

Free Energy and EMF

Review

The relationship between ΔG and ΔG°

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

the change in free energy that occurs if the reactants in their standard states are converted to the products in their standard states

$$\Delta G = \Delta H - T\Delta S$$

the absolute change in free energy change

The relationship between ΔG and ΔG°

$$\Delta G = \Delta G^\circ + RT \ln(Q)$$

$$\Delta G = 0$$

$$\Delta G = \Delta G^\circ + RT \ln \frac{[\text{products}]}{[\text{reactants}]}$$

The relationship between ΔG and ΔG°

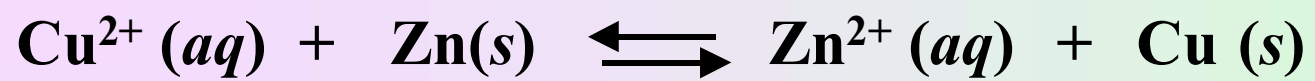
$$\Delta G = \Delta G^\circ + RT \ln(Q)$$

$$\Delta G = 0$$

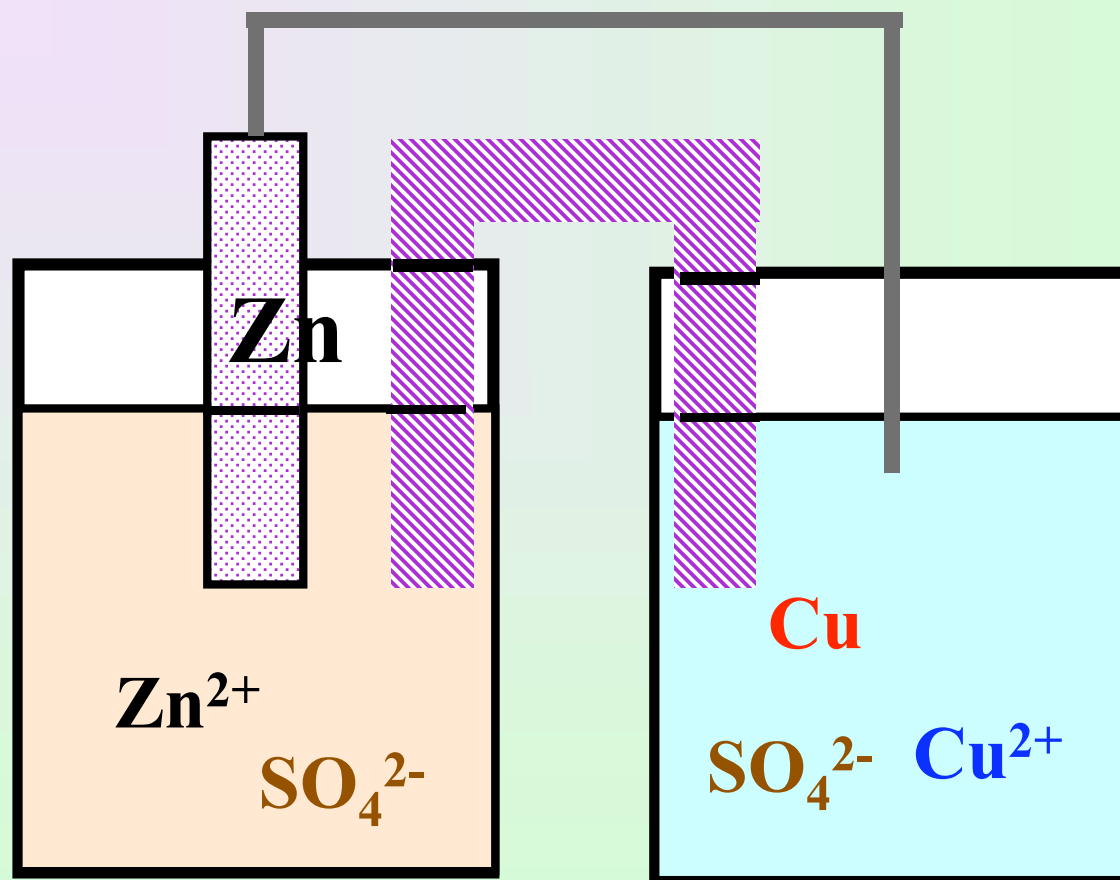
a large negative
value ΔG°

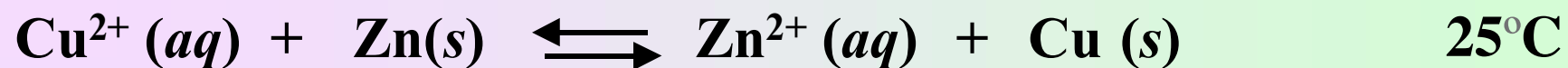
a large relative value for products
needed to make $(RT \ln Q)$
equivalent to ΔG°

