Enthalpy change (ΔH_r) of the reaction – amount of chemical heat energy taken in (giving out) in a reaction.

Enthalpy of formation (ΔH_f), when 1 mol of a substance is formed from is constituent elements in their standard state.

Bond enthalpy: energy required to break 1 mole of a bond.

We can use enthalpy change of formation and bond enthalpy to calculate enthalpy change of reactions. Information about enthalpy change of formation for different substances, as well as bond enthalpy for different bonds can be found in text books or internet.

ΔH_r = sum of ΔH_f (products) – sum of ΔH_f (reactants)

ΔH_r = sum of bond enthalpies (reactants) – sum of bond enthalpies (products)

Answer to problem 3 from HW5:

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

$\Delta H_f^\circ [NH_3(g)] = -46$ $\quad \frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow NH_3$

$\Delta H_f^\circ [NO(g)] = 90$ $\quad N + O \rightarrow NO$

$\Delta H_f^\circ [H_2O(g)] = -242$ $\quad H_2 + \frac{1}{2}O_2 \rightarrow H_2O$

$$\Delta H_r^\circ = \sum \Delta H_f^\circ(\text{products}) - \sum \Delta H_f^\circ(\text{reactants})$$

ΔH_f products $= 4 \cdot 90 + 6 \cdot (-242) = -1092$

ΔH_f reactant $= 4 \cdot -46 = -184$

$-1092 - (-184) = -908$ kJ/mol

Specific heat capacity: The energy required to raise the temperature of 1 g of substance by 1 C.
Using calorimetry we can calculate heat flow using this formula:
$Q = mc\Delta T$
Where

Q – heat
m – mass
C – heat capacity
ΔT – temperature change

Note, that q or $Q = -\Delta H$

In the experiment with coffee cup calorimeter we heated peace of cadmium to 100 C and put it in a coffee cup with 100 ml of water at room temperature. We registered the temperature change of water, the specific heat capacity of water is known. This experiment allowed us to calculate specific heat capacity of cadmium.

	Initial T	Final T	Mass
Water	22C°	25°C	100g
Cd	100C°	25°C	58.953g

specific heat capacity of water $4.18\ Jg^{-1}\,°C^{-1}$

$Q = mc\Delta T$ Q or q – heat. c – heat capacity
m – mass, g   ΔT – temperature change

1. We can calculate heat flow using information from water.
Temperature rised by 3°C, so $\Delta T = 3$

$Q = 100g \times 4.18\ Jg^{-1}\,°C^{-1} \times 3\,°C = 1254\ J$

2. Now we know heat, and we know that Cadmium changed temperature from 100 C to 25C. We can calculate heat capacity of Cadmium

$c = \frac{Q}{m\Delta T} = \frac{1254}{58.953 \times 75} = 0.284\ Jg^{-1}\,°C^{-1}$

Question.

In the calorimeter the following reaction was conducted: 1 g of magnesium oxide was mixed with 100 ml of HCl.

$MgO (s) + 2HCl (l) \rightarrow MgCl_2 (s) + H_2O (l)$

And change in temperature of 6.9 C was registered.

Assumption: the specific heat capacity of the solution is the same as that of water.

When we using the m (mass of our solution) we do not count the solids (s), 100 ml = 100 g.

Calculate the heat (q) of the process. Calculate the number of moles of MgO (we had 1 g of this oxide) and recalculate change of enthalpy of the reaction (per mole of MgO). Remember q = - enthalpy change.

Second reaction was performed in calorimeter. 0.5 g of magnesium (Mg) was mixed with 100 ml of HCl.

$Mg (s) + 2HCl (l) \rightarrow MgCl_2 (s) + H_2 (g)$

The temperature change was 18.3 C.

Calculate the enthalpy change for the reaction.

Calculate the enthalpy change of formation for MgO.

$Mg + \frac{1}{2} O_2 \rightarrow MgO$

We will use the enthalpy changes of the reactions above. And we will need third enthalpy change of the following process

$H_2 (g) + 1/2 O_2 (g) \rightarrow H_2O (l)$, $\Delta H = -286$ kJ/mol.