Essential Question

How much metal can a current make?

What Is Electrolysis?

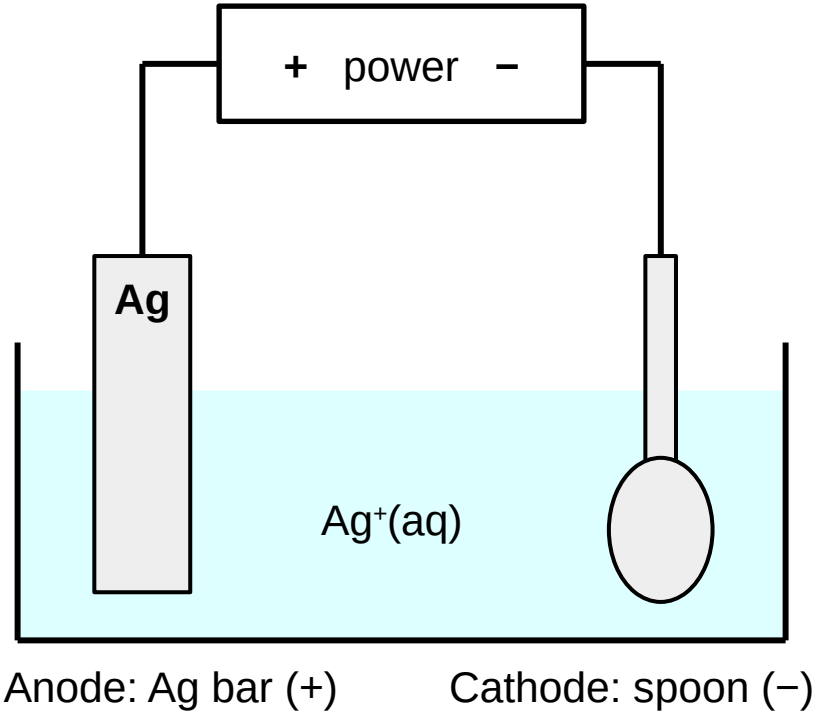
- Electrolysis: electrical energy drives a thermodynamically unfavored reaction
- An outside power source pushes the electrons

Galvanic cell
favored reaction
makes electricity
$E° > 0$

Electrolytic cell
electricity forces an
unfavored reaction
$E° < 0$

Electroplating

- The object being plated is the cathode
- $Ag^+ + e^- \rightarrow Ag$ coats the object



Current and Charge

- Current (*I*): charge that flows per second
- 1 A = 1 C/s

$$I = q / t$$

$$q = I \times t$$

q = charge in coulombs (C)

t = time in seconds (s)

The Faraday Constant

- *F* = charge on 1 mole of electrons
- Converts coulombs ↔ moles of e^-

$$1 \text{ mol } e^- = 96{,}485 \text{ C}$$

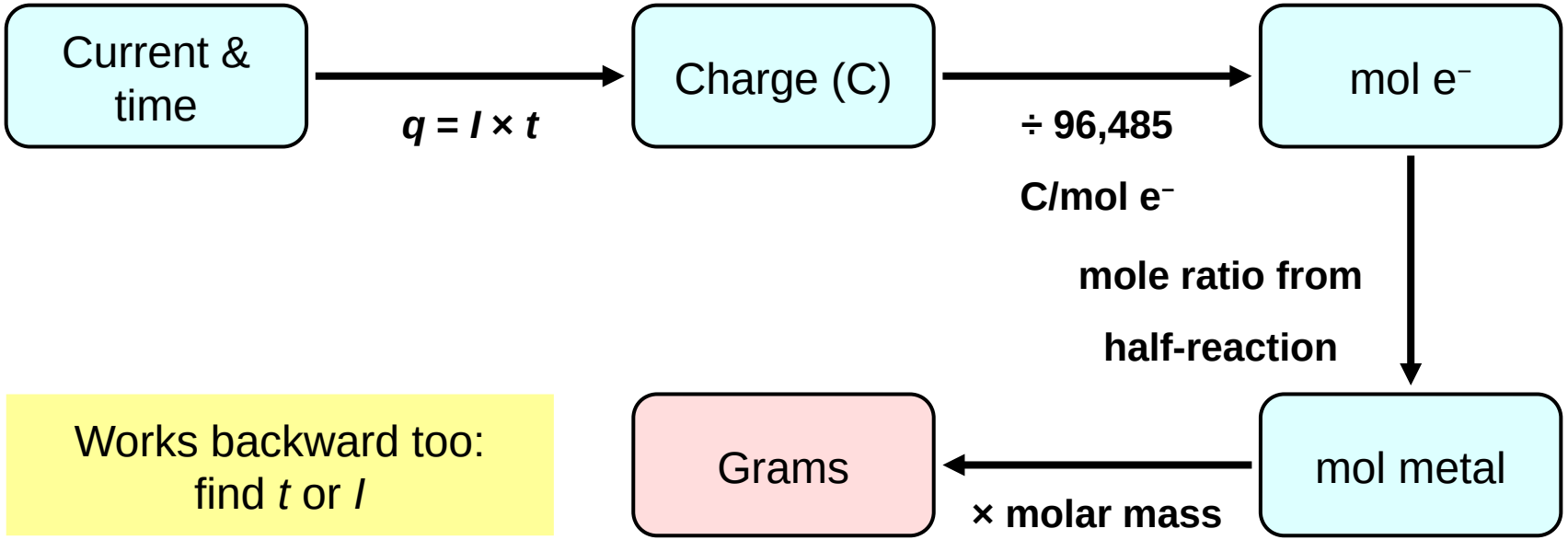
$$(1.60218 \times 10^{-19} \text{ C per } e^-) \times (6.02214 \times 10^{23} \ e^- \text{ per mol})$$

