Marks 8

- The conversion of hydroquinone ($C_6H_6O_2(aq)$) to quinone ($C_6H_4O_2(aq)$) is involved in many important biochemical reactions. The bombardier beetle, for example, uses the explosive reaction between hydroquinone and hydrogen peroxide (as described by the equation below) as a defence mechanism.

$$C_6H_6O_2(aq) + H_2O_2(aq) \rightarrow C_6H_4O_2(aq) + 2H_2O(l)$$

From the following reaction data, calculate ΔH_{rxn} for the reaction between 1.00 mol of hydroquinone and 1.00 mol of hydrogen peroxide.

$C_6H_6O_2(aq) \rightarrow C_6H_4O_2(aq) + H_2(g)$	$\Delta H_{rxn} = +177.4$ kJ mol^{-1}
$O_2(g) + 2H_2O(l) \rightarrow 2H_2O_2(aq)$	$\Delta H_{rxn} = +189.1$ kJ mol^{-1}
$H_2O(l) \rightarrow H_2(g) + ½O_2(g)$	$\Delta H_{rxn} = +285.8$ kJ mol^{-1}

$O_2(aq)$ and $H_2O_2(aq)$ and this is related to reaction (1) and the *reverse* of reaction (2). As the former generates $H_2(g)$ and the latter $O_2(g)$ neither of which are present in the conversion reaction, they are combined with the *reverse* of reaction (3).

To ensure a balance equation, the combination is thus (1) – ½ × (2) - (3):

				ΔH_{rxn}
(1)	$C_6H_6O_2$	→	$C_6H_4O_2 + H_2$	**177.4**
- ½ × (2)	H_2O_2	→	$½O_2 + H_2O$	**- ½ x 1891.**
- (3)	$H_2 + ½O_2$	→	H_2O	**- 285.8**
	$C_6H_6O_2 + H_2O_2$	→	$C_6H_4O_2 + 2H_2O$	**-203 kJ mol^{-1}**

ΔH_{rxn} = **-203 kJ mol^{-1}**

Use the answer you obtained above to calculate the heat liberated (in joules) in the oxidation of 3.86×10^{-4} mol of hydroquinone to quinone.

As 203 kJ are liberated by 1 mol, the heat change for 3.86×10^{-4} mol is:

$$q = (203 \text{ kJ mol}^{-1}) \times (3.86 \times 10^{-4} \text{ mol}) = 0.0784 \text{ kJ} = 78.4 \text{ J}$$

Answer: **78 J**

Calculate the temperature rise of 0.250 g of water for this quantity of heat.
(The heat capacity of water, $C_p = 4.184$ J K^{-1} g^{-1})

Using, $q = m \times C \times \Delta T$,

$$\Delta T = \frac{q}{m \times C} = \frac{(78.4\,\text{J})}{(0.250\,\text{g}) \times (4.184\,\text{J K}^{-1}\,\text{g}^{-1})} = 74.9\,\text{K}$$

Answer: **74.9 K**