Marks

- Anhydrous copper(II) sulfate is a white powder that reacts with water to give the familiar light blue crystals of copper(II) sulfate-5-water. **2**

$$CuSO_4(s) + 5H_2O(l) \rightarrow CuSO_4{\cdot}5H_2O(s)$$

Calculate the standard enthalpy change for this reaction from the heats of solution.

Compound	$\Delta H°_{solution}$ / kJ mol^{-1}
$CuSO_4(s)$	-66.5
$CuSO_4{\cdot}5H_2O(s)$	+11.7

The heats of solution correspond to the reactions:

(1) **$CuSO_4(s) \rightarrow CuSO_4(aq)$**

(2) **$CuSO_4.5H_2O(s) \rightarrow CuSO_4(aq) + 5H_2O(l)$**

The reaction $CuSO_4(s) + 5H_2O(l) \rightarrow CuSO_4{\cdot}5H_2O(s)$ therefore corresponds to (1) – (2):

(1)	**$CuSO_4(s)$**	**$\rightarrow$**	**$CuSO_4(aq)$**
–(2)	**$CuSO_4(aq) + 5H_2O(l)$**	**$\rightarrow$**	**$CuSO_4.5H_2O(s)$**
(1) – (2)	**$CuSO_4.5H_2O(s)$**	**$\rightarrow$**	**$CuSO_4{\cdot}5H_2O(s)$**

Therefore,

$$\mathbf{\Delta_{rxn}H° = \Delta_{solution}H°\ (1) - \Delta_{solution}H°\ (2) = (-66.5) - (+11.7) = -78.2\ kJ\ mol^{-1}}$$

Answer: **–78.2 kJ mol^{-1}**

- Using the given data, calculate $\Delta H°$ for the reaction: $H(g) + Br(g) \rightarrow HBr(g)$ **3**

Data: $H_2(g) \rightarrow 2H(g)$ $\Delta H° = +436$ kJ mol^{-1}

$Br_2(g) \rightarrow 2Br(g)$ $\Delta H° = +193$ kJ mol^{-1}

$H_2(g) + Br_2(g) \rightarrow 2HBr(g)$ $\Delta H° = -72$ kJ mol^{-1}

The reaction involves the formation of HBr(g) from H(g) and Br(g) and so involves the combination:

½ × – (1)	**H(g)**	**$\rightarrow$**	**½ $H_2(g)$**
½ × – (2)	**Br(g)**	**$\rightarrow$**	**½ $Br_2(g)$**
½ × (3)	**½ $H_2(g)$ + ½ $Br_2(g)$**	**$\rightarrow$**	**HBr(g)**
½ × [(3) – (1) – (2)]	**H(g) + Br(g)**	**$\rightarrow$**	**HBr(g)**

Therefore,

$$\mathbf{\Delta_{rxn}H° = ½\ [\Delta H°(3) - \Delta H°(1) - \Delta H°(2)] = ½\ [(-72) - (436) - (193)] = -351\ kJ\ mol^{-1}}$$

Answer: **–351 kJ mol^{-1}**