What is Heat?

Heat is energy that is transferred from hot objects to cold objects

Added heat can cause objects to increase in temperature, melt, or boil

Removal of heat may cause objects to decrease in temp, freeze/solidify/crystallize, or condense

Pressure also affects phase:

If the solid is less dense than the liquid, added pressure will cause melting (Ex: water)

If the solid is more dense than the liquid, added pressure to the liquid will cause freezing (EX Almost everything except water)

Increased pressure always causes gases to be more likely to condense.

Temperature – measure of average kinetic energy of particles

$0^\circ C$ = melt/freeze H_2O

$100^\circ C$ = boil/condense H_2O

K → Kelvin

Based on absolute zero

$0K = -273^\circ C$

Heat energy is related to but different from temperature.

Depends on – Temp °C

mass g

specific heat – the amount of heat to increase the temp of 1 g by 1 °C sand low vs. H_2O high

$Q = mc\Delta T$

Q = heat, m = mass, c = specific heat, ΔT = change in temp

$\Delta T = T_f - T_i$ (final − initial)

EX 1: Calculate the amount of energy needed to heat 300g of H_2O from 20°C to 50°C.

U: Q

P: $Q = m \cdot c \cdot \Delta T$

K: 300g = m

H_2O $c = 4.18 \frac{J}{g \cdot ^\circ C}$

$30^\circ C = \Delta T$

S: $Q = 300g \cdot 4.18 \frac{J}{g \cdot ^\circ C} \cdot 30^\circ C$

$Q = 37620 J$ ☺

EX2: Calculate the change in temp if 300 J of heat energy are added to a 12.0 g sample of copper.

U: change in temp

K: 300 J 12.0 g of Cu

P: $Q = m \cdot C \cdot \Delta T$

$300 = 12.0 \cdot 0.385 \cdot \Delta T$

S: $\frac{300}{4.62} = \Delta T$

$\Delta T = 64.9^\circ C$

$300\,J = 12.0\,g \cdot 0.385 \frac{J}{g^\circ C} \cdot \Delta T$

$\frac{300\,J}{4.62\,J/^\circ C} = \frac{4.62\,J/^\circ C}{4.62\,J/^\circ C} \cdot \Delta T$

$64.9^\circ C$

Phase Changes — ~~$Q = mc\Delta T$~~ ↳ doesn't work

T is constant

Heat of Fusion - amount of energy to melt (+) / freeze (−) 1 gram of a substance

$$Q = m H_f$$

Heat of Vaporization — amount of energy to boil (+) / evaporate (+) / condense (−) 1 gram of a substance.

$$Q = m H_v$$

Ex3: How many grams of ice will melt at 0°C if the ice absorbs 150 J of energy

P: $mH_f = Q$

U: m

K: 334 J/g 150 J

S: $\frac{150\,J}{334\,J/g} = \frac{m \cdot 334\,J/g}{334}$

$\frac{150}{334}$ .449 g = m

EX4: Energy to raise temp of ice (100g) from -20°C to 0°C

Energy to melt ice.

Energy to raise temp of water from 0°C to 30°C.

Total Energy?

U: Energy

P: $Q = mc_{solid}\Delta T$

$Q = mH_f$

$Q = mc_{liquid}\Delta T$

K: 100g = m

-20°C to 0°C to 30°C

S: $Q = 100g(2.05\,J/g°C)(20°C)$

$Q = 4100\,J$

$Q = 100g(334\,J/g)$

$Q = 33400\,J$

$Q = 100g(4.18\,J/g°C)(30°C)$

$Q = 12540\,J$

Total 50040 J

EX5: How much energy is needed to change 30g of H_2O at 80°C into steam at 110°C?

U: Energy!

K: 30g @ 80°C → Steam @ 110°C → Boil-100°C

P: $mc\Delta T_L$ + mH_V + $mc\Delta T_g$

$30g(20°C)(4.18\frac{J}{g°C})$

2508 J

$30g \cdot 2260 J/g$

67800 J

$30g \cdot 2.02\frac{J}{g°C} \cdot 10°C$

606 J

70914 J

Determine the energy released when converting 500 g of steam at 110°C to ice at −25°C.

U: energy

K: $500\,g = m$

110°C to 100°C to 0°C to −25°C

P: $mc_g\Delta T$, mH_v, $mc_l\Delta T$, mH_f, $mc_s\Delta T$

$500\,g\,(2.02\,J/g°C)(-10°C) = -10100\,J$

$mH_v = 500\,g\,(2260\,J/g) = -1130000\,J$

$mc_l\Delta T = 500\,g\,(4.18\,J/g°C)(-100°C) = -209000\,J$

$mH_f = 500\,g\,(334\,J/g) = -167000\,J$

$mc_s\Delta T = 500\,g\,(2.05\,J/g°C)(-25°C) = -2625\,J$

$-1541125\,J$