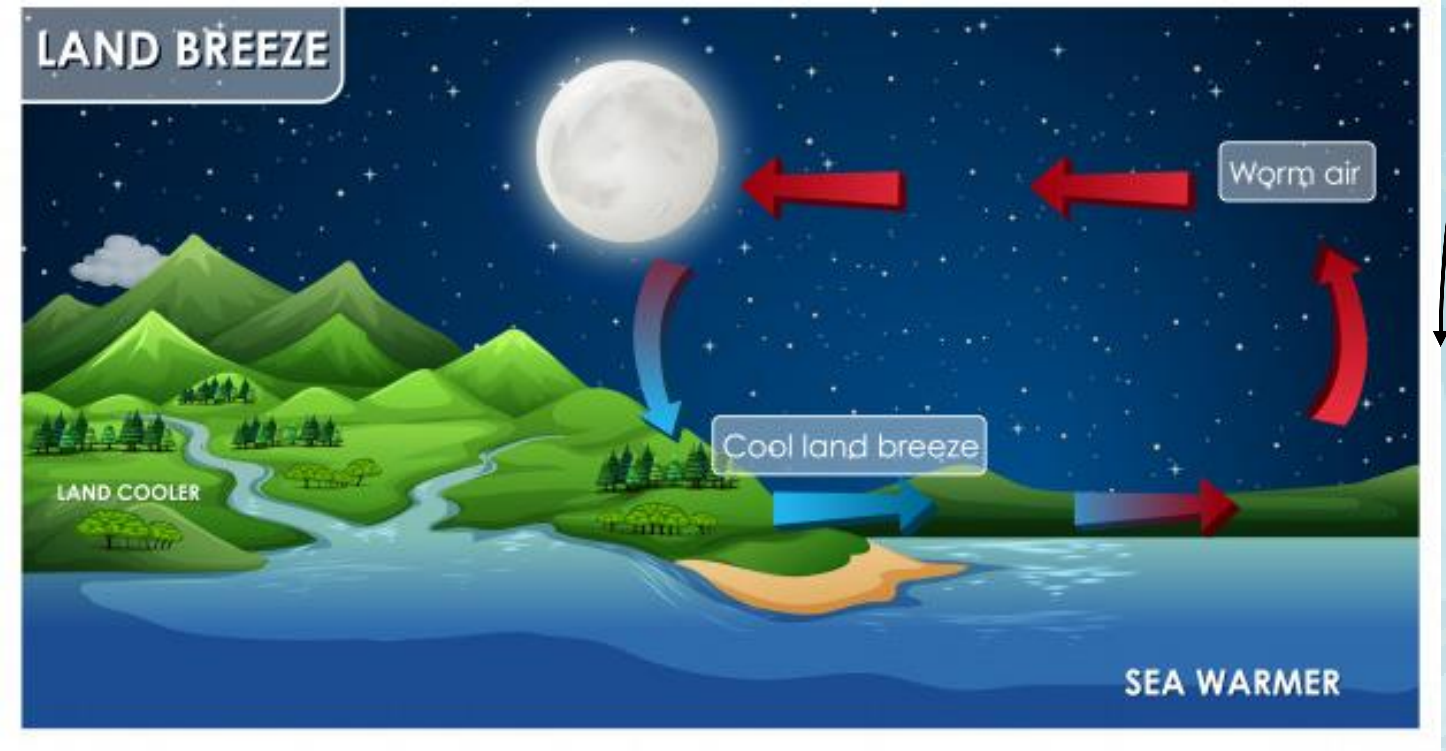

Land Breeze

During the night, the land cools very quickly. The warmer air above the sea now rises and the cooler denser air above the land now flows towards the sea.

Boiling vs Evaporation

	Boiling	Evaporation
1	Boiling takes place at a fixed temperature	Evaporation occurs at any convenient temperature
2	Boiling occurs through the liquid	Evaporation occurs on the surface of the liquid
3	Bubbles are formed	No bubbles are formed
4	Boiling is not affected by surface area	Evaporation is affected by surface area

Boiling – This process occurs at a fixed temperature known as the boiling point. In the process, particles gain energy and are able to break away from the liquid state and form gas.

Evaporation – This process occurs at any convenient temperature and only the particles at the surface gain enough energy to break away from the liquid state to the gaseous state.

Note: Evaporation is normally followed by a cooling sensation. This is due to the fact that the particles use up their energy to change to the gaseous state.

