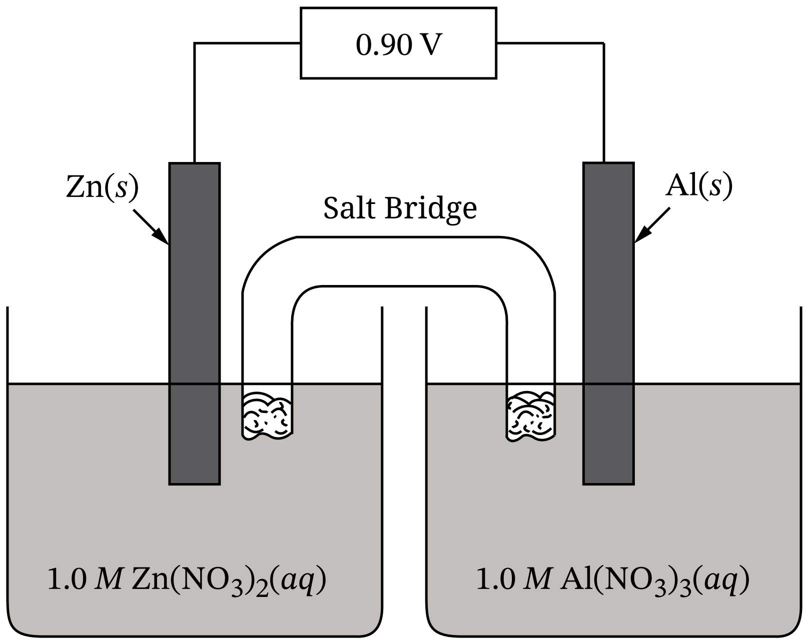
6. A scientist constructs a galvanic cell as shown in the diagram. As the cell operates, the $Zn(s)$ electrode increases in mass and the $Al(s)$ electrode decreases in mass. A data table with the standard reduction potentials for the substances follows the diagram.



Half-Reaction	$E°$ (V)
$Zn^{2+}(aq) + 2\,e^- \rightarrow Zn(s)$	−0.76
$Al^{3+}(aq) + 3\,e^- \rightarrow Al(s)$	−1.66

A. Write the half-reaction for the oxidation that occurs at the anode.

B. Write the balanced net ionic equation for the overall reaction that occurs in the galvanic cell.

C. Initially, each electrode has a mass of 50.0 g. The cell is allowed to run for a period of time and is then stopped. Which electrode's mass changed the most? Justify your answer with a calculation.

Reduction Half-Reaction	$E°$ (V)
$Au^{3+}(aq) + 3\,e^- \rightarrow Au(s)$	+1.50
$Zn^{2+}(aq) + 2\,e^- \rightarrow Zn(s)$	−0.76
$Mn^{2+}(aq) + 2\,e^- \rightarrow Mn(s)$	−1.19
$Al^{3+}(aq) + 3\,e^- \rightarrow Al(s)$	−1.66
$Be^{2+}(aq) + 2\,e^- \rightarrow Be(s)$	−1.85

D. The standard Zn/Al cell has a value of E°_{cell} equal to 0.90 V. The scientist needs a galvanic cell that produces a greater voltage. The scientist has access to the chemical systems in the table. If the scientist uses the Zn half-cell and one of the other options from the table, what is the MAXIMUM voltage that could be generated at standard conditions?

Question 6: Short Answer — 4 points

A	For the correct equation (state symbols not required): $Al(s) \rightarrow Al^{3+}(aq) + 3\,e^-$	**Point 01**
B	For the correct balanced net ionic equation (state symbols not required): $2\,Al(s) + 3\,Zn^{2+}(aq) \rightarrow 2\,Al^{3+}(aq) + 3\,Zn(s)$	**Point 02**
C	For the correct answer and a valid justification that correctly compares the masses of Al and Zn based on their molar masses and the stoichiometry of the balanced equation. Examples of acceptable responses may include the following: • Zn *experiences a greater change in mass. Assuming the entire* Al *anode reacts:* $50.0\text{ g Al} \times \frac{1\text{ mol Al}}{26.98\text{ g Al}} \times \frac{3\text{ mol Zn}}{2\text{ mol Al}} \times \frac{65.38\text{ g Zn}}{1\text{ mol Zn}} = 182\text{ g Zn}$ • Zn *experiences a greater change in mass.* $1\text{ mol}_{rxn} \times \frac{3\text{ mol Zn}}{1\text{ mol}_{rxn}} \times \frac{65.38\text{ g Zn}}{1\text{ mol Zn}} = 196.1\text{ g Zn}$ $1\text{ mol}_{rxn} \times \frac{2\text{ mol Al}}{1\text{ mol}_{rxn}} \times \frac{26.98\text{ g Al}}{1\text{ mol Al}} = 53.96\text{ g Al}$ *Thus, for however many moles of reaction that proceed, the mass of* Zn *produced will be greater than the mass of* Al *consumed.* • Zn *experiences a greater change in mass. As the reaction proceeds, three moles of* Zn *are used for every two moles of* Al. *Thus, for every* 196 g *of* Zn *that are produced,* 54 g *of* Al *are consumed.*	**Point 03**
D	For the correct calculated value. Examples of acceptable responses may include the following: • $E^\circ_{cell} = 1.50\text{ V} + 0.76\text{ V} = 2.26\text{ V}$ • $Au^{3+}(aq) + 3\,e^- \rightarrow Au(s) \quad +1.50\text{ V}$ $\underline{Zn(s) \rightarrow Zn^{2+}(aq) + 2\,e^- \quad +0.76\text{ V}}$ $E^\circ_{cell} = 2.26\text{ V}$	**Point 04**