Once Upon a Curriculum: The Greening of General Chemistry at Arizona Western College

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44 acres
4.6MW solar
Springerville, AZ
Presentation Outline

- Solar H₂-O₂ Fuel Cell
- Measuring Solar Intensity
- In vivo Photosynthesis

6CO₂ + 6H₂O + hv \rightarrow C₆H₁₂O₆ + 6O₂
Which swatch best represents the color green?
Based on current consumption rates, global electricity demand is projected to increase at least 160% by 2050.

Average Daily Total Solar Radiation

Source: U.S. Dept. of Energy

Units: kWh/m²/day

Source: U.S. Dept. of Energy
$350 - 400 per kit

www.hi-tech.com
Electrolyzer: $2H_2O \rightarrow 2H_2 + O_2$

Fuel Cell: $2H_2 + O_2 \rightarrow 2H_2O$

Solar panel, 45° fixed angle

Multimeter, Voltage (V)

Decade resistor

Multimeter, Amperage (mA)
Solar Panel Efficiency, \( n \)

\[
n = \frac{\text{Power Out}^*}{\text{Power In}^*}
\]

*: W\( \cdot \)m\(^{-2} \)
Solar Panel Efficiency Lab Setup

75W light

Solar Fuel Cell

>30cm distance

pyranometer, W/m²
Maximum Power Point Curve
For Solar Cell At Each Distance

Current, I

Voltage, V

P = V \cdot I

Short circuit amperage
R = 0, V = 0

Open circuit voltage
R = \infty, I = 0

Area = 40cm^2
Panel Efficiency vs. Light Intensity

Light intensity, W m$^{-2}$

9am/5pm                   noon                   10am/3pm

η, %
Other Solar Fuel Cell Labs

- Efficiency of Electrolyzer and Fuel Cell
- Electrochemical Characteristics of Electrolyzer and Fuel Cell
- Kinetics of $\text{H}_2$ and $\text{O}_2$ Production
Based on the data, how much H₂ can be produced annually by a 40 acre photovoltaic station?

How many gallons of gasoline is this amount of H₂ equivalent to?
Measuring the Solar Constant

Plate colors: black, silver

pyranometer, $450

Intensity = \frac{\text{Power}}{\text{Area}} = \frac{mC(\Delta T/\Delta t)}{\text{Area}}

m = 86g
Area = 0.038m^2

\text{Ambient temp.} = \$150

= \text{slope tangent to the curve, } \Delta T/\Delta t
6\text{CO}_2 + 6\text{H}_2\text{O} + h\nu \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \text{ is the most famous redox reaction in nature. Why is it not taught in chemistry courses?}
A = 75W halogen light
B = leaf chamber
C = drying column
D = light sensor
E = gas lines
F = CO$_2$ analyzer
G = data acquisition
H = gas flow meter
I = gas pump

*Air bag & light dimmer not shown

Qubit Systems
$3,600
With or without colored filter

Leaf chamber

Light sensor, \( \text{\textmu mole quanta m}^2\text{s}^{-1} \)

*Gas entry & exit tubing not visible
Photosynthesis is **red** and **blue** wavelength dependent.

*: Red filter removes **blue** wavelengths.
Photosynthesis depends on light intensity.
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