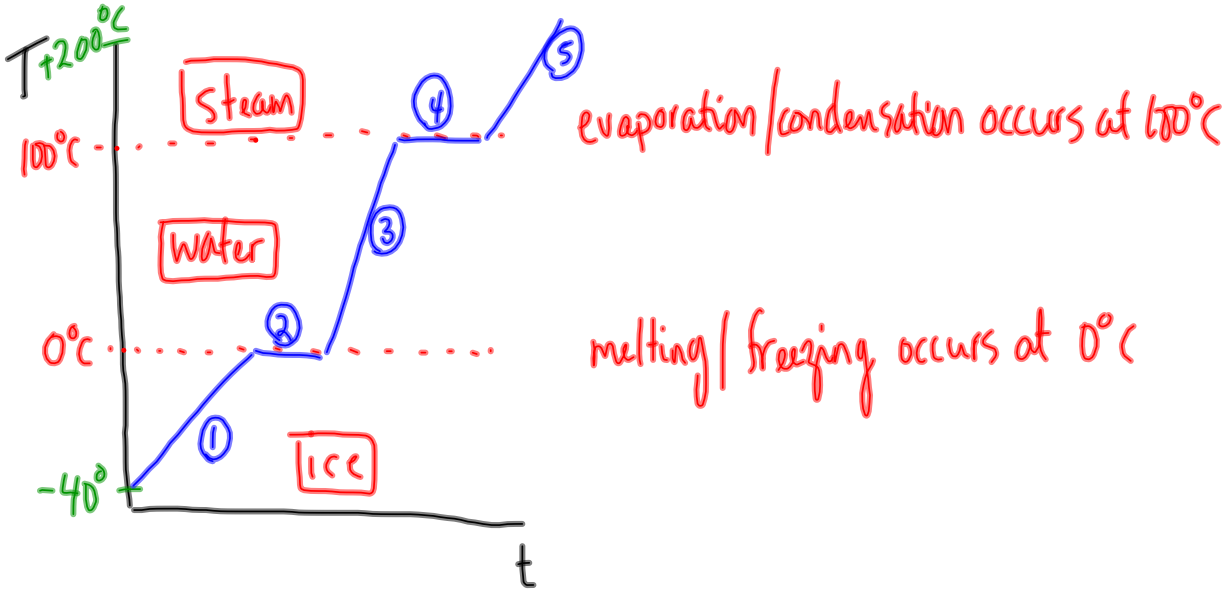
Changes in Temperature Through Changes in State

How much heat energy is required to change 50 g of ice at -40°C to steam at 200°C.



① heating ice (temperature change, $+40^\circ C$) $\Rightarrow Q = mc\Delta T$ $\left(c = 2.08 \frac{J}{g^\circ C}\right)$

② melting ice (phase change) $\Rightarrow Q = m\Delta H^\circ_{fus}$ $\left(\Delta H^\circ_{fus} = 333 J/g\right)$

③ heating water (temperature change, $+100^\circ C$) $= Q = mc\Delta T$ $\left(c = 4.18 \frac{J}{g^\circ C}\right)$

④ evaporation of water (phase change) $\Rightarrow Q = m\Delta H^\circ_{vap}$ $\left(\Delta H^\circ_{vap} = 2260 \frac{J}{g}\right)$

⑤ heating steam (temperature change, $+100^\circ C$) $\Rightarrow Q = mc\Delta T$ $\left(c = 1.87 \frac{J}{g^\circ C}\right)$

Step 1 (heating ice from -40°C to 0°C)

$Q = mc\Delta T$

$Q = (50g)\left(2.08\frac{J}{g°C}\right)(+40°C)$

$Q = 4160\,J$

Step 2 (melting the ice)

$Q = m\Delta H°_{fus}$

$Q = (50g)\left(333\frac{J}{g}\right)$

$Q = 16650\,J$

Step 3 (heating water from 0° to 100°C)

$Q = mC\Delta T$

$Q = (50g)\left(4.18\frac{J}{g°C}\right)(+100°C)$

$Q = 20900\,J$

Step 4 (evaporation of water)

$Q = m\Delta H°_{vap}$

$Q = (50g)\left(2260\frac{J}{g}\right)$

$Q = 113000\,J$

Step 5 (heating steam from 100°C to 200°C)

$Q = mc\Delta T$

$Q = (50g)\left(1.87\frac{J}{g°C}\right)(+100°C)$

$Q = 9350\,J$

TOTAL

4160 J
16650 J
20900 J
113000 J
9350 J
+
164060 J

least precise place value.

* Sketch your heating/cooling curve first!!

$1.6 \times 10^5\,J$ is required