

Thermodynamics Equations Worksheet

Level: A-Level / AP Physics 2 | Difficulty: Intermediate | Topic: Thermal Physics

Practice thermodynamic equations with 10 problems on heat capacity, latent heat, and the ideal gas law. Full worked solutions included.

Equations you will need

$Q = mc\Delta T$	Heat energy = mass x specific heat capacity x temp change
$Q = mL$	Heat for phase change (latent heat)
$pV = nRT$	Ideal gas law
$p_1V_1/T_1 = p_2V_2/T_2$	Combined gas law

Symbol key

Symbol	Quantity	Unit
Q	heat energy	J
m	mass	kg
c	specific heat capacity	J/kg*K
ΔT	temperature change	K or degC
L	specific latent heat	J/kg
p	pressure	Pa
V	volume	m ³
n	moles	mol
R	gas constant	8.31 J/mol*K
T	temperature	K

Practice problems

1. How much energy is needed to heat 2 kg of water by 30degC? (c = 4200 J/kg*K)
2. Find the energy to melt 0.5 kg of ice. (L_f = 334,000 J/kg)
3. 0.2 kg of water at 20degC is heated by 50,400 J. Find the final temperature.
4. 2 moles of gas at 300 K occupy 0.05 m³. Find the pressure. (R = 8.31)
5. A gas at 100 kPa and 300 K is compressed to half its volume at constant temperature. Find the

new pressure.

6. How much energy is needed to vaporise 0.1 kg of water at 100degC? ($L_v = 2,260,000$ J/kg)
7. A 500 g aluminium block ($c = 900$ J/kg*K) absorbs 13,500 J. Find the temperature rise.
8. A gas at 27degC is heated at constant pressure to 127degC. Original volume 2 L. Find final volume.
9. Energy needed to heat 1 kg of ice from -10degC to 0degC then melt it. ($c_{ice}=2100$, $L_f=334000$)
10. 1 mole of gas at 1 atm (101,325 Pa) and 273 K. Find the volume. ($R = 8.31$)

Answer key

Full worked solutions for each problem.

1. $Q = mc\Delta T = 2(4200)(30) = 252,000 \text{ J}$
2. $Q = mL = 0.5(334,000) = 167,000 \text{ J}$
3. $\Delta T = Q/(mc) = 50400/(0.2 \times 4200) = 60\text{degC}$; final = 80degC
4. $p = nRT/V = (2)(8.31)(300)/0.05 = 99,720 \text{ Pa}$
5. $p_1V_1 = p_2V_2 \rightarrow p_2 = 200 \text{ kPa}$
6. $Q = mL = 0.1(2,260,000) = 226,000 \text{ J}$
7. $\Delta T = Q/(mc) = 13500/(0.5 \times 900) = 30\text{degC}$
8. $V_1/T_1 = V_2/T_2 \rightarrow V_2 = 2(400/300) = 2.67 \text{ L}$
9. $Q = (1)(2100)(10) + (1)(334000) = 21,000 + 334,000 = 355,000 \text{ J}$
10. $V = nRT/p = (1)(8.31)(273)/101325 = 0.0224 \text{ m}^3 \text{ (22.4 L)}$