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

1 Joule = 10 million ergs
1 Watt = 1 Joule/1 second
1 hour = 3600 seconds
1 kilowatt = 1,000 watts
1 megaJoule = 1,000,000 Joules
3 feet = 1.0 meters

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

$$5 \text{ Watt-hours} \times \frac{1 \text{ Joule}}{1 \text{ sec } 1 \text{ watt}} \times \frac{3{,}600 \text{ sec}}{1 \text{ hour}} = 18{,}000 \text{ Joules}$$

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?

Problem 1 –

Answer: $1300 \frac{\text{Watts}}{\text{meter}^2} \times \frac{10 \text{ million ergs}}{\text{sec Watt}} \times \frac{1 \text{ meter}}{100 \text{ cm}} \times \frac{1 \text{ meter}}{100 \text{ cm}} = \mathbf{1.3 \times 10^6 \ \frac{ergs}{sec\ cm^2}}$

Problem 2 –

Answer: $100 \text{ watts} \times \left(\frac{1 \text{ Joule}}{1 \text{ sec watt}}\right) \times \frac{1}{25 \text{ meters}^2} = \mathbf{4.0 \ \frac{Joules}{sec\ meters^2}}$

Problem 3 –

Answer: $1 \text{ kilowatt-hour} \times \frac{1 \text{ Joule}}{1 \text{ sec } 1 \text{ Watt}} = 1{,}000 \frac{\text{Joules}}{\text{sec}} \times 1 \text{ hour}$

$$1{,}000 \frac{\text{Joules}}{\text{sec}} \times 1 \text{ hour} \times \left(\frac{3{,}600 \text{ sec}}{1 \text{ hour}}\right)$$

$$1{,}000 \frac{\text{Joules}}{\text{sec}} \times 3{,}600 \text{ seconds}$$

$$3{,}600{,}000 \text{ Joules} \times \frac{1 \text{ megaJoule}}{1{,}000{,}000 \text{ Joules}} = \mathbf{3.6 \text{ megaJoules}}$$

Problem 4 -

Answer: Area of roof = $27 \text{ feet}^2 \times (1 \text{ meter}/ 3 \text{ feet}) \times (1 \text{ meter}/ 3 \text{ feet}) = 3 \text{ meter}^2$

Flux = Power/Area so Power = Flux x Area:

$$\text{Power} = 300 \frac{\text{Joules}}{\text{sec meter}^2} \times 3 \text{ meters}^2 = 900 \frac{\text{Joules}}{\text{sec}}$$

Energy = Power x Time

$$= 900 \frac{\text{Joules}}{\text{sec}} \times \left(\frac{3{,}600 \text{ sec}}{1 \text{ hour}}\right) \times 8 \text{ hours} = 25{,}920{,}000 \text{ Joules}$$

$$= 25{,}920{,}000 \text{ Joules} \times \left(\frac{10 \text{ million ergs}}{1 \text{ Joule}}\right) = \mathbf{258.2 \text{ trillion ergs}}$$