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