Redox reactions – Using E^o tables to predict reactions.

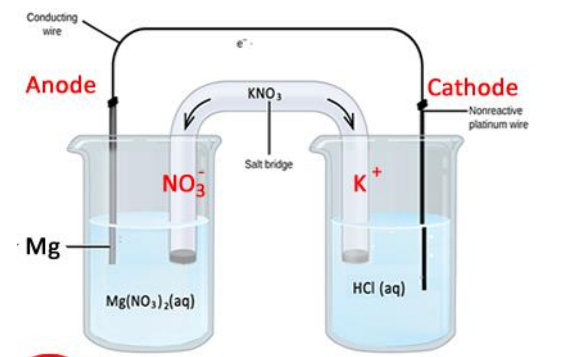
Lesson 4c

A student has set up the following 6 galvanic cells as shown below. Using the E^o tables predict if electrical energy, heat energy or no energy is produced in each.
If electrical energy is produced then:

When predicting if a reaction will occur to produce electrical energy in a galvanic cell, two things must be taken into account.
1) The strongest oxidant present is above the strongest reductant present
2) The strongest oxidant and the strongest reductant are in separate half-cells

Yes electrical energy will be produced as the strongest reductant (Mg) and the strongest oxidant (H^+) are in separate half cells.
- identify the anode and cathode
- direction of electron flow
- direction of cation movement
- the theoretical voltage at standard conditions *2.34 volt*
- write the oxidation and reduction half equations and overall equation.

$2H^+(aq) + 2e \rightarrow H_2(g)$ ---- reduction
$Mg(s) \rightarrow Mg^{2+}(aq) + 2e$---- oxidation
$2H^+(aq) + Mg(s) \rightarrow H_2(g) + Mg^{2+}(aq)$ ---- overall



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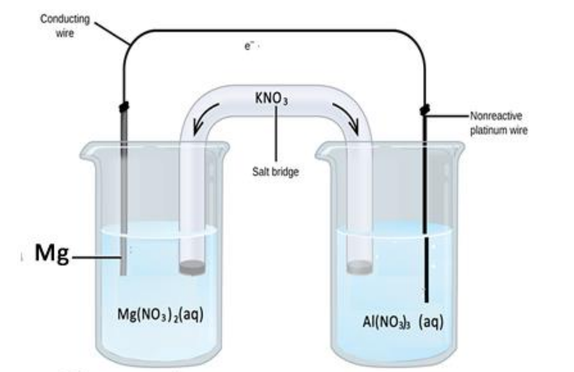
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	–0.13
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	–0.14
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	–0.23
$Co^{2+}(aq) + 2e^- \rightarrow Co(s)$	–0.28
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	–0.76
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	–0.83
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	–1.03
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	–1.67
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	–2.34

No, electrical energy will not be produced as the strongest reductant (Mg) and the strongest oxidant (H_2O) are in the same half cell.

Heat energy will be produced as the following reactions take place in the half cell on the left.

$2H_2O(l) + 2e \rightarrow H_2(g) + 2OH^-(aq)$ ---- reduction
$Mg(s) \rightarrow Mg^{2+}(aq) + 2e$---- oxidation
Overall
$2H_2O(l) + Mg(s) \rightarrow H_2(g) + Mg^{2+}(aq) + 2OH^-(aq)$



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$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	–0.14
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	–0.23
$Co^{2+}(aq) + 2e^- \rightarrow Co(s)$	–0.28
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	–0.76
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	–0.83
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	–1.03
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	–1.67
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	–2.34

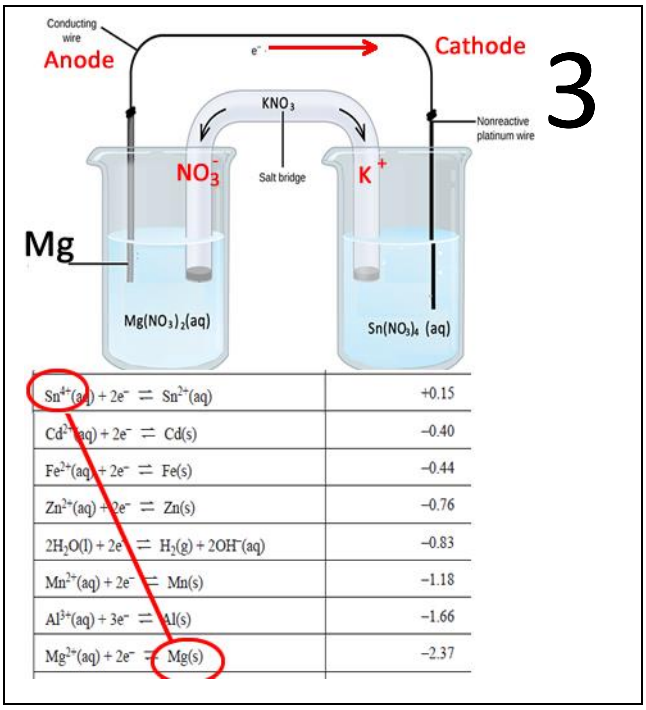
Yes electrical energy will be produced as the strongest reductant (Mg) and the strongest oxidant (Sn^{4+}) are in separate half cells.