$$0 = \Delta G^\circ + RT \ln \frac{[\text{products}]}{[\text{reactants}]}$$



25°C

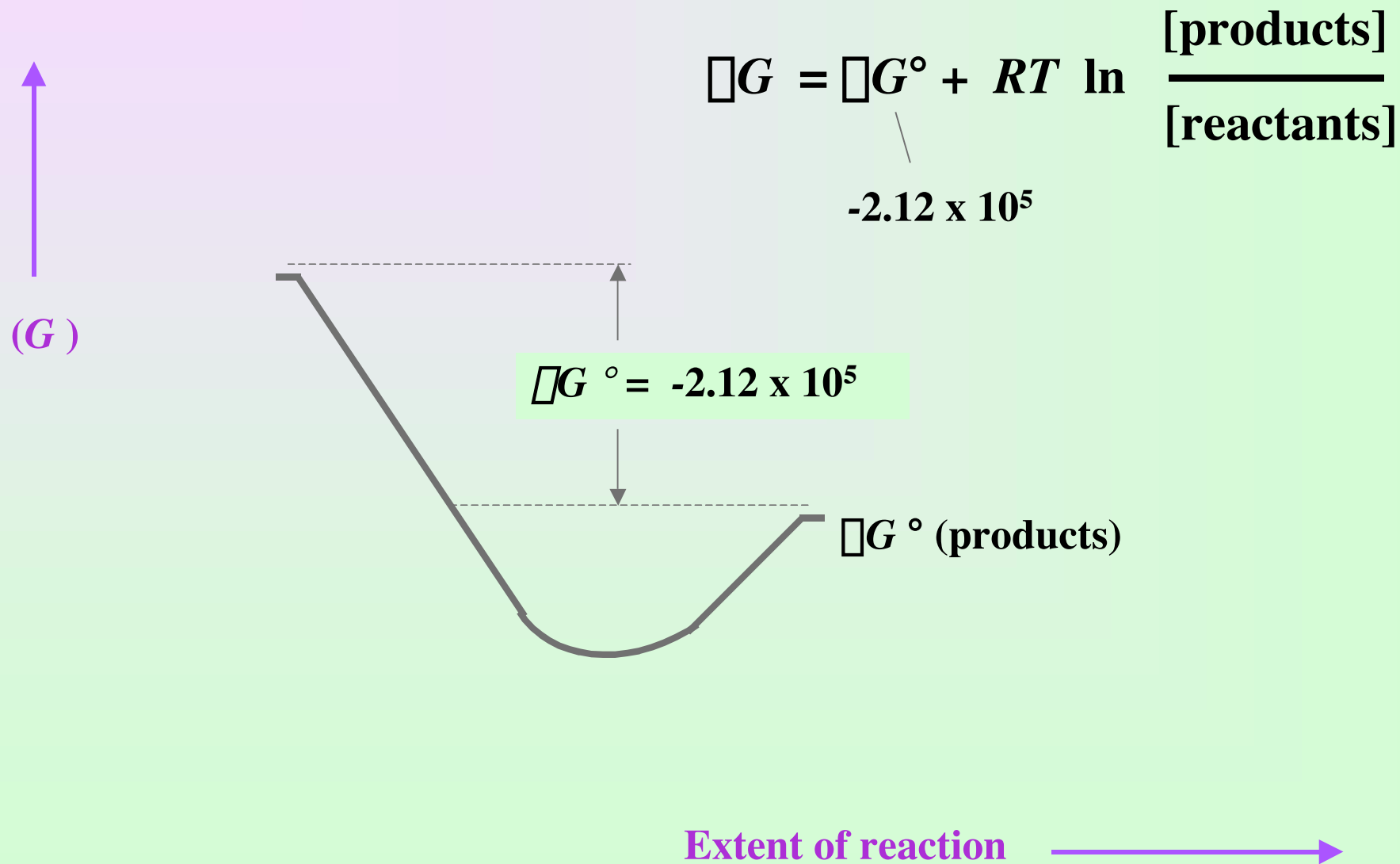
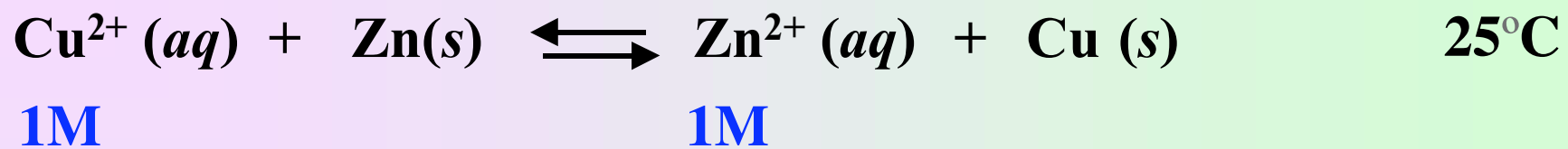


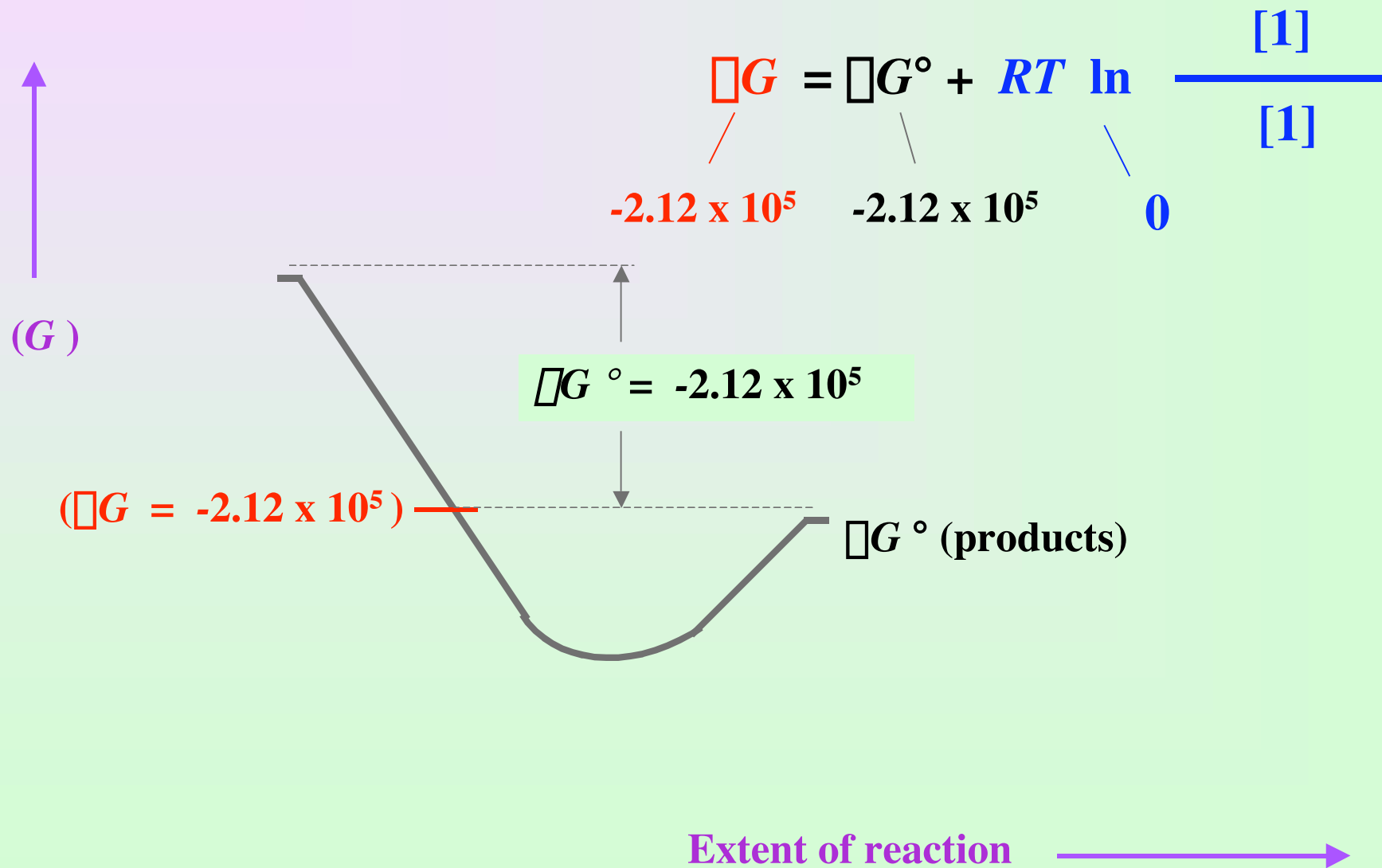
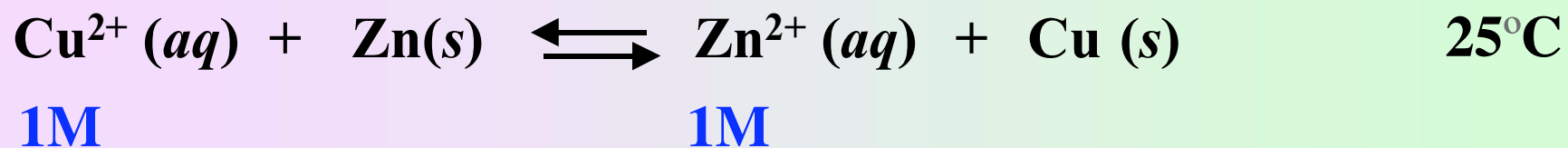


