

Heat in and out of reactions

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer shows the formula, the substitution and the result in bold. Check the sign of every ΔH , because exothermic reactions are negative and endothermic reactions are positive. For bond energy problems, check that each bond is multiplied by its coefficient.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-4

Problem 1 Classify the changes

1. Exothermic. 2. Endothermic. 3. Exothermic. 4. Endothermic. **Exo, endo, exo, endo.**

Problem 2 Thermometer evidence

1. $17.5 - 24.0 = -6.5$ °C. 2. The temperature falls, so energy is taken in from the surroundings: endothermic. 3. ΔH is positive. **Endothermic, ΔH positive.**

Problem 3 Hand warmers and cold packs

1. Hand warmer: exothermic; cold pack: endothermic. 2. Energy is transferred from the chemicals to the surroundings, including your hands. 3. Warmer: cold winter morning at a cricket match; cold pack: treating a bruise after football. **Warmer exothermic, cold pack endothermic.**

Problem 4 Labelling a profile

1. A is the energy of the reactants and D the energy of the products. 2. B is the activation energy. 3. C is the energy change ΔH , and it is negative because the products are lower. 4. Exothermic. **Exothermic; ΔH negative.**

Problem 5 Breaking and making

1. Endothermic. 2. Exothermic. 3. Endothermic. 4. Exothermic. **Breaking absorbs energy; making releases energy.**

Problem 6 Signs of ΔH

1. Rises; negative. 2. More. 3. Activation. **Rises and negative; more; activation.**

Problem 7 Heat from magnesium

1. $q = 50 \times 4.2 \times 11.0 = 2310$ J. 2. $2310 \div 1000 = 2.31$ kJ. 3. Exothermic. **2310 J = 2.31**

kJ.

Problem 8 Hydrogen and bromine

1. $436 + 193 = 629$ kJ. 2. $2 \times 366 = 732$ kJ. 3. $\Delta H = 629 - 732 = -103$ kJ/mol, exothermic. **$\Delta H = -103$ kJ/mol.**

Problem 9 Making ammonia

1. $945 + 3 \times 436 = 945 + 1308 = 2253$ kJ. 2. $6 \times 391 = 2346$ kJ. 3. $\Delta H = 2253 - 2346 = -93$ kJ/mol. **$\Delta H = -93$ kJ/mol.**

Problem 10 Sketch an endothermic profile

1. Draw the reactants at a low energy level and the products at a higher level. 2. The activation energy is an upward arrow from the reactants to the top of the hump; the energy change is an arrow from the reactants level up to the products level. 3. ΔH is positive.

Products higher than reactants; ΔH positive.

Problem 11 Reading numbers from a profile

1. 120 kJ/mol. 2. -85 kJ/mol. 3. The reverse reaction starts 85 kJ lower and climbs to the same peak: $120 + 85 = 205$ kJ/mol. **$E_a(\text{reverse}) = 205$ kJ/mol.**

Problem 12 Why light a match?

1. The gas and oxygen particles collide with less than the activation energy, so bonds do not break. The spark gives enough energy. 2. The energy released by the first reactions supplies the activation energy for the following particles. **The spark supplies the activation energy.**

Problem 13 Reading a temperature graph

1. 38°C . 2. $38 - 20 = 18^\circ\text{C}$. 3. After the reaction finishes, the warm solution loses energy to the cooler surroundings. 4. Exothermic. **Maximum 38°C ; rise 18°C .**

Problem 14 Energy per gram of fuel

1. Hydrogen: $286 \div 2 = 143$ kJ/g; methane: $890 \div 16 = 55.6$ kJ/g; ethanol: $1367 \div 46 = 29.7$ kJ/g. 2. Hydrogen, methane, ethanol. 3. Hydrogen is a gas that is hard to store and needs high pressure or very low temperature. **143, 55.6 and 29.7 kJ/g.**

Problem 15 Per mole from joules

1. $4500 \div 1000 = 4.5$ kJ. 2. $4.5 \div 0.030 = 150$ kJ/mol. 3. The reaction is exothermic, so $\Delta H =$

–150 kJ/mol. **$\Delta H = -150$ kJ/mol.**

Problem 16 Burning ethanol under a can

1. $q = 100 \times 4.2 \times 30 = 12\,600 \text{ J} = 12.6 \text{ kJ}$. 2. $n = 0.50 \div 46 = 0.0109 \text{ mol}$. 3. $12.6 \div 0.01087 = 1159 \text{ kJ/mol}$, about $1.2 \times 10^3 \text{ kJ/mol}$, which is about 15% lower than 1367 kJ/mol. 4. Energy is lost to the air and the can, and combustion may be incomplete. **$\Delta H \approx -1.2 \times 10^3 \text{ kJ/mol}$.**

Problem 17 Burning methane

1. $4 \times 413 + 2 \times 498 = 1652 + 996 = 2648 \text{ kJ}$. 2. $2 \times 805 + 4 \times 464 = 1610 + 1856 = 3466 \text{ kJ}$. 3. $\Delta H = 2648 - 3466 = -818 \text{ kJ/mol}$. 4. $n = 8.0 \div 16 = 0.50 \text{ mol}$, so $0.50 \times 818 = 409 \text{ kJ}$. **$\Delta H = -818 \text{ kJ/mol}$; 409 kJ released.**

Problem 18 Hydrogen iodide

1. $2 \times 299 = 598 \text{ kJ}$. 2. $436 + 151 = 587 \text{ kJ}$. 3. $\Delta H = 598 - 587 = +11 \text{ kJ}$, endothermic. 4. The products are 11 kJ higher than the reactants, below the top of the activation hump. **$\Delta H = +11 \text{ kJ/mol}$; endothermic.**

Problem 19 Evaluate a claim

1. ΔH only tells the energy difference. The particles still need 150 kJ/mol to start, so many reactions are slow at room temperature. 2. The reverse reaction starts 200 kJ/mol lower, so its activation energy is $150 + 200 = 350 \text{ kJ/mol}$. 3. Supply energy by heating or a spark, or use particles that collide more energetically. **$E_a \text{ reverse} = 350 \text{ kJ/mol}$.**

Problem 20 Spot the errors

1. Bond making is exothermic. 2. The products have less energy than the reactants. 3. $\Delta H = \text{bonds broken} - \text{bonds formed}$. 4. The temperature rises in an exothermic reaction. **Four corrections.**