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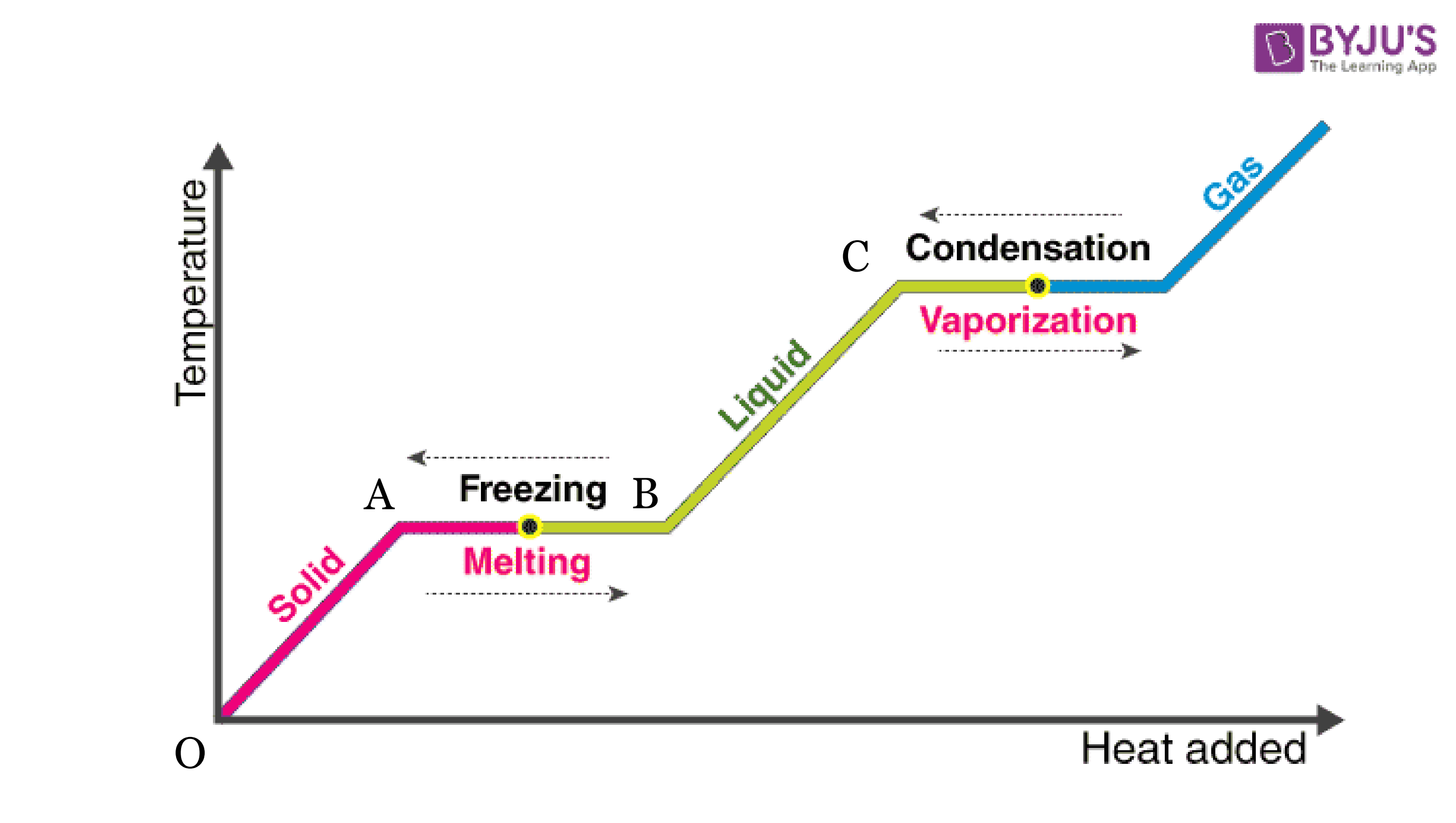
Latent heat and phase changes

When a substance changes state, heat is usually added or removed. The change of state or phase usually takes place at a constant temperature. A pure substance melts at a definite temperature called a melting point, it also solidifies at the same temperature called freezing point.

- The boiling point is the fixed temperature at which a liquid is converted to vapour(gas) while a gas changes to a liquid at this same temperature, it is called the condensation point.
- Latent heat is involved when there is a change of state and this change of state occurs without a change in temperature. As a result “Latent Heat” is regarded as hidden heat.

Heating curve of a solid



- From O-A, the substance is a solid and heat causes an increase in temperature but no change in state.
- From A-B, the substance remains constant as the energy is used to break the bonds between the particles and a change of state occurs. Both solid and liquid exist at this state.
- For B-C, the substance is liquid and there is no change of state as the heat simply causes an increase in temperature.