Ion Charge Sets the Electrons

- Ion charge = moles of e^- per mole of metal

Ion	Half-reaction	mol e^- per mol metal
Ag^+	$Ag^+ + e^- \rightarrow Ag$	1
Cu^{2+}	$Cu^{2+} + 2e^- \rightarrow Cu$	2
Al^{3+}	$Al^{3+} + 3e^- \rightarrow Al$	3

The Road Map



Works backward too:
find *t* or *I*

Example: Copper Plating

A current of 2.50 A passes through a $CuSO_4$ solution for 30.0 min. What mass of Cu is plated at the cathode?

I = 2.50 A

t = 30.0 min

Cu: 63.55 g/mol

Example: Time to Plate Silver

How long, in seconds, does it take to plate 2.00 g of Ag onto a spoon from a solution of Ag^+ using a current of 1.50 A?

m = 2.00 g Ag

I = 1.50 A

Ag: 107.87 g/mol

Example: Current to Make Aluminum

Aluminum is made by electrolysis of molten Al_2O_3, which contains Al^{3+}. What current is needed to produce 10.0 g of Al in 1.00 hour?

m = 10.0 g Al

t = 1.00 h

Al: 26.98 g/mol

Example: Finding the Ion Charge

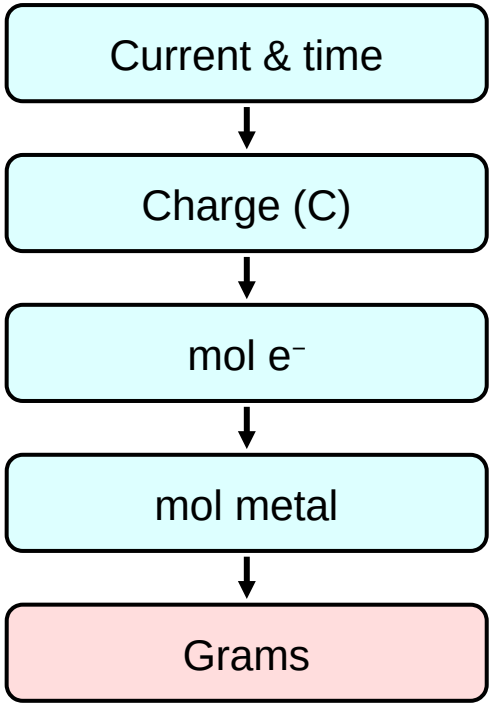
A current of 0.800 A flows for 45.0 min through a solution of an iron salt, and 0.625 g of Fe is deposited. What is the charge on the iron ion?

I = 0.800 A

t = 45.0 min

m = 0.625 g Fe

Fe: 55.85 g/mol

Big Ideas

- Electrolysis: electricity drives an unfavored reaction
- $I = q / t$, and 1 A = 1 C/s
- 1 mol e^- = 96,485 C
- Ion charge = mol e^- per mol metal