PhyzExamples: Temperature and Heat

Physical Quantities • Symbols • Units • Brief Definitions

Temperature • T • kelvin: K; also °C, °F, R • A measure of the average kinetic energy in the random translational motions of the particles in a body.

Absolute temperature is measured on the Kelvin or Rankine scale.

Relative temperature is measured on the Celsius or Fahrenheit scale.

Heat • Q • joule: J • Internal energy that is transferred between bodies, typically from hotter bodies to colder bodies.

Specific Heat Capacity • c • J/kg·°C • The amount of heat needed to raise the temperature of a specific mass of a substance by a given quantity. Typically, the heat added to one kilogram of a substance to raise its temperature by one Celsius degree. Also the heat removed from one kilogram of a substance to reduce its temperature by one kilogram by one Celsius degree.

Work done by a heat engine • W • J • Mechanical energy released from a system such as a sample of gas when it expands. (As defined in California's Science Framework for 9-12 Physics.)

Heat added to a heat engine • Q_H • Thermal energy added to a system by contact with an external source (hotter body).

Heat removed from a heat engine • Q_C • Thermal energy removed from a system by contact with a heat sink (colder body).

Equations

$Q = mc\Delta T$ • *heat added = specific heat capacity · mass · change in temperature*

$W = Q_H - Q_C$ • *work done by a heat engine = heat added – heat removed*

Examples

1. What is the specific heat of a substance if 37 kJ of heat gives rise to an 8.2 °C rise in the temperature of a 23 kg sample?

1. Q = 37,000 J T = 8.2 °C m = 23 kg c=?
Q = mc T
c = Q/m T = 37,000 J / (23 kg)(8.2 °C)
c = 196 J/kg°C

2. How much energy is given off when a 45 kg iron ingot at 800 °C is quenched in water to a final temperature of 80 °C?

2. m = 45 kg T = –720 °C c = 460 J/kg°C
Q = mc T = (45 kg)(460 J/kg°C)(–720 °C)
Q = –14.9x10^6 J = 14.9 MJ given off

Examples

1. What is the specific heat of a substance if 37 kJ of heat gives rise to an 8.2 °C rise in the temperature of a 23 kg sample?

3. Q = 37,000 J T = 8.2 °C m = 23 kg c=?

Q = mc T

c = Q/m T = 37,000 J / (23 kg)(8.2 °C)

c = 196 J/kg°C

2. How much energy is given off when a 45 kg iron ingot at 800 °C is quenched in water to a final temperature of 80 °C?

4. m = 45 kg T = −720 °C c = 460 J/kg°C

Q = mc T = (45 kg)(460 J/kg°C)(−720 °C)

Q = -14.9×10^6 J = 14.9 MJ given off