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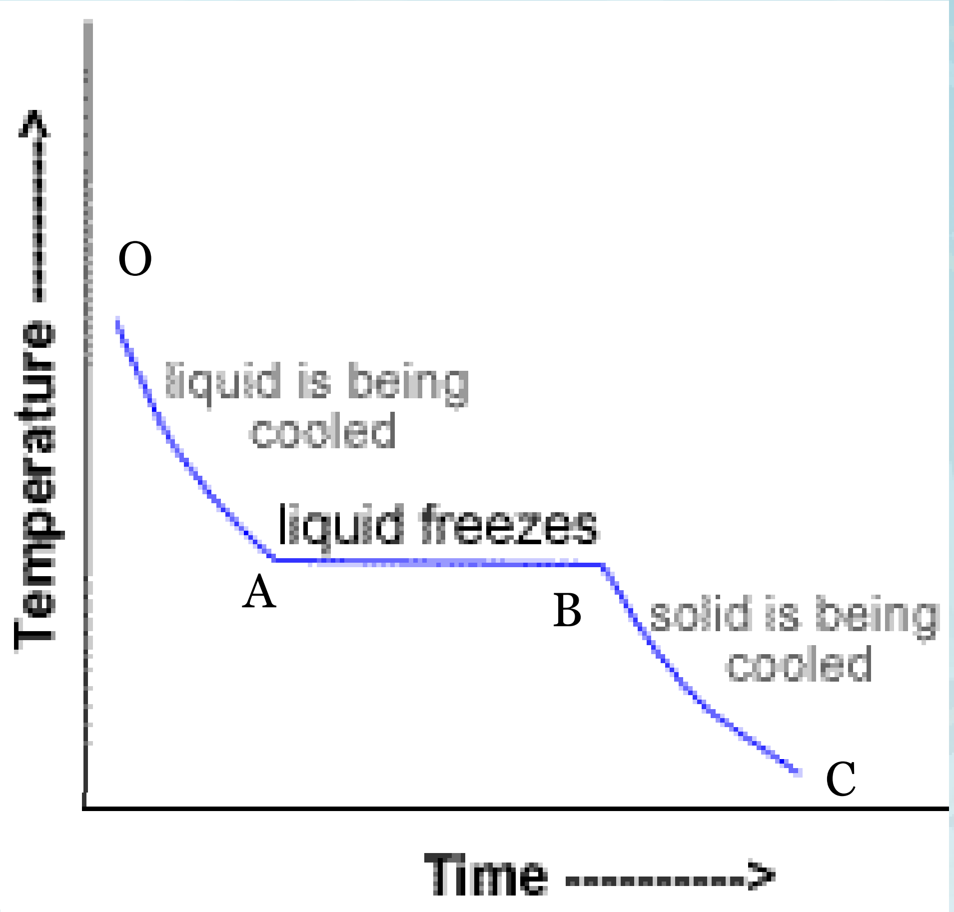
Cooling curve of a solid



- From O-A, the substance is a liquid and heat is being given off as the temperature falls.
- From A-B, the temperature is constant, a change is state occurs as the bonds are formed. Liquid and solid exists together.
- From B-C, the temperature is solid and continues cooling.

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Latent heat and Specific latent heat of fusion(L_f)

- Latent heat – This is the heat absorbed or released when a substances changes state.

- Specific latent heat of fusion – This is the amount of energy required to convert 1kg of a substance at a fixed temperature from solid to liquid.

- Specific latent heat of vaporisation This is the amount of energy required to convert 1kg of a substance at a fixed temperature from liquid to gas.

L_f (water)	**L_v (water)**
340 Jkg^{-1}	2,500,000 Jkg^{-1} / 2.5 x 106 Jkg^{-1}

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Calculating energy

$E_H = m^* L_f$ or $E_H = m^* L_v$ where: E_H – Heat energy/J

m – Mass/kg

L_f - latent heat of fusion

L_v - latent heat of vaporisation

- $m = \frac{E_H}{L_v}$
- $m = \frac{EH}{L_f}$
- $L_v = \frac{E_H}{m}$
- $L_f = \frac{E_H}{m}$

