

The JETS Challenge  
 Provided by Dave Meredith, Associate Professor,  
 Penn State University-Fayette

Challenge 52 – The Gigajoule Power Challenge

Problem:

*The great San Francisco earthquake occurred a century ago on April 18, 1906 and moved 430 km of fault line through about 6 meters of offset (horizontally). The sideways speed was about 1 m/s but the rupture propagated at 2.7 km/s (supersonic at over Mach 8) along the length of the fault line. Spectral amplitude ratios of the surface waves indicated a total moment release of about  $5 \times 10^{27}$  ergs of energy. A joule of energy is  $10^7$  ergs. A metric ton (1000 kg) of TNT is equal to about 4.184 gigajoules. By comparison the Hiroshima bomb dropped on Aug 6, 1945 to end World War II was rated as equivalent to 15 kilotons of TNT.*

**How many times greater than the Hiroshima bomb was the energy release of the San Francisco earthquake?**

Solution:

**Earthquake**

$$5 \times 10^{27} \text{ ergs}$$

$$5 \times 10^{27} \text{ ergs} \cdot \frac{1 \text{ joule}}{10^7 \text{ ergs}}$$

$$= 5 \times 10^{20} \text{ joules}$$

**Bomb**

15 kilotons of TNT

$$= 15,000 \text{ tons of TNT}$$

$$= 15,000 \times 4.184 \text{ gigajoules}$$

$$= 62,760 \text{ gigajoules} \cdot \frac{10^9}{1 \text{ gigajoule}}$$

$$= 6.2760 \times 10^{13} \text{ joules}$$

**Ratio**

$$\frac{\text{quake}}{\text{bomb}} = \frac{50 \times 10^{20}}{6.2760 \times 10^{13}}$$

$$= 7,966,857.87126 \text{ times} \quad \text{or} \quad \text{about 8 million times}$$