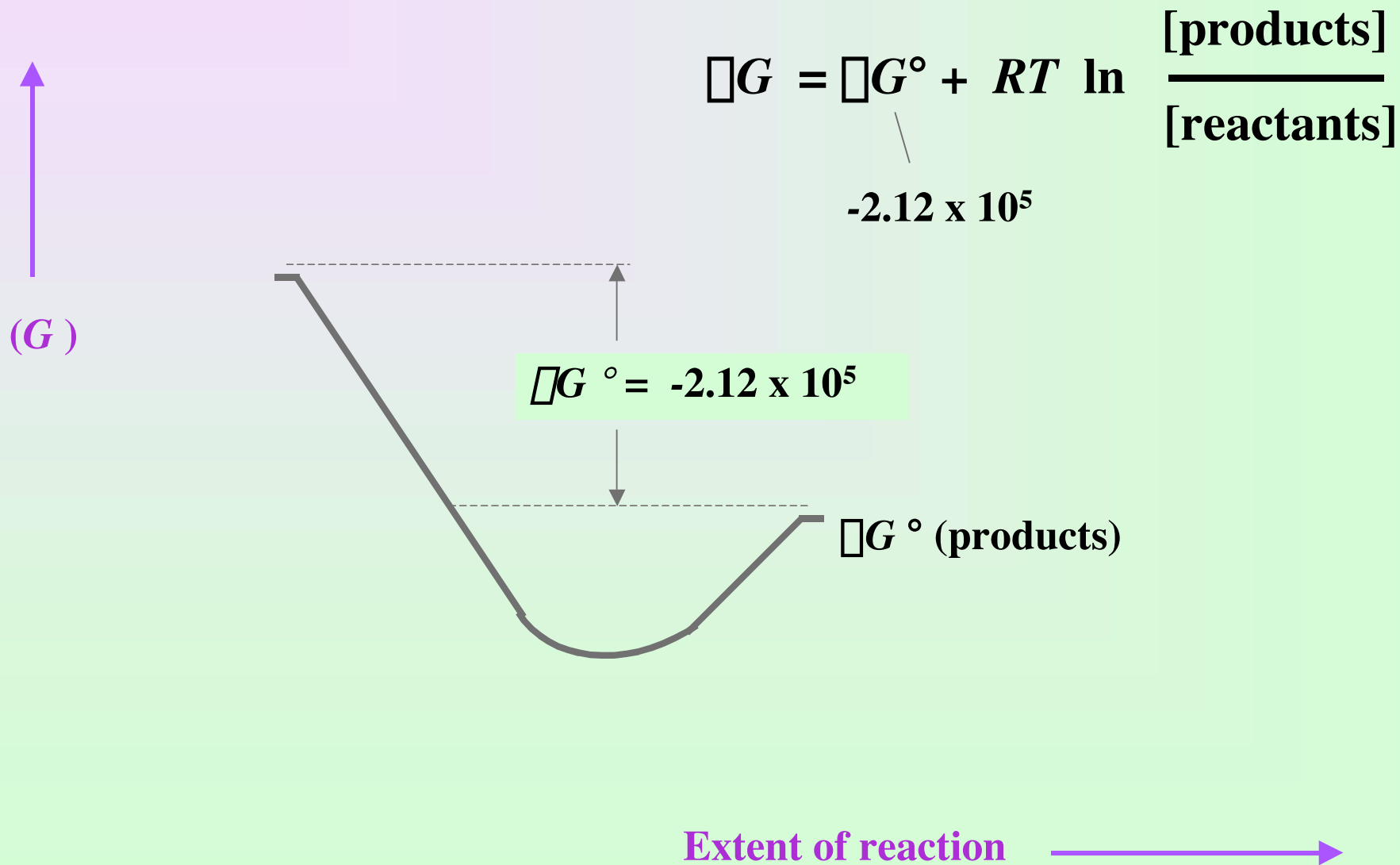
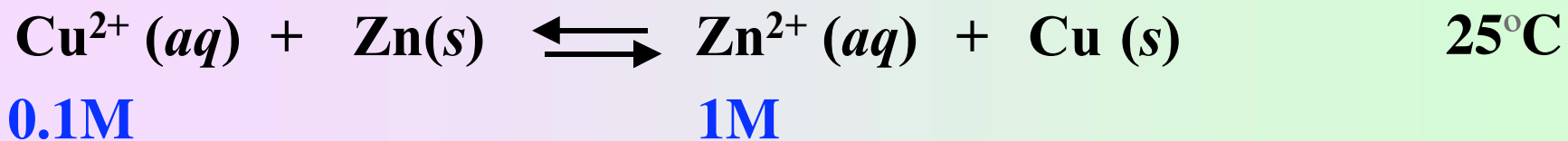
$$\Delta G_{\text{rxn}}^{\circ} = \Delta n \Delta G_f^{\circ} (\text{products}) - \Delta m \Delta G_f^{\circ} (\text{reactants})$$

