

Heat in and out of reactions

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

Use the sample table to check your working. The signs matter: a temperature fall means energy was taken in, so ΔH is positive. Your own results will differ, but the order of the three salts and the large size of the calcium chloride value should appear in any careful data set.

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

Question 1 Temperature changes

Ammonium nitrate: $9.0 - 21.0 = -12.0\text{ }^{\circ}\text{C}$, endothermic. Calcium chloride: $34.5 - 21.0 = +13.5\text{ }^{\circ}\text{C}$, exothermic. Sodium chloride: $19.5 - 21.0 = -1.5\text{ }^{\circ}\text{C}$, slightly endothermic. **$-12.0\text{ }^{\circ}\text{C}$, $+13.5\text{ }^{\circ}\text{C}$, $-1.5\text{ }^{\circ}\text{C}$.**

Question 2 Energy transferred

Ammonium nitrate: $25 \times 4.2 \times 12.0 = 1260\text{ J} = 1.26\text{ kJ}$. Calcium chloride: $25 \times 4.2 \times 13.5 = 1417.5\text{ J} = 1.42\text{ kJ}$. Sodium chloride: $25 \times 4.2 \times 1.5 = 157.5\text{ J} = 0.16\text{ kJ}$. **1.26 kJ, 1.42 kJ, 0.16 kJ.**

Question 3 Moles of salt

NH_4NO_3 : $M = 80$, $n = 5.0 \div 80 = 0.0625\text{ mol}$. CaCl_2 : $M = 111$, $n = 2.0 \div 111 = 0.0180\text{ mol}$. NaCl : $M = 58.5$, $n = 5.0 \div 58.5 = 0.0855\text{ mol}$. **0.0625, 0.0180 and 0.0855 mol.**

Question 4 Energy change per mole

NH_4NO_3 : $1.26 \div 0.0625 = +20\text{ kJ/mol}$ (endothermic). CaCl_2 : $-1.42 \div 0.0180 = -79\text{ kJ/mol}$ (exothermic). NaCl : $0.16 \div 0.0855 = +1.8\text{ kJ/mol}$. **+20, -79 and +1.8 kJ/mol.**

Question 5 Comparing with accepted values

1. $(26 - 20) \div 26 \times 100 = 23\%$. 2. Energy flows into the cup from the warmer room during the experiment and the thermometer reading lags, so the temperature drop is smaller than it should be. **About 23% smaller.**

Question 6 Sources of error

The polystyrene and lid reduce energy transfer with the room, so ΔT is closer to the true value. A further error is that the water has a different mass than the 25 g assumed once the salt dissolves, or that the thermometer has limited accuracy. **Insulation reduces energy exchange.**

Question 7 Conclusion and use

Ammonium nitrate gives the largest fall and suits a cold pack; calcium chloride gives the largest rise and suits a hand warmer, although it is an irritant. Improve the method by adding a second lid layer or by repeating each test and taking a mean. **Cold pack: ammonium nitrate; warmer: calcium chloride.**