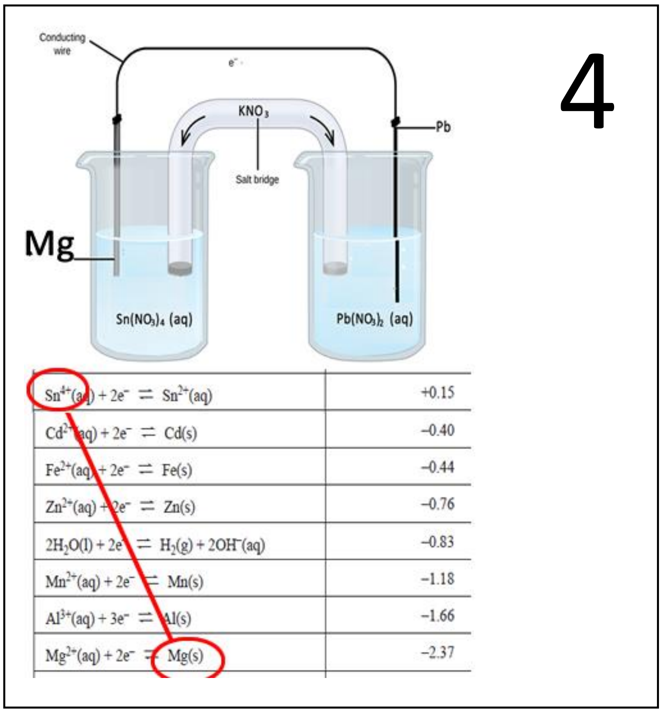
- identify the anode and cathode
- direction of electron flow
- direction of cation movement
- the theoretical voltage at standard conditions *2.52 volt*
- write the oxidation and reduction half equations and overall equation.

$Sn^{4+}(aq) + 2e \rightarrow Sn^{2+}(aq)$ ---- reduction

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e$---- oxidation

$Sn^{4+}(aq) + Mg(s) \rightarrow Sn^{2+}(aq) + Mg^{2+}(aq)$ ---- overall





No, electrical energy will not be produced as the strongest reductant (Mg) and the strongest oxidant (Sn^{4+}) are in the same half cell.

Heat energy will be produced as the following reactions take place in the half cell on the left.

$Sn^{4+}(aq) + 2e \rightarrow Sn^{2+}(aq)$ ---- reduction

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e$---- oxidation

Overall

$Sn^{4+}(aq) + Mg(s) \rightarrow Sn^{2+}(aq) + Mg^{2+}(aq)$

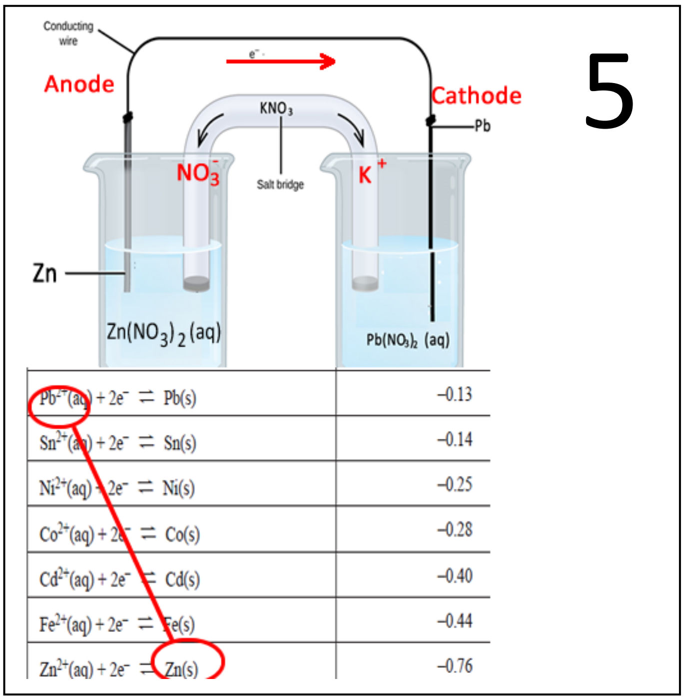
Yes electrical energy will be produced as the strongest reductant (Zn) and the strongest oxidant (Pb^{2+}) are in separate half cells.

- identify the anode and cathode
- direction of electron flow
- direction of cation movement
- the theoretical voltage at standard conditions *0.63 volt*
- write the oxidation and reduction half equations and overall equation.

