Ex. 1 Standard redox potential — Lead-acid battery

The overall chemical reaction in a lead-acid battery (car) is:

$$\mathrm{Pb + PbO_2 + 2\ H_2SO_4 \iff 2\ PbSO_4 + 2\ H_2O}$$

Looking up the thermodynamic data for this reaction (e.g., in CRC Handbook hbcpnetbase.com, NIST.gov website, CRM's form, etc.), you would find the standard-state data at 25°C:

Compound	$\Delta_f\tilde{h}^{\ominus}_{25°C}$ kJ/mol	$\tilde{s}^{\ominus}_{25°C}$ J/(mol·K)
$PbSO_4$	-920.00	148.5
Pb	0	64.80
PbO_2	-274.47	71.78
H_2SO_4 aqueous	-909.00	20.08
H_2O(l)	-285.80	70.00
H^+ aqueous	0 (definition)	0 (definition)

Derive from these the standard redox potential for a lead-acid battery at 25°C.

Ex. 2 Standard redox potential – Influence of temperature and gases

The table below gives the standard molar enthalpy-change of formation and the standard molar entropy for some compounds, at 1 bar and 25°C.

Compound	$\Delta_f\tilde{h}^{\ominus}_{25°C}$	$\tilde{s}^{\ominus}_{25°C}$
	kJ/mol	J/(mol·K)
H_2	0	130.6
O_2	0	205.0
H_2O *(l)*	-285.8	69.9
H_2O *(g)*	-241.8	188.7
CH_4	-74.85	186.2
CO_2	-393.5	213.6

1. Compute the standard redox potential, $E^{\ominus}$, for the electrochemical oxidation of:
   a) hydrogen at 25°C;
   b) methane at 25°C.

2. Write the standard redox potential as a function of temperature, $E^{\ominus}(T)$.
   a) Plot $E^{\ominus}(T)$ in the interval T = [25, 1000]°C, for hydrogen and for methane.
   b) Draw conclusions regarding the influence of temperature and of gases on $E^{\ominus}$.