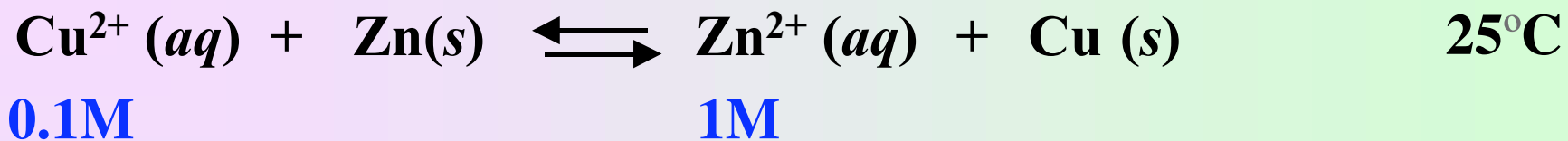
$$= 1\text{mol}(-147.2 \text{ kJ/mol}) - [1\text{mol}(64.98 \text{ kJ/mol})]$$

$$= -212.18 \text{ kJ}$$






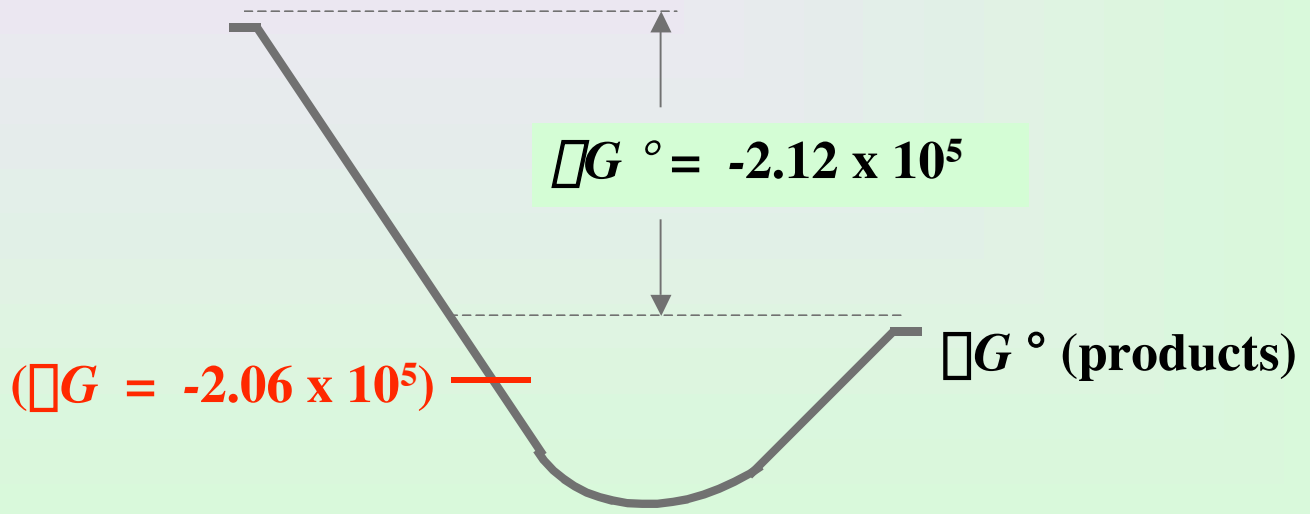




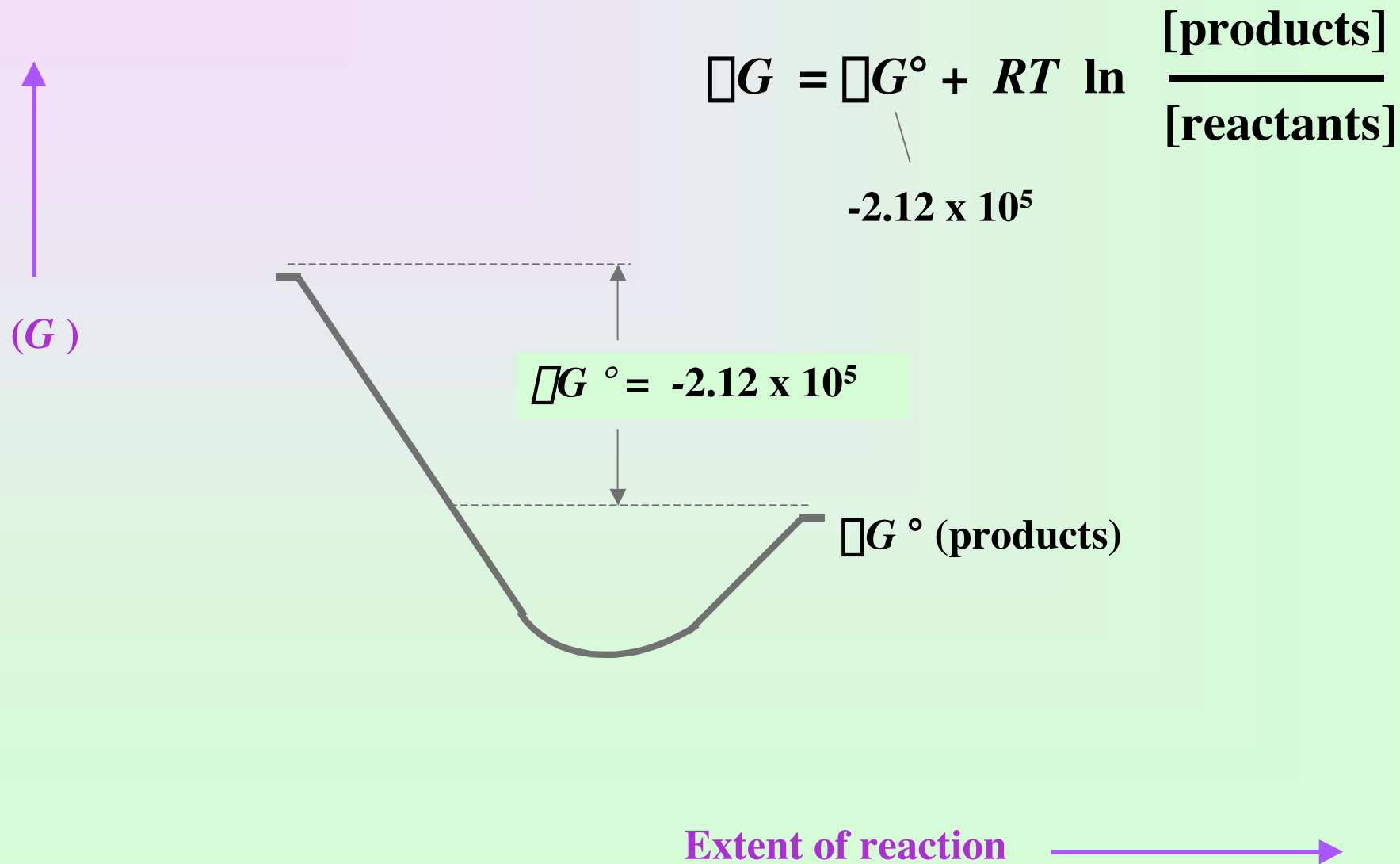
