

Units for quantifying energy have evolved separately in so many areas that the one-ness of the concept is lost.

Such measures include BTU's, food calories (kcal), gallons of gasoline, & life power stream time (cf. <http://newton.umsl.edu/infophys/lsp.html>).

The relationship between these units is seldom noticed. For example, do you get more energy per dollar buying food, gasoline, or electricity?

Here is a table of various energy values in various units, including (to bring it home) "person days", defined here as 2100 Calories (kcal).

For extra credit, by next class fill in the blanks below AND answer the question about food, gas & electricity above.

| Various Energies   | Joules               | BTU                  | kcal                 | m&m's                | eV                   | pdays                | kwh                  | LPS time             |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Nuclear fuel in the Sun  | 1.00E+45             | 9.49E+41             | 2.39E+41             | 4.80E+40             | 6.25E+63             | 1.14E+38             | 2.78E+38             | 3.2E+22 yr           |
| Energy release in a supernova  | 1.00E+44             | 9.49E+40             | 2.39E+40             | 4.80E+39             | 6.25E+62             | 1.14E+37             | 2.78E+37             | 3.2E+21 yr           |
| Yearly solar energy incident on earth                                | 5.00E+24             | 4.74E+21             | 1.19E+21             | 2.40E+20             | 3.13E+43             | 5.69E+17             | 1.39E+18             | 150 yr               |
| Fossil fuel available on earth                                       | 2.00E+23             | 1.90E+20             | 4.78E+19             | 9.60E+18             | 1.25E+42             | 2.28E+16             | 5.56E+16             | 6 yr                 |
| Mutual recombination of one kg each of matter and antimatter         | 9.00E+16             | 8.54E+13             | 2.15E+13             | 4.30E+12             | 5.63E+35             | 1.02E+10             | 2.50E+10             | 90 sec               |
| Energy thermalized in a 1 megaton explosion                          | 4.00E+15             | 3.80E+12             | 9.56E+11             | 1.90E+11             | 2.50E+34             | 4.55E+08             | 1.11E+09             | 4 sec                |
| Gravitational potential energy of Boeing 747 at 9 km                 | 2.00E+10             | 1.90E+07             | 4.78E+06             | 960000               | 1.25E+29             | 2275                 | 5556                 | 20 μsec              |
| Kinetic energy of a Boeing 747 at 600 mph                            | 8.00E+09             | 7.59E+06             | 1.91E+06             | 384000               | 5.00E+28             | 910                  | 2222                 | 8 μsec               |
| Energy depth of the solar system gravitational well for an earthling | 8.00E+09             | 7.59E+06             | 1.91E+06             | 384000               | 5.00E+28             | 910                  | 2222                 | 8 μsec               |
| Energy depth of the earth's gravitational well for an earthling      | 4.00E+09             | 3.80E+06             | 9.56E+05             | 192000               | 2.50E+28             | 455                  | 1111                 | 4 μsec               |
| Energy per mile used by a Boeing 747 jet                             | 1.00E+09             | 9.49E+05             | 2.39E+05             | 48000                | 6.25E+27             | 114                  | 278                  | 1 μsec               |
| Energy expenditure of the US, per person per day                     | 1.00E+09             | 9.49E+05             | 2.39E+05             | <input type="text"/> | 6.25E+27             | 114                  | 278                  | 1 μsec               |
| Energy to power a lightning flash                                    | 1.00E+09             | 9.49E+05             | 2.39E+05             | 48000                | 6.25E+27             | 114                  | 278                  | 1 μsec               |
| Combustion energy of a gallon of gasoline                            | 1.00E+08             | 9.49E+04             | 2.39E+04             | 4800                 | 6.25E+26             | 11                   | 28                   | 100 nsec             |
| Daily solar energy thermalized (lost) per square meter on earth      | 9.00E+07             | 8.54E+04             | 2.15E+04             | 4320                 | 5.63E+26             | 10                   | 25                   | 90 nsec              |
| Daily food energy <i>needed</i> by a person (e.g. 2100 kcal)         | 8750000              | 8302                 | 2090                 | 420                  | 5.47E+25             | 1.00                 | 2.43                 | 8.75 nsec            |
| Energy thermalized by a 100 watt bulb in 1 day                       | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |
| Explosion of a kg of TNT   | 5000000              | 4744                 | 1194                 | 240                  | 3.13E+25             | 0.57                 | 1.39                 | 5 nsec               |
| Energy per mile used by a 22 mpg car                                 | 5000000              | 4744                 | 1194                 | 240                  | 3.13E+25             | 0.57                 | 1.39                 | 5 nsec               |
| Maximum work energy output of a human in 1 hour                      | 700000               | 664                  | 167                  | 33.6                 | 4.38E+24             | 0.08                 | 0.19                 | 0.7 nsec             |
| Food energy of one apple (e.g. 120 kcal)                             | 500000               | 474                  | 119                  | 24                   | 3.13E+24             | 0.06                 | 0.14                 | 0.5 nsec             |
| Energy per mile used by a fast walking person                        | 200000               | 190                  | 48                   | 9.6                  | 1.25E+24             | 0.023                | 0.056                | 0.2 nsec             |
| Solar energy "captured" daily by plants per square meter on earth    | 90000                | 85                   | <input type="text"/> | 4.32                 | 5.63E+23             | 0.010                | 0.025                | 90 psec              |
| Work done by mower on lawn (¼ hp for 30 minutes)                     | 40000                | 38                   | 9.56                 | 1.92                 | 2.50E+23             | 0.005                | 0.011                | 40 psec              |
| Minimal work (gravitational) to lift a piano up one story            | 20000                | 19                   | 4.78                 | 0.96                 | 1.25E+23             | 0.002                | 0.006                | 20 psec              |
| Kinetic energy of a running person                                   | 4000                 | 3.80                 | 0.96                 | 0.192                | 2.50E+22             | 4.55E-04             | 1.11E-03             | 4 psec               |
| Kinetic energy of a 0.357 magnum bullet                              | 1000                 | 0.95                 | 0.24                 | 0.048                | 6.25E+21             | 1.14E-04             | 2.78E-04             | 1 psec               |
| Rotational kinetic energy of skater's crossed-arm spin on ice        | 500                  | 0.47                 | 0.12                 | 0.024                | 3.13E+21             | 5.69E-05             | 1.39E-04             | 0.5 psec             |
| Work energy needed for a push-up                                     | <input type="text"/> | 0.285                | 0.