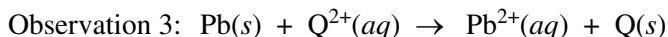
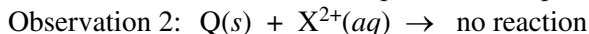
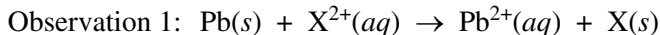


2012 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS

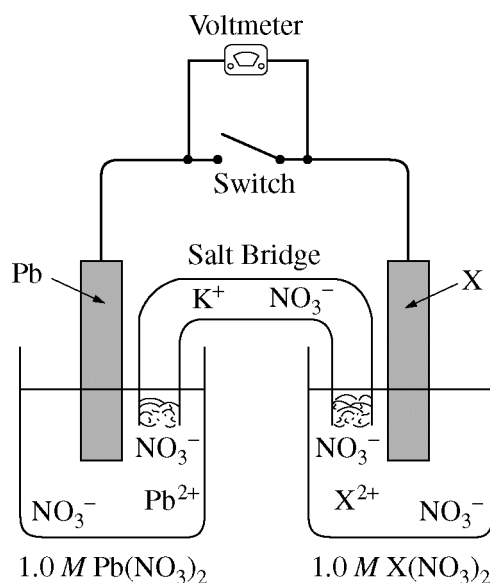
6. In a laboratory experiment, Pb and an unknown metal Q were immersed in solutions containing aqueous ions of unknown metals Q and X. The following reactions summarize the observations.



- (a) On the basis of the reactions indicated above, arrange the three metals, Pb, Q, and X, in order from least reactive to most reactive on the lines provided below.

\_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_  
least reactive metal                      most reactive metal

The diagram below shows an electrochemical cell that is constructed with a Pb electrode immersed in 100. mL of 1.0 M  $\text{Pb}(\text{NO}_3)_2(aq)$  and an electrode made of metal X immersed in 100. mL of 1.0 M  $\text{X}(\text{NO}_3)_2(aq)$ . A salt bridge containing saturated aqueous  $\text{KNO}_3$  connects the anode compartment to the cathode compartment. The electrodes are connected to an external circuit containing a switch, which is open. When a voltmeter is connected to the circuit as shown, the reading on the voltmeter is 0.47 V. When the switch is closed, electrons flow through the switch from the Pb electrode toward the X electrode.



- Write the equation for the half-reaction that occurs at the anode.
- The value of the standard potential for the cell,  $E^\circ$ , is 0.47 V.
  - Determine the standard reduction potential for the half-reaction that occurs at the cathode.
  - Determine the identity of metal X.
- Describe what happens to the mass of each electrode as the cell operates.