**TEACHER NOTES**

**DETERMINING AVOGADRO’S NUMBER WITH LABQUEST**

**LABQUEST 31**

***From Advanced Chemistry with Vernier***

1. Prepare 1.0 L of 1 M sulfuric acid solution by adding 56 mL of concentrate H2SO4 (GHS Signal Word :**DANGER**) solution to about 800 mL of distilled water and then adding distilled water to make a total volume of 1.0 Liter.
2. Provide a waste container into which the students will dispose of their used electrolyte solutions. Please follow good laboratory practices in disposing of the waste.
3. In 2011, we began selling anew device for electroplating and electrolysis experiments, the constant current system, which is a combination power supply/current probe. To use the Constant Current System with Logger Pro (versions 3.8.5 or newer), your students should use the default settings rather than a specific experiment file. Graphical Analysis 4, all versions supports the Constant Current System. On LabQuest, LabQuest App version 1.5.2 or newer is required.
4. For use with the Current Probe and a power supply, the best type of connecting wire will have a banana plug at one end and an alligator clip at the other end. Connecting wires with alligator clips at both ends also work well. No additional connecting wires are needed if you are using the Constant Current System.
5. The Constant Current System does not have an on/off switch. Thus, when connected to its power supply, the device is “on” and a small amount of current is flowing through it. Note that the student procedure instructs the user to turn the control dial to a minimum setting before connecting the Constant Current System to power.
6. For additional information about the Vernier Probeware used in this experiment, including tips and product specifications, visit www. Vernier.com/start/go-direct for information about how to connect your sensor.

**HAZARD ALERTS**

 The chemical safety signal words used in this experiment (DANGER, WARNING, AND N/A) are part of the Globally Harmonized System of Classification and labeling of Chemicals (GHS).

Refer to the Safety Data Sheet (SDS) that came with the chemical for proper handling, storage, and disposal information. These can also be found online from the manufacturer. See Appendix C for more information.

Copper, Cu, solid: This chemical is considered nonhazardous according to GHS classifications. Treat all laboratory chemicals with caution. Prudent laboratory practices should be observed.

Sulfuric acid, 1M and concentrated H2SO4: **DANGER**: Causes severe skin burns and eye damage. Do not breathe mist, vapors or spray. Maybe harmful if inhaled. Harmful to aquatic life. Considerable heat generated when diluted with water. Industrial exposure to vapors and mists is listed as a known human carcinogen by International Agency for Research on Cancer. (IARC).

Zinc, solid, Zn: This chemical is considered nonhazardous according to GHS classifications. Treat all laboratory chemicals with caution. Prudent laboratory practices should be observed.

**ANSWERS TO THE DATA ANALYSIS QUESTIONS**

1. Answers will vary. For the sample data, the total charge that passed through the electrolytic cell was 84.2 C. The calculation is:

Total charge (C) = (Average Current) x (Time of current application)

C = 0.468 A x 180 s = 84.2 C

**Note:** The total charge can also be determined by calculating the integral of the graph of current *vs.* time. The first integral is the area under the curve, current x time, which is the definition of a coulomb (C). The Sample Data graph shows an example of how the graph would appear in Logger *Pro*, the integral can also be calculated in Graphical Analysis 4 or LabQuest App).

1. Answers will vary. For the sample data, 5.26 x 1020 electrons passed in the electrolysis. The calculation is:

Electrons = 84.2 C ÷ 1.602 x 10-19C/electron = 5.26 x 1020 electrons

1. Answers will vary. For the sample data, the number of copper atoms lost from the anode was 2.63 x 1020 because there are two electrons per copper atom in this electrolysis.
2. Answers will vary. For the sample data, the number of copper atoms per g of copper was 9.74 x 1020 , determined as

Cu atoms/g = 2.63 x 1020 ÷0.027 g=9.74 x 1021 Cu atoms/g

1. Answers will vary. For the sample data, the number of atoms of Cu in one mole, or Avogadro’s number, was 6.19 x 1023. The calculation is:

Avogadro’s number =9.74 x 1021 Cu atoms/g x 63.54 g/mol = 6.19 x 1023  atoms/mol

**SAMPLE DATA**

|  |  |
| --- | --- |
|  | Trial 1 |
| Initial mass of copper electrode (g) | 5.100 |
| Final mass of copper electrode (g) | 5.073 |
| Average current (A) | 0.468 |
| Time of current application (s) | 180 |

