

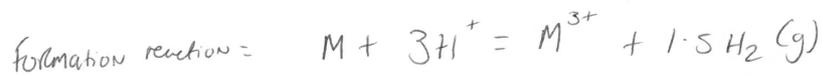
$$S^\ominus H_2 \quad 130.7$$

$$S^\ominus H^+ \quad 0$$

Table 1 Thermodynamic data at 298.15 K for unknown metal, M, and one of its cations.

Substance	State	$\frac{\Delta H_f^\ominus}{\text{kJ mol}^{-1}}$	$\frac{\Delta G_f^\ominus}{\text{kJ mol}^{-1}}$	$\frac{S^\ominus}{\text{JK}^{-1} \text{mol}^{-1}}$
M	s	0	0	28.3
M ³⁺	aq	-531.0		-321.7

(a) Write down the formation reaction for aqueous M³⁺ ions. Calculate the value of ΔG_f^\ominus (M³⁺, aq) at 298.15 K. Use this calculated value to identify the position that M would have in Table 12.1 of Book 4. Finally, identify M.



Formula:- $\Delta G_f^\ominus = \Delta H_f^\ominus - T \Delta S_f^\ominus$

Then convert S^\ominus into S_f^\ominus

$$= S^\ominus(M^{3+}) - \frac{1}{2} S^\ominus(H_2) - S^\ominus(M) - 3S^\ominus(H^+)$$

$$= -321.7 - \frac{1}{2} \times 130.7 - 28.3$$

$$= -415.3 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta H_f^\ominus = -531.0 \text{ kJ mol}^{-1}$$

$$\Delta G_f^\ominus = (298.15 \text{ K}) \times (-415.3 \text{ J K mol}^{-1}) = -12820 \text{ J mol}^{-1}$$

$$\Delta G_f^\ominus = -415.3 \text{ kJ mol}^{-1} + 12820 \text{ J mol}^{-1}$$

$$= 415.3 \text{ kJ mol}^{-1} + 12.8 \text{ kJ mol}^{-1}$$

$$= -402.5 \text{ kJ mol}^{-1}$$