$Pb^{2+}(aq) + 2e \rightarrow Pb(s)$ ---- reduction

$Zn(s) \rightarrow Zn^{2+}(aq) + 2e$---- oxidation

$Pb^{2+}(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + Pb(s)$ ---- overall



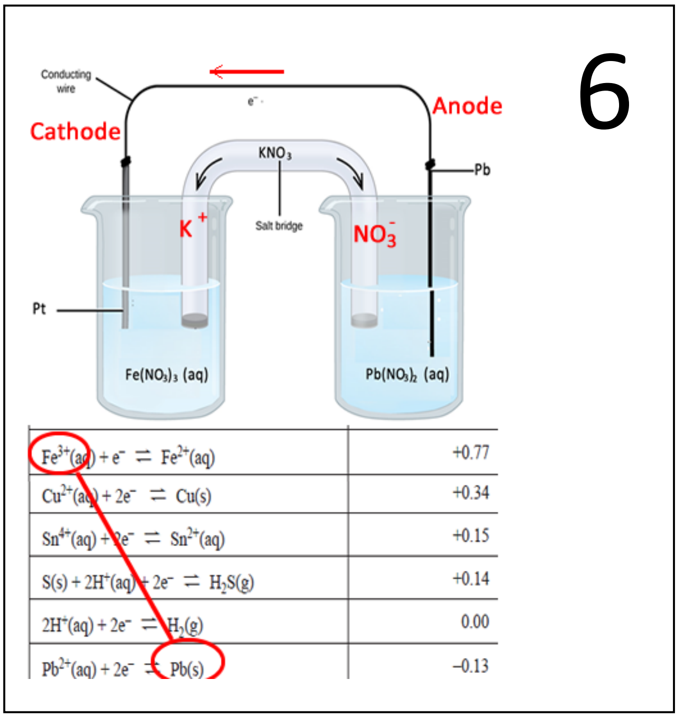
Yes electrical energy will be produced as the strongest reductant (Pb) and the strongest oxidant (Fe^{3+}) are in separate half cells.

- identify the anode and cathode
- direction of electron flow
- direction of cation movement
- the theoretical voltage at standard conditions *0.90 volt*
- write the oxidation and reduction half equations and overall equation.

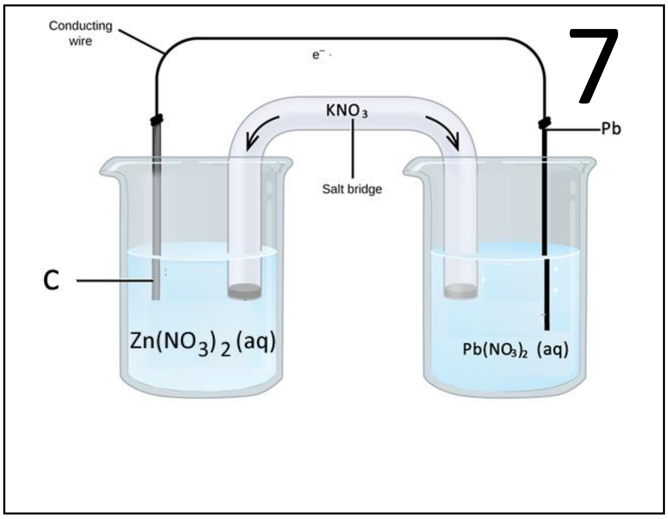
$Fe^{3+}(aq) + e \rightarrow Fe^{2+}(aq)$ ---- reduction

$Pb(s) \rightarrow Pb^{2+}(aq) + 2e$---- oxidation

$2Fe^{3+}(aq) + Pb(s) \rightarrow 2Fe^{2+}(aq) + Pb^{2+}(aq)$ ---- overall



No energy is produced as the strongest oxidant , Pb^{2+}(aq) has no reductant below it on the E^o table. Or it can also be stated that the strongest reductant , Pb(s) has no oxidant above it.



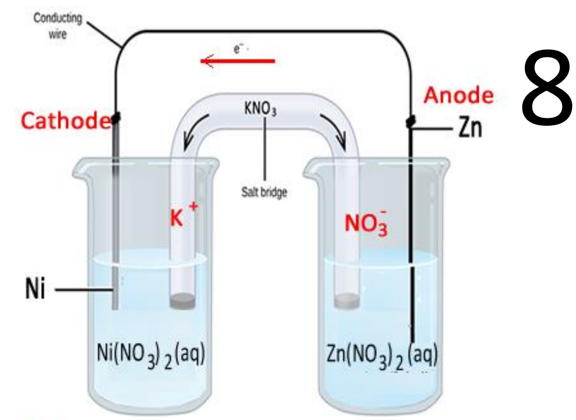
Yes electrical energy will be produced as the strongest reductant (Zn) has an oxidant (Ni^{2+}) above it on the E^o table and are in separate half cells.

- identify the anode and cathode
- direction of electron flow
- direction of cation movement
- the theoretical voltage at standard conditions *0.51 volt*
- write the oxidation and reduction half equations and overall equation.

Ni^{2+}(aq) + 2e → Ni (s) ---- reduction

Zn(s) → Zn^{2+} (aq) + 2e---- oxidation

Ni^{2+}(aq) + Zn(s) → Ni(s) + Zn^{2+} (aq) ---- overall



$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	–0.25
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	–0.28
$Cd^{2+}(aq) + 2e^- \rightleftharpoons Cd(s)$	–0.40
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	–0.76