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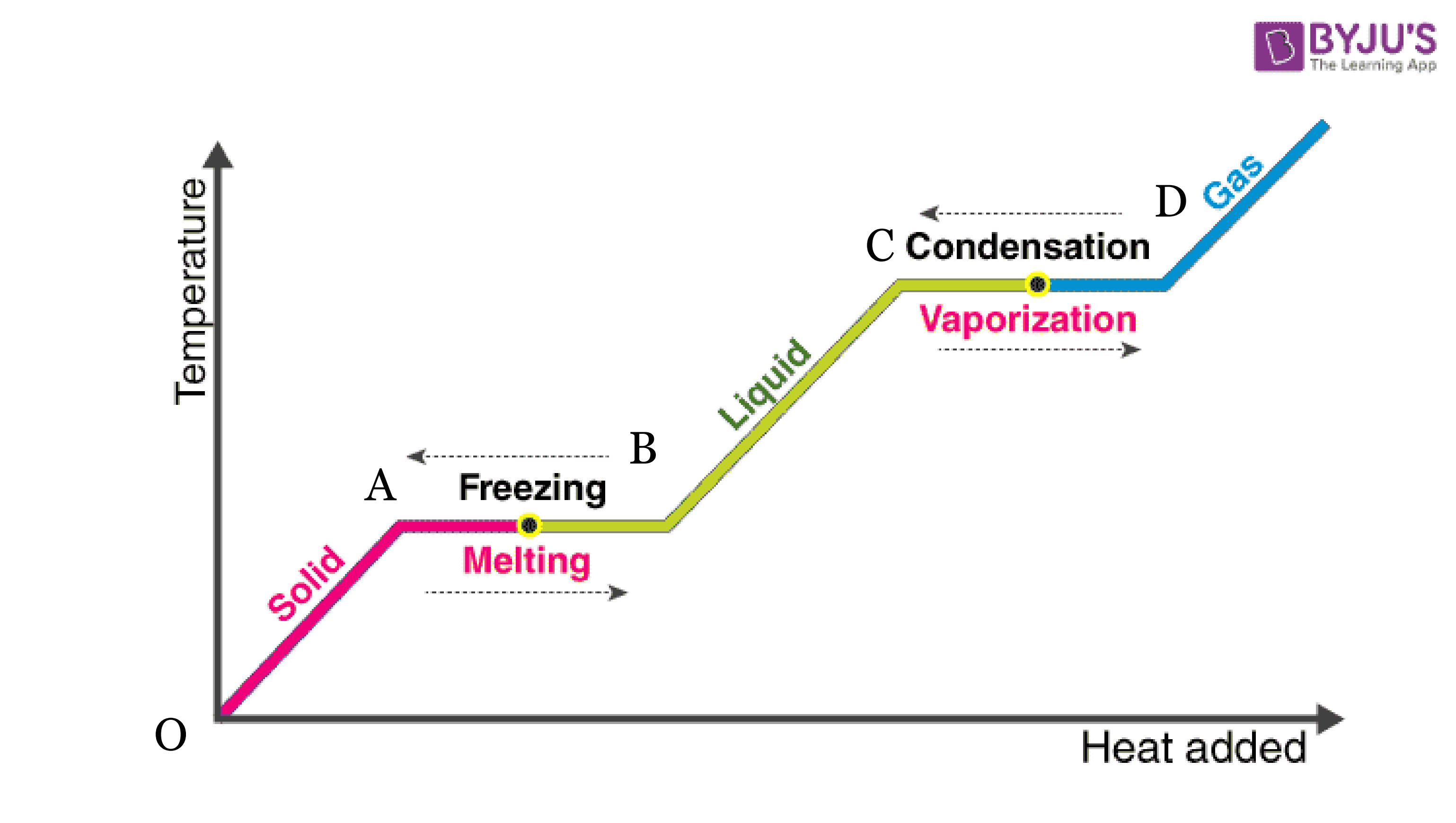
Calculating the energy to move from O-D

- $E_{HOD} = E_{HOA} + E_{HAB} + E_{HBC} + E_{HCD}$
- $E_{HOD} = m*c*\Delta T + m* L_f + m*c*\Delta T + m* L_v$



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Examples

1. How much heat is needed to change 20g of ice at 0°C to steam at 100°C. SHC of ice is 2000 $Jkg^{-1}K^{-1}$. 61,200J/61.2KJ

Ice at 0°C to 100°C

$E_H = m^* L_f$

Water at 0°C to 100°C

$E_H = m^*c^*\Delta T$

Water at 100°C to steam at 100°C

$E_H = m^* L_v$

Total energy

$E_H = m^* L_f + m^*c^*\Delta T + m^* L_v$

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Examples CONT'D

2. Calculate the energy to convert 170g of ice at 5°C to steam at 100°C given that the SHC of ice is 2000 $Jkg^{-1}K^{-1}$. $\Delta T = 105°C$ 521,900J/521.9KJ

Ice at -5°C to 100°C

$E_H = m*c*\Delta T$

Ice at 0°C to water at 0°C

$E_H = m* L_f$

Water at 0°C to water at 100°C

$E_H = m*c*\Delta T$

Water at 100°C to steam at 100°C

$E_H = m* L_v$

Total energy

$E_H = m*c*\Delta T + m* L_f + m*c*\Delta T + m* L_v$

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