Energy is measured in a number of ways depending on what property is being represented.

**Total Energy - Joules and ergs** - The total amount of energy in various forms (kinetic, potential, magnetic, thermal, gravitational)

**Power - Watts, Joules/second or ergs/second** – the rate at which energy is produced or consumed in time. Power = Energy/Time

**Flux - Watts/meter$^2$, Joules/sec/meter$^2$ or ergs/sec/meter$^2$** – the rate with which energy flows through a given area in given amount of time: Flux=Power/Area

<table>
<thead>
<tr>
<th>Conversion</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Joule</td>
<td>10 million ergs</td>
</tr>
<tr>
<td>1 Watt</td>
<td>1 Joule/1 second</td>
</tr>
<tr>
<td>1 hour</td>
<td>3600 seconds</td>
</tr>
<tr>
<td>1 kilowatt</td>
<td>1,000 watts</td>
</tr>
<tr>
<td>1 megaJoule</td>
<td>1,000,000 Joules</td>
</tr>
<tr>
<td>3 feet</td>
<td>1.0 meters</td>
</tr>
</tbody>
</table>

Example: A 5-watt flashlight is left on for 1 hour: Convert its energy consumption of 5 watt-hours to Joules.

\[
\begin{align*}
1 \text{ Joule} & = 3,600 \text{ sec} \\
5 \text{ Watt-hours} \times \frac{1 \text{ Joule}}{1 \text{ sec}} \times \frac{3,600 \text{ sec}}{1 \text{ hour}} = 18,000 \text{ Joules}
\end{align*}
\]

Notice how the compound unit ‘watt’ is handled so that the appropriate colored units cancel. The canceling units are color-coded for convenience.

**Problem 1** – The flux of sunlight at Earth’s surface is 1300 Watts/meter$^2$. Convert this flux to ergs/sec/cm$^2$.

**Problem 2** – A 100-watt bulb shines light over a wall with a surface area of 25 meters$^2$. What is the flux of light energy in Joules/sec/meter$^2$?

**Problem 3** – The common energy unit for electricity is the watt-hour (Wh), which can be written as 1 watt x 1 hour. How many megajoules equal 1 kilowatt-hour (1 kWh)?

**Problem 4** – How many ergs of energy are collected from a solar panel on a roof, if the sunlight provides a flux of 300 Joules/sec/meter$^2$, the solar panels have an area of 27 square feet, and are operating for 8 hours during the day?

Space Math  
http://spacemath.gsfc.nasa.gov
Problem 1 –
Watts: 1300
10 million ergs: 1300
1 meter: \(\frac{1}{100}\)
1 meter: \(\frac{1}{100}\)

\[
\text{ergs/meter}^2 = 1300 \times \frac{1}{100} \times \frac{1}{100} = 1.3 \times 10^6 \text{ ergs/sec cm}^2
\]

Problem 2 –
1 Joule: 100 watts
1 joule: \(\frac{100}{1} \text{ watts}\)
25 meters: \(\frac{25}{1} \text{ meters}\)

\[
\text{Joules/sec meters}^2 = \frac{100}{1} \times \frac{25}{1} = 4.0 \text{ Joules/sec meters}^2
\]

Problem 3 –
1 Joule: 1 kilowatt-hour
1 joule: \(\frac{1}{1000} \text{ kilowatt-hour}\)
3,600 seconds: \(\frac{3600}{1} \text{ seconds}\)

\[
\text{Joules/sec} = \frac{1}{1000} \times \frac{3600}{1} = 3.6 \text{ Joules/sec}
\]

Problem 4 –
Area of roof: 27 feet\(^2\)
3 meters: \(\frac{3}{1} \text{ meters}\)

\[
\text{Flux} = \frac{\text{Power}}{\text{Area}} \Rightarrow \text{Power} = \text{Flux} \times \text{Area}:
\]

\[
\text{Joules/sec meter}^2 = \frac{300}{1} \times \frac{3}{1} = 900 \text{ Joules/sec}
\]

Energy: Power \times Time

\[
\text{Joules} = \frac{900}{1} \times \frac{3600}{1} \times 8 \text{ hours} = 25,920,000 \text{ Joules}
\]

\[
\text{10 million ergs} = \frac{25,920,000 \text{ Joules}}{1 \text{ Joule}} = 258.2 \text{ trillion ergs}
\]

Space Math
http://spacemath.gsfc.nasa.gov