# 5.8 ACTIVITY: DESIGNER CELLS

**(Pages 401–402)**

## Observations

Maximum Cell Potentials of Galvanic Cells

| Combination of metals | Cell potential or voltage (V) |
|---|---|
| Zn/Cu | 0.78 |
| Zn/Fe | 0.26 |
| Mg/Zn | 0.65 |
| Fe/Cu | 0.47 |
| Mg/Cu | 1.52 |
| Mg/Fe | 1.00 |

Step 8. The cell with the largest cell potential (voltage) was Mg/Cu. This cell made the buzzer buzz.
Step 9. The buzzer buzzed much more loudly with the alkaline cell than with the Mg/Cu cell.

## Analysis

(a) (i) Magnesium was most often the anode, while copper was most often the cathode.
(ii) The magnesium/copper cell had the largest cell potential, $E_{cell} = 1.52$ V.
(iii) The metals that resulted in the largest cell potential, magnesium and copper, are farther apart on the activity series than any other pair of metals used in this experiment.

(b) Magnesium/copper cell:

anode: $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2\ e^-$
cathode: $Cu^{2+}_{(aq)} + 2\ e^- \rightarrow Cu_{(s)}$
overall: $Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Cu_{(s)} + Mg^{2+}_{(aq)}$

Zinc/copper cell:

anode: $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2\ e^-$
cathode: $Cu^{2+}_{(aq)} + 2\ e^- \rightarrow Cu_{(s)}$
overall: $Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Cu_{(s)} + Zn^{2+}_{(aq)}$

Iron/copper cell:

anode: $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2\ e^-$
cathode: $Cu^{2+}_{(aq)} + 2\ e^- \rightarrow Cu_{(s)}$
overall: $Fe_{(s)} + Cu^{2+}_{(aq)} \rightarrow Cu_{(s)} + Fe^{2+}_{(aq)}$

Magnesium/iron cell:

anode: $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2\ e^-$
cathode: $Fe^{2+}_{(aq)} + 2\ e^- \rightarrow Fe_{(s)}$
overall: $Mg_{(s)} + Fe^{2+}_{(aq)} \rightarrow Fe_{(s)} + Mg^{2+}_{(aq)}$

Zinc/iron cell:

anode: $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2\ e^-$
cathode: $Fe^{2+}_{(aq)} + 2\ e^- \rightarrow Fe_{(s)}$
overall: $Zn_{(s)} + Fe^{2+}_{(aq)} \rightarrow Zn_{(s)} + Fe^{2+}_{(aq)}$

Magnesium/zinc cell:

anode: $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2\ e^-$
cathode: $Zn^{2+}_{(aq)} + 2\ e^- \rightarrow Zn_{(s)}$
overall: $Mg_{(s)} + Zn^{2+}_{(aq)} \rightarrow Zn_{(s)} + Mg^{2+}_{(aq)}$

(c) Criteria might include power output, voltage, portability, rechargeability, safety, environmental impact, cost, and efficiency.

(d) The most successful laboratory cell was the magnesium/copper cell, so we will compare this cell with the alkaline dry cell.

| Criteria | Mg/Cu cell | Alkaline dry cell |
|---|---|---|
| cell potential (voltage) | 1.52 V | 1.6 V |
| power output | unable to light an LED<br>faint sound produced with buzzer | lit an LED<br>louder sound produced with buzzer than Mg/Cu cell |
| portability | cumbersome<br>chemicals need to be sealed | designed to be portable<br>little chance of chemicals leaking |
| rechargeability | needs to be tested to see if it is rechargeable | not rechargeable (however, other types of dry cells are rechargeable) |

Students may include more of their own criteria in the table.

### Synthesis

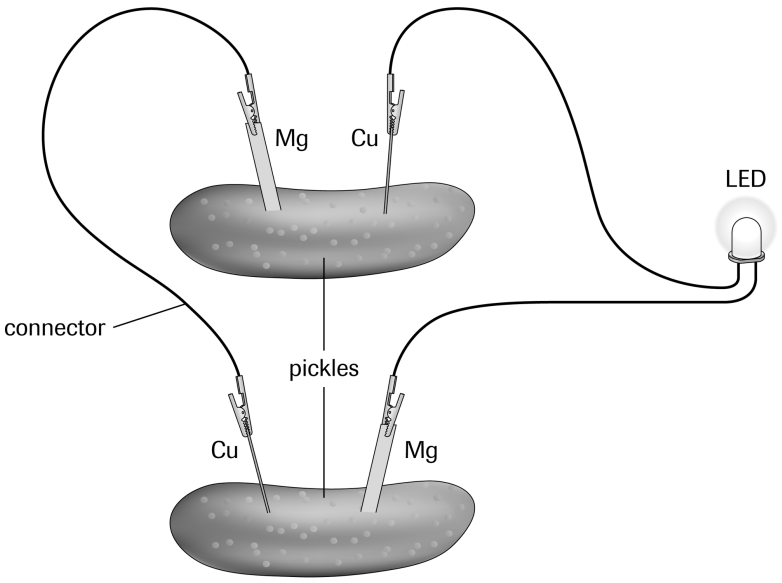
(e) The cells, ordered from smallest to largest predicted cell potentials, are:
Mg/Pb, Mg/Cu, Mg/Ag. This prediction is based on the relative position of the metals. Mg and Pb are closest together on the activity series while Mg and Ag are the farthest apart.

## 5.9 CONSUMER CELLS AND BATTERIES

### TRY THIS ACTIVITY: PICKLE POWER

**(Page 407)**

(a)




(b) Connecting the cells in series results in an overall battery potential that was the sum of the individual cell potentials.
(c) 12 V
(d) A cordless phone may contain three 1.2-V Ni–Cd batteries connected in series, for a total cell potential of 3.6 V. A typical portable CD player requires two 1.5-V alkaline dry cells in series, for a total cell potential of 3.0 V.