Marks 6

- The first step in the metabolism of glucose in biological systems is the addition of a phosphate group in a dehydration-condensation reaction:

$$\text{glucose(aq)} + H_2PO_4^-\text{(aq)} \rightleftharpoons [\text{glucose phosphate}]^-\text{(aq)} + H_2O\text{(l)}$$

The free energy change associated with this reaction is $\Delta G° = 13.8$ kJ mol^{-1}. The reaction is driven forwards by harnessing the free energy associated with the hydrolysis of adenosine triphosphate, ATP^{4-}, to adenosine diphosphate, ADP^{3-} :

$$ATP^{4-}\text{(aq)} + H_2O\text{(l)} \rightleftharpoons ADP^{3-}\text{(aq)} + H_2PO_4^-\text{(aq)} \qquad \Delta G° = -30.5 \text{ kJ mol}^{-1}$$

The overall reaction is thus:

$$\text{glucose(aq)} + ATP^{4-}\text{(aq)} \rightleftharpoons [\text{glucose phosphate}]^-\text{(aq)} + ADP^{3-}\text{(aq)}$$

Calculate the equilibrium constant associated with this overall reaction at body temperature (37 ºC).

Answer:

This overall equilibrium reaction is investigated by adding 0.0100 mol of ATP^{4-} to a flask containing 175 mL of a 0.0500 M aqueous solution of glucose at 37 ºC. What percentage of the ATP^{4-} will have been consumed when the system reaches equilibrium?

Answer: **87%**

Suggest two simple ways of further reducing the remaining percentage of ATP^{4-}.