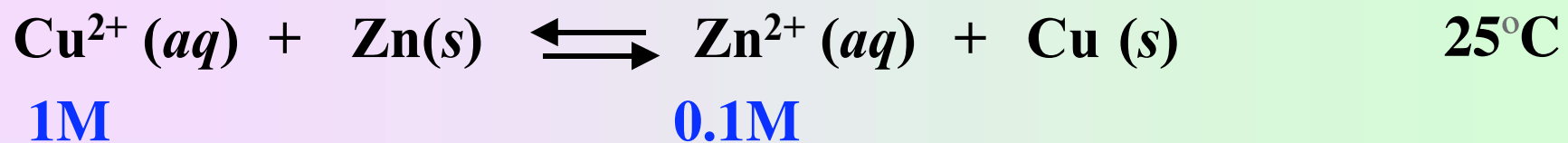
$$\Delta G = \Delta G^\circ + RT \ln \frac{[1]}{[0.1]}$$

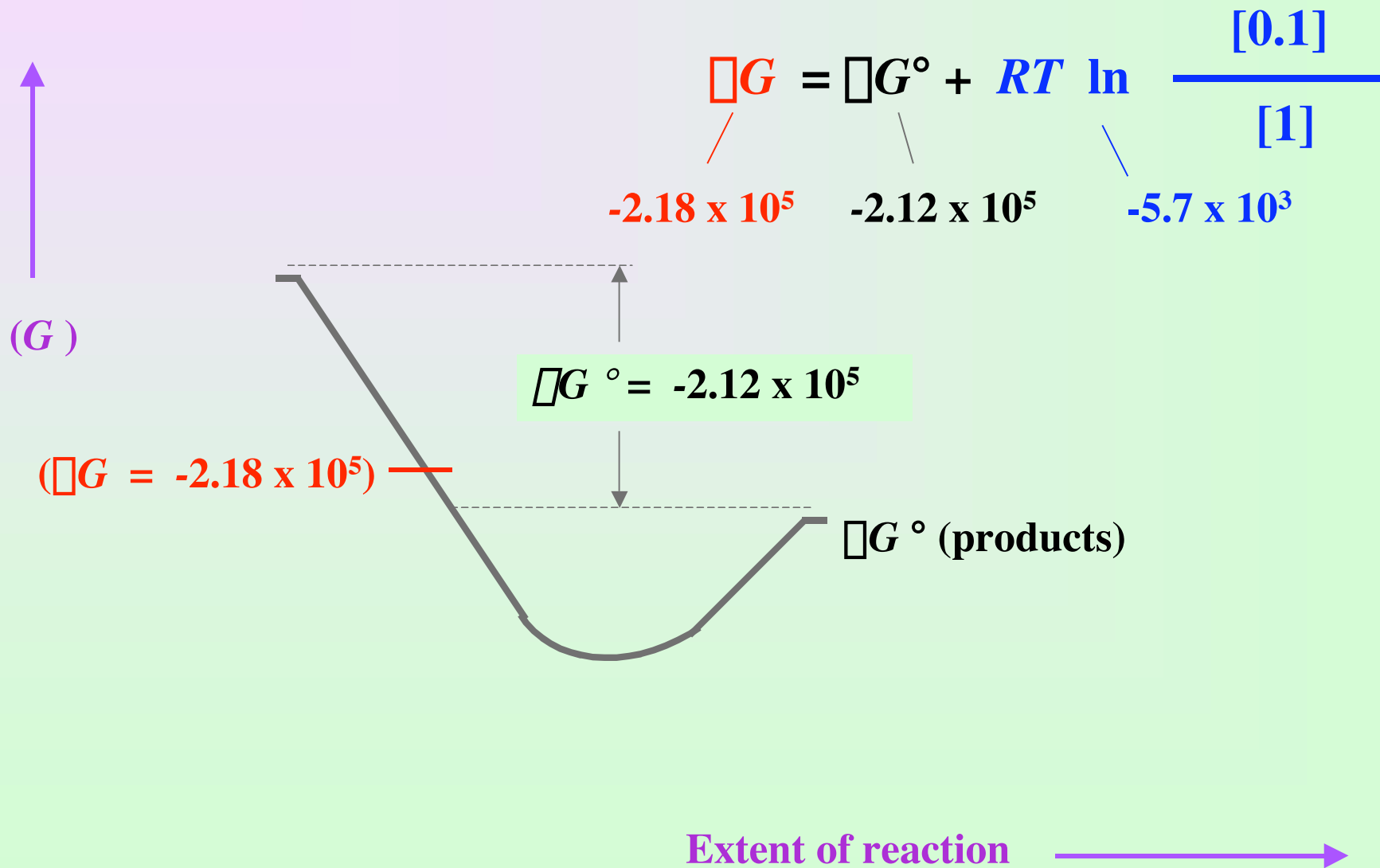
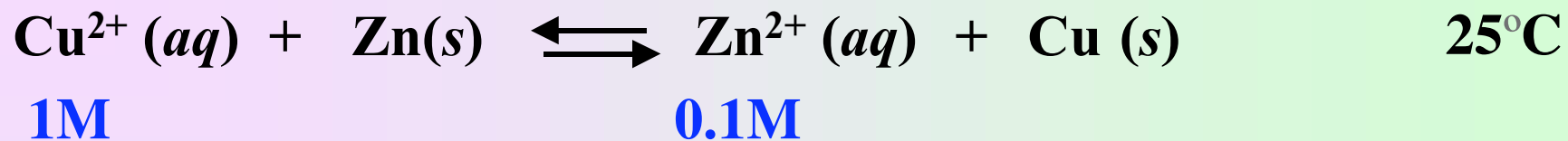
-2.06×10^5 -2.12×10^5 5.7×10^3

