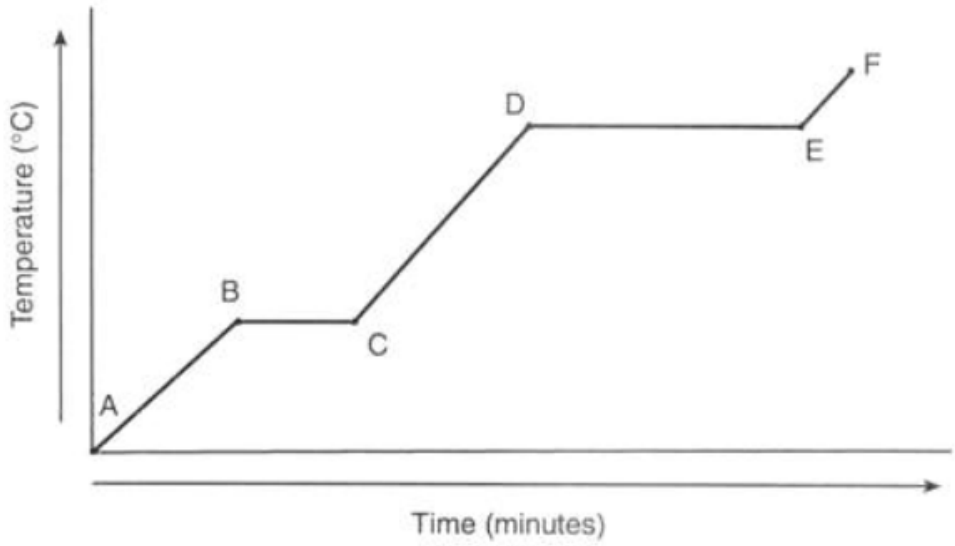

Temperature (°C)
A
B
C
D
E
F
Time (minutes)

Phase Changes

During a phase change there is

NO ΔT!

have ΔT:

$Q = mC\Delta T$

- same phase
- changing Temp

No ΔT:

$Q = mL$

- changing phase
- no temp change

$Q = mL$

Q = Heat energy (J)

m = mass (kg)

L = latent heat ($^{J}/_{kg}$)

latent heat - energy required to change the phase of 1 kg of a material

latent heat of fusion (L_f)

energy to melt at the melting point.

latent heat of vaporization (L_v)

energy to vaporize (boiling) at the boiling point.

For water:

$$L_f = 3.33 \times 10^5 \text{ J/kg}$$

$$L_v = 2.26 \times 10^6 \text{ J/kg}$$

Ex1:

Find the heat required to melt 0.5 kg of ice at 0°C.

$$Q = mL$$

$$= (.5)(3.33 \times 10^5)$$

$$= 166{,}500\ \text{J}$$

Ex2: Find the energy required to raise the temp of 0.5kg of water from 0°C to 100°C.

$$Q = m\,c\,\Delta T$$

$$= (.5)(4186)(100-0)$$

$$\boxed{Q = 209{,}300\,J}$$

Ex3: Find the heat required to raise the temp of 0.5kg of ice @ -20°C to water at 10°C.

① ice @ -20°C → ice @ 0°C

$Q_1 = mc\Delta T$

$= (.5)(2090)(0-(-20))$

$= 20,900 J$

② ice @ 0°C → water @ 0°C

$Q_2 = mL_f$

$= (.5)(3.33 \times 10^5)$

$= 166500 J$

③ water @ 0°C → water @ 10°C

$Q_3 = mc\Delta T$

$= (.5)(4186)(10-0)$

$= 20,930 J$

$Q_{total} = Q_1 + Q_2 + Q_3$

$= 208,330 J$

Ex 4: Find the energy required for 0.25kg of ice @ -15°C to become steam @ 120°C

770,787.5 J

Conservation of Energy

- E cannot be created or destroyed

- Isolated systems, net E = 0

$$\Delta ME + \Delta U = 0$$

$$* \boxed{\Delta KE + \Delta PE + \Delta U = 0}$$

ΔU = Internal energy = E associated with the motion of molecules

Ex 1: A nail is driven into a wooden board with an initial KE of 150J. If the PE is the same before and after the event, what is the change in internal energy?

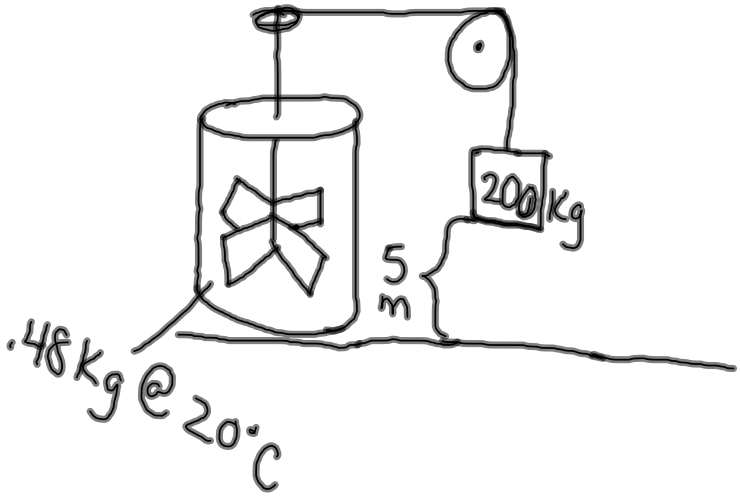
$KE_f = 0$, $KE_i = 150$

$$0 = \Delta KE + \Delta PE + \Delta U$$

$$0 = -150 + 0 + \Delta U$$

$$\boxed{\Delta U = 150\,J}$$

Internal E is related to heat (thermal E ΔTE)



$$\Delta ME + \Delta U = 0$$

$$\Delta KE + \Delta PE + \Delta TE = 0$$

$$KE_i + PE_i + TE_i = KE_f + PE_f + TE_f$$

$PE_i = mgh$, $TE_i = mcT_i$, $TE_f = mcT_f$

$$0 + (200)(9.81)(5) + (.48)(4186)(20°C) = 0 + 0 + (.48)(4186)T_f$$