

Thought Lab: Assigning Reference Values Answer Key

1.

Reduction half-reaction	Accepted E° (V)	Adjusted E° (V) [+ 1.66 (V)]
$\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$	+2.87	+4.53
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77	+2.43
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0.00	+1.66
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	-1.66	0.00
$\text{Li}^+(\text{aq}) + \text{e}^- \rightarrow \text{Li}(\text{s})$	-3.04	-1.39

2. (a) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 0.00 \text{ V} - (-3.04 \text{ V}) = +3.04 \text{ V}$
 (b) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 2.87 \text{ V} - (-1.66 \text{ V}) = +4.53 \text{ V}$
 (c) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 0.77 \text{ V} - 0.000 \text{ V} = +0.77 \text{ V}$
 (d) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = -1.66 \text{ V} - (-3.04 \text{ V}) = +1.38 \text{ V}$
3. (a) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 1.66 \text{ V} - (-1.38 \text{ V}) = +3.04 \text{ V}$
 (b) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 4.53 \text{ V} - 0.00 \text{ V} = +4.53 \text{ V}$
 (c) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 2.43 \text{ V} - 1.66 \text{ V} = +0.77 \text{ V}$
 (d) $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 0.00 \text{ V} - (-1.38 \text{ V}) = +1.38 \text{ V}$

Answers to Analysis Questions

1. (a) Shifting the zero value by +1.66 V increased each reduction potential by +1.66 V.
 (b) Changing the zero on the scale of reduction potentials has no effect on the calculated cell potentials.
2. (a) On the Celsius temperature scale the difference between the temperature at which water boils and the temperature at which water freezes is $100.0 \text{ }^\circ\text{C} - 0.0 \text{ }^\circ\text{C} = 100 \text{ }^\circ\text{C}$.
 (b) On the Kelvin temperature scale the difference between the temperature at which water boils and the temperature at which water freezes is $373.15 \text{ K} - 273.15 \text{ K} = 100 \text{ K}$.
3. The Celsius and Kelvin temperature scales have two different zero values, but a change of 1 degree is the same on both scales. Zero on the Celsius scale is 273.15 K on the Kelvin scale. Zero on the Kelvin scale is $-273.15 \text{ }^\circ\text{C}$. The zero value of the Celsius scale is defined based on the freezing point of water under standard conditions. For the Kelvin scale, the zero is shifted to occur at absolute zero – the temperature at which particles of matter have zero energy under standard conditions.
4. The Celsius scale and reduction potentials have a zero value that is arbitrarily set.
5. Mass is a measure of the quantity of matter in an object. The zero value means that there is no matter present at all. This reference point cannot change, so the zero value of a mass scale is not arbitrary.