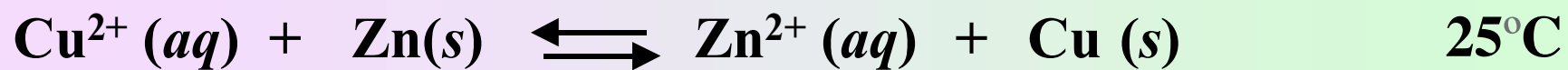
(G)

Extent of reaction 

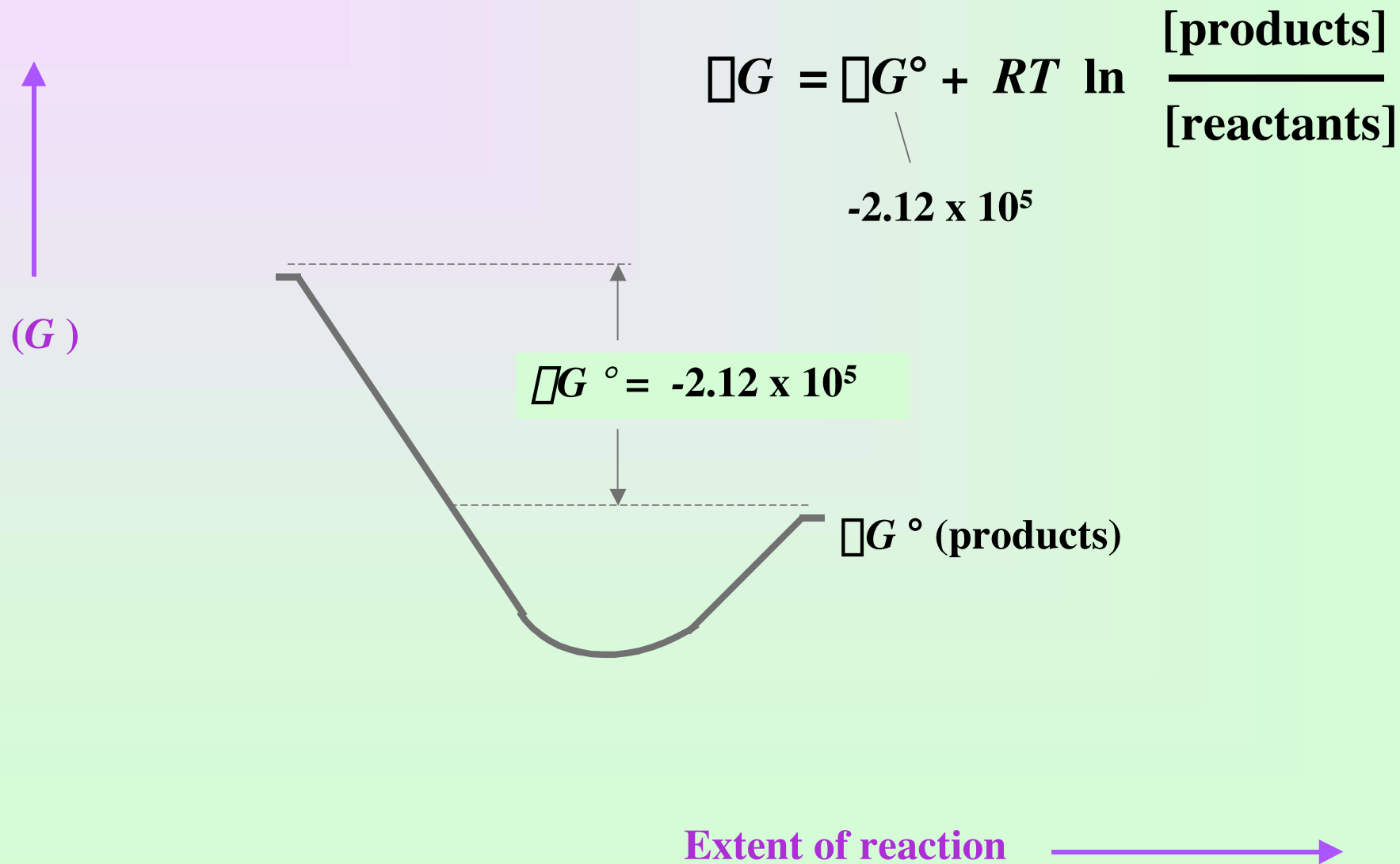






$6.90 \times 10^{-38} \text{ M}$

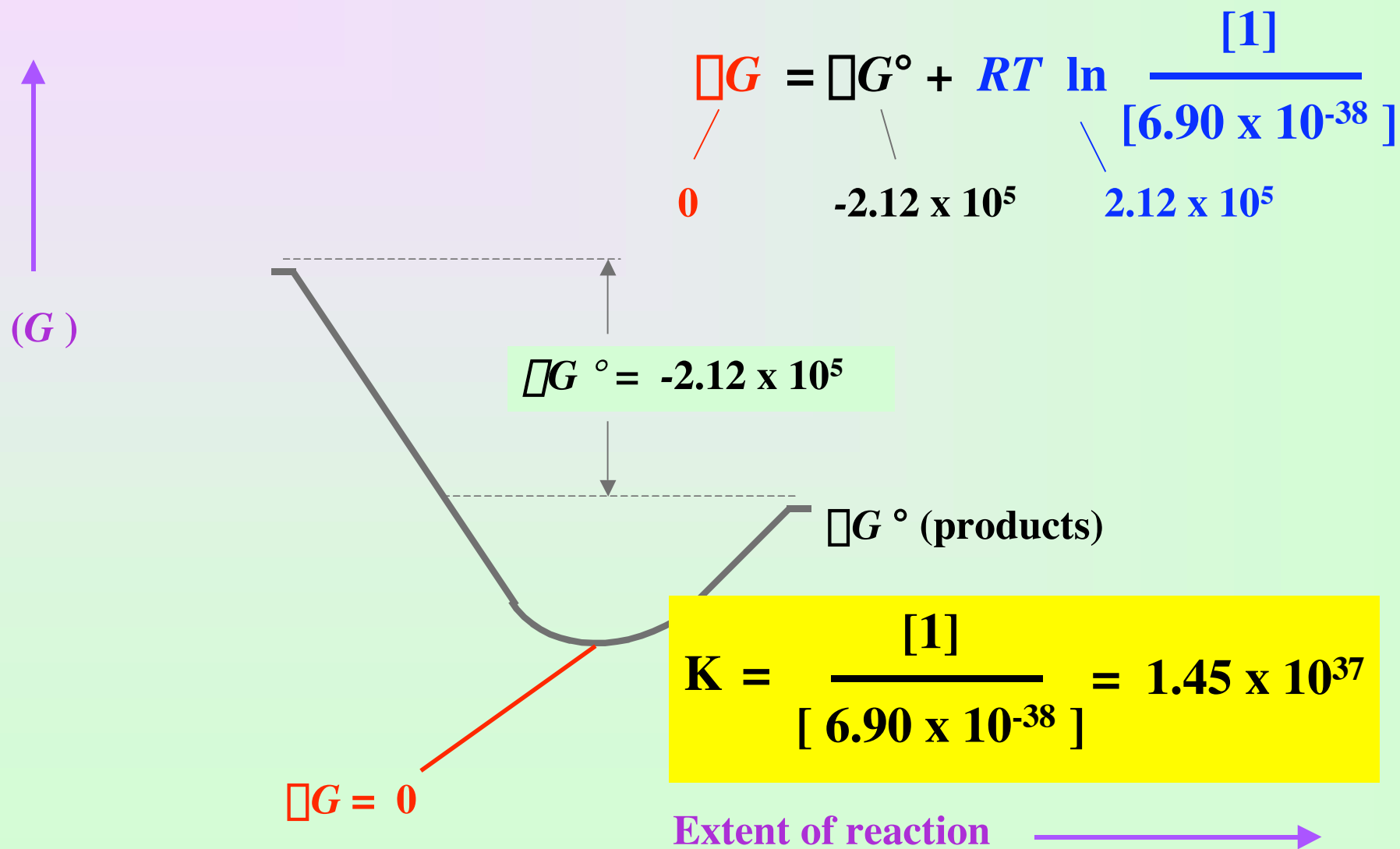
1M





$6.90 \times 10^{-38} \text{ M}$

1M



Cell potential and concentration

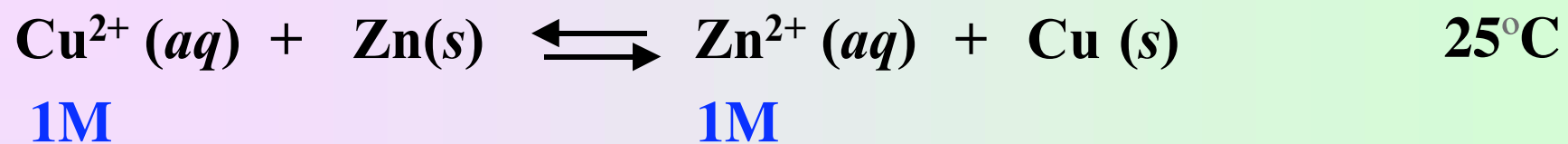
the dependence of the cell potential on concentration results directly from the dependence of free energy on concentration

