

1. (i) How many moles of copper atoms are in a copper penny, which has a mass $\simeq 3.1$ g? (ii) How many copper atoms are in the penny? (iii) What is the mass in grams of 10^{12} (a trillion) gold atoms? (iv) How many moles of carbon atoms and oxygen atoms are in 0.25 mol of CO_2 (or carbon dioxide)? (v) If 5×10^9 bbl oil are burn in the U.S./yr, and each barrel has a mass of about 300 lb, how many pounds of matter disappear/yr due to oil consumption in the U.S.?

2. Feynman pointed out that if two persons stood at arm's length from each other and each person had 1% more electrons than protons, the force of repulsion between the two people would be enough to lift a "weight" equal to that of the entire Earth. Carry out an order-of-magnitude calculation to substantiate this assertion.

3. If 1 gram of carbon extracted from the soot on a cave wall is 40% as radioactive as 1 gram of carbon extracted from a living tree, estimate the age of the soot. Before proceeding you must convince yourself that $0.5^{1.3} = 0.4$.

4. The average solar energy falling on each square meter of a roof top is about 700 watts (= 0.7 kw). If a house has 10 m^2 of collector, how long would it take to bring 60 gallons of water (1 bathtub-full) to 150°F from an initial temperature of 50°F .

5. On the 21st August 2017, a giant shadow moving west to east temporarily removed a large amount of the photovoltaic resources from the U.S. This was the first total solar eclipse to darken the skies of the country in a generation, and forced utilities to draw up contingency plans for an electric grid increasingly powered by the Sun. The previous total solar eclipse crossed the U.S. in 1979, when president Jimmy Carter bemoaned an energy crisis and renewable technology was in its infancy. The state of California lost on average about 3,400 MW of output during the event, a big chunk of the 10,000 MW of solar power that currently provides one-tenth of the states electricity; see Fig. 1. At 12¢/kWh , what was the total electrical cost during the eclipse? Remember: $1 \text{ kw} = 1\text{kwh}/\text{hour} = 3410 \text{ Btu}/\text{hour}$, 1 gallon of $\text{H}_2\text{O} = 8 \text{ lb}$, and to heat 1 lb of H_2O 1°F takes 1 Btu.

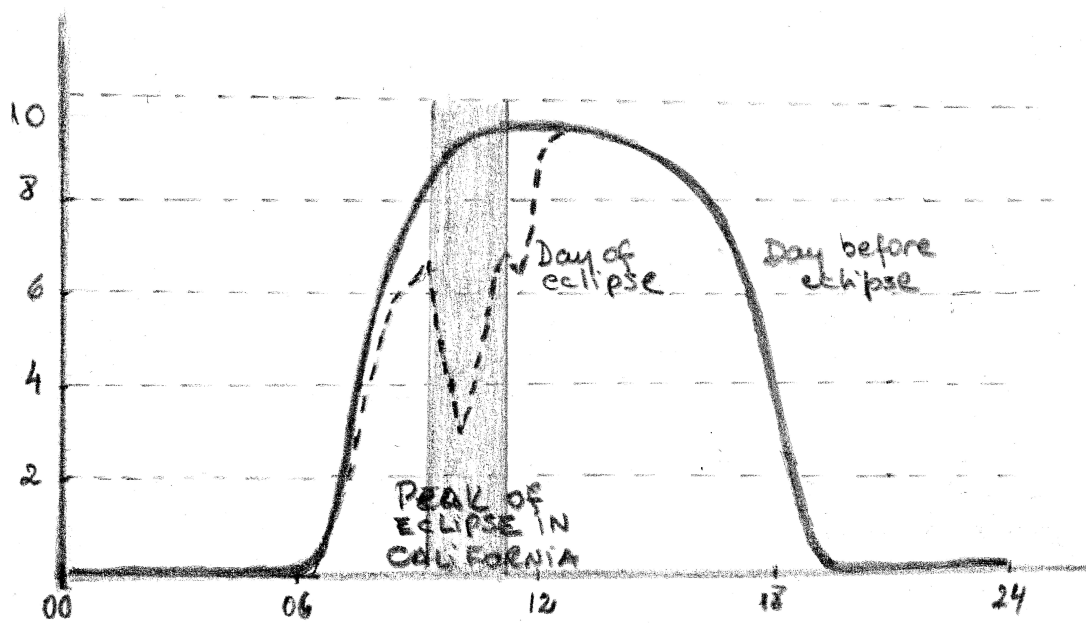


Figure 1: The California solar power output dropped during 21st August 2017 eclipse. The vertical axis shows the power in units of 1,000 MW and the horizontal axis indicates the Pacific daylight time.