1. Which is the correct value for the standard potential for a gold-rhodium voltaic cell?

The standard half cell potential at $298\ K$ are:

$Rh^{3+}(aq) + 3e^- \rightarrow Rh(s);\ E^o_{red} = 0.76\ V$

$Au^+(aq) + e^- \rightarrow Au(s);\ E^o_{red} = 1.69\ V$

A. $2.45\ V$

B. $0.93\ V$ ✔

C. $5.83\ V$

D. $4.31\ V$

The standard reduction potential of the half cells are given.

$E^\circ_{Rh^{3+}(aq)/Rh(s)} = 0.76\ V$

$E^\circ_{Au^+(aq)/Au(s)} = 1.69\ V$

Metal which having higher reduction potential will undergo reduction and metal having lower reduction potential will undergo oxidation.

So, Au will undergo reduction and act as cathode and Rh will undergo oxidation and act as anode.

The standard cell potential (ΔE^o) of a galvanic cell can be calculated by considering the standard reduction potentials of the two half cells E^o.

$E^\circ_{cell} = \text{SRP of substance reduced} - \text{SRP of substance oxidised}$

(SRP - Standard reduction potential)

$$E^\circ_{cell} = E^\circ_{cathode\ (red)} - E^\circ_{anode\ (red)}$$

$$E^o_{cell} = (1.69 - 0.76)\ V = 0.93\ V$$

2. KCl is used in salt bridge because:

A. It forms a good jelly with agar-agar

B. It is a strong electrolyte

C. It is a good conductor of electricity

D. Mobility of K^+ and Cl^- ions are almost same

Salt bridge is a U–shaped inverted tube that contains a gel (paste of agar-agar powder) permeated with an inert electrolyte (eg: KCl)
Salt bridge connects the cathode and anode electrode internally.

Criteria for electrolyte in a salt bridge:
1. The electrolytes should consist of cations and anions having same mobility.
2. It should not react with the ions in the solution.
3. It should not oxidised/reduced at the electrodes

KCl has all these 3 criteria and is generally preferred for salt bridge.

3. The value for the standard emf (electromotive force) of a galvanic cell described by the balanced chemical equation is $0.79\ V$. Determine the value of the standard half-cell potential for the I^-/I_2 couple.
$Cr_2O_7^{2-}(aq) + 2I^-(aq) \rightarrow I_2(g) + Cr^{3+}(aq)$
$E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\ V$

A. $+0.18\ V$

B. $-0.18\ V$

C. $0.54\ V$

D. $-0.54\ V$ ✔

In the given reaction, I^- has been oxidised to I_2 and $Cr_2O_7^{2-}$ ions have been reduced to Cr^{3+}

$E^\circ_{cell} = \text{SRP of substance reduced} - \text{SRP of substance oxidised}$
(SRP - Standard reduction potential)

$$E^\circ_{cell} = E^\circ_{cathode\ (red)} - E^\circ_{anode\ (red)}$$

$$E^\circ_{cell} = E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} - E^\circ_{I_2/I^-}$$

$$0.79 = 1.33 - E^\circ_{I_2/I^-}$$

$$E^\circ_{I_2/I^-} = 0.54\ V$$
$$E^\circ_{I^-/I_2} = -0.54\ V$$

4. The electrode with reaction
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$
can be represented as:
[If needed, use platinum as an inert electrode]

A. $Pt(s)|H^+(aq), Cr_2O_7^{2-}(aq)$

B. $Pt(s)|H^+(aq)||Cr_2O_7^{2-}(aq), Cr^{3+}(aq)$

C. $Pt(s), H_2(g)|H^+(aq), Cr_2O_7^{2-}$

D. $H^+(aq), Cr_2O_7^{2-}(aq), Cr^{3+}(aq)|Pt(s)$

It is a redox electrode.
Here,
$Cr_2O_7^{-2}$ is reduce to $2Cr^{3+}$, so it must be represented at cathode.
It is a single electrode. Thus, there is no salt bridge.

Rules for Cell representation:
1. Anode half cell should be on left side and cathode half cell should be on right side.

2. Separation of two phase should be shown by vertical line $(|)$. This line indicates phase boundary.

3. If various material present in the same phase, it should be shown together with commas (,).

4. The salt bridge is represented by double slash $(||)$ between the two half cells.

5. The significant features of the substance like pressure of a gas, concentration of ions, etc. should be indicated in brackets immediately after writing the substance.

6. For gas electrode, gas should be indicated after electrode for anode and should be indicated before electrode for cathode.

So, the cell representation is:
$H^+(aq), Cr_2O_7^{-2}(aq), Cr^{3+}(aq)|Pt(s)$

5. The standard reduction potential of the half cells at $298\ K$ are,
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s); E^o = -0.28\ V$
$Mg^{2+}(aq) + 2e^- \rightarrow Mg\,(s)\,; E^o = -2.37\ V$

The standard cell potential for a voltaic cell constructed using the two half reaction is

- A. $-2.65\ V$
- B. $-2.09\ V$
- C. $+2.65$
- D. $2.09\ V$ ✔

The standard reduction potential of the half cells are given.
$E^\circ_{Ni^{2+}(aq)/Ni(s)} = -0.28\ V$
$E^\circ_{Mg^{2+}(aq)/Mg(s)} = -2.37\ V$

Metal which having higher reduction potential will undergo reduction and metal having lower reduction potential will undergo oxidation.
Thus, Ni electrode will act as cathode and Mg electrode will act as anode.

The standard cell potential (ΔE^o) of a galvanic cell can be calculated by considering the standard reduction potentials of the two half cells E^o.
$E^\circ_{cell} = \text{SRP of substance reduced} - \text{SRP of substance oxidised}$
(SRP - Standard reduction potential)

$$E^\circ_{cell} = E^\circ_{cathode\ (red)} - E^\circ_{anode\ (red)}$$

$$E^\circ_{cell} = E^\circ_{Ni^{2+}(aq)/Ni(s)} - E^\circ_{Mg^{2+}(aq)/Mg(s)}$$

$$E^\circ_{cell} = -0.28 - (-2.37)$$
$$E^\circ_{cell} = -0.28 + 2.37$$
$$E^\circ_{cell} = 2.09\ V$$