$$\Delta G = \Delta G^\circ + RT \ln (Q)$$

$$-n f \Delta = -n f \Delta^\circ + RT \ln (Q)$$

$$\Delta = \Delta^\circ - \frac{RT}{n f} \ln (Q)$$

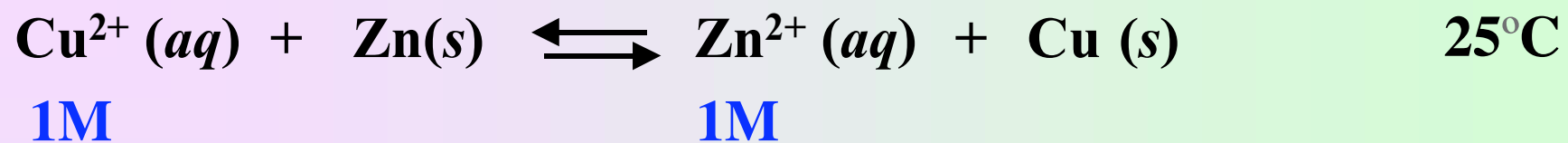
$$\Delta = \Delta^\circ - \frac{0.0592 \text{ v}}{n} \log \frac{[\text{products}]}{[\text{reactants}]}$$



$$E = E^{\circ} - \frac{0.0592\text{V}}{n} \log \frac{[\text{products}]}{[\text{reactants}]}$$

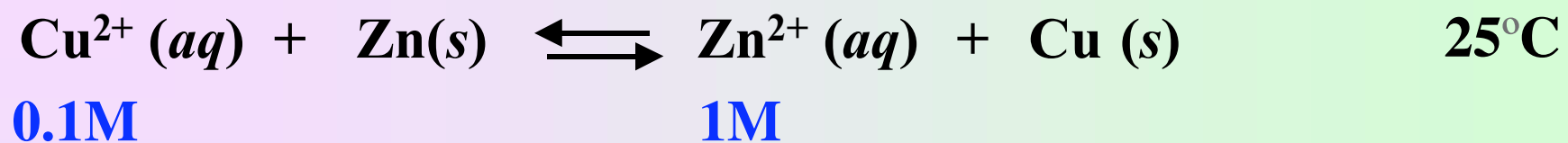
\

1.10 V



$$\boxed{1.10 \text{ V}} = \boxed{1.10 \text{ V}} - \frac{0.0592 \text{ v}}{2} \log \frac{[1]}{[1]}$$

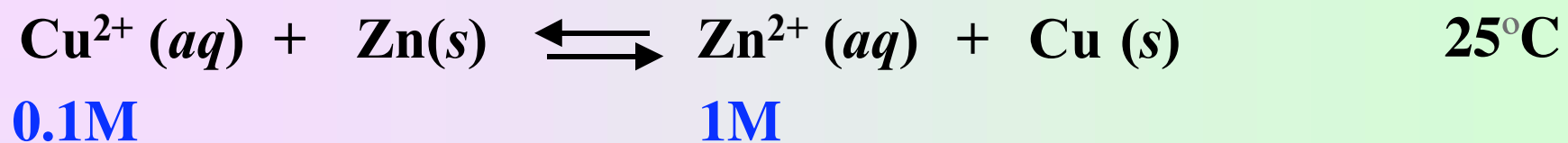
1.10 V **1.10 V** **0**



$$E = E^{\circ} - \frac{0.0592\text{v}}{n} \log \frac{[\text{products}]}{[\text{reactants}]}$$

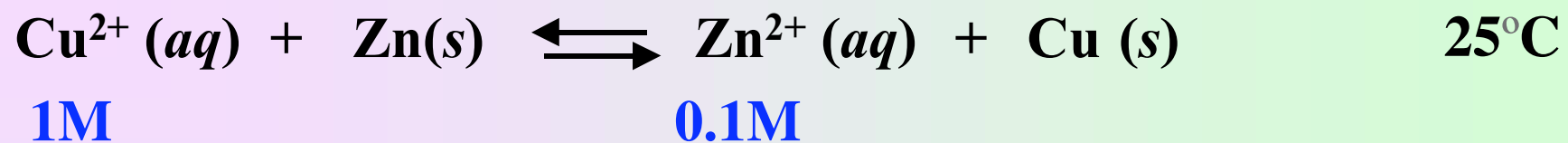
\

1.10 V



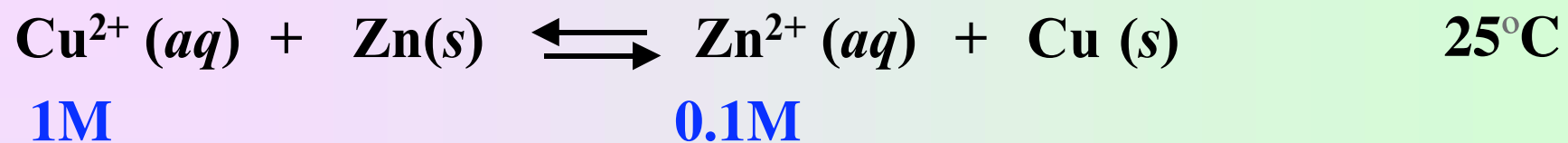
$$\boxed{1.07 \text{ V}} = \boxed{1.10 \text{ V}} - \frac{0.0592 \text{ V}}{2} \log \frac{[1]}{[0.1]}$$

0.0296



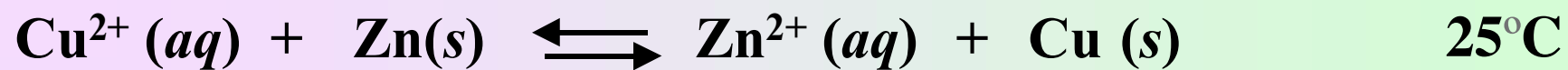
$$E = E^{\circ} - \frac{0.0592\text{V}}{n} \log \frac{[\text{products}]}{[\text{reactants}]}$$

\
1.10 V



$$\boxed{1.13 \text{ V}} = \boxed{1.10 \text{ V}} - \frac{0.0592 \text{ V}}{2} \log \frac{[0.1]}{[1]}$$

-0.0296

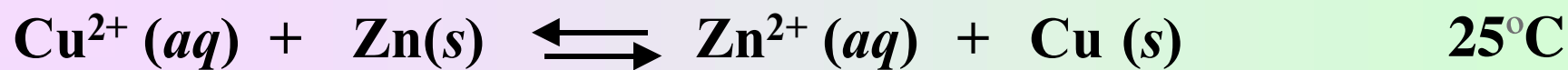


$$6.90 \times 10^{-38} \text{ M}$$

$$1\text{M}$$

$$E = E^{\circ} - \frac{0.0592\text{V}}{n} \log \frac{[\text{products}]}{[\text{reactants}]}$$

1.10 V



$$6.90 \times 10^{-38} \text{ M}$$

$$1\text{M}$$

$$0 = 1.10 \text{ V} - \frac{0.0592\text{V}}{2} \log \frac{[1]}{[6.90 \times 10^{-38}]}$$

$$K = \frac{[1]}{[6.90 \times 10^{-38}]} = 1.45 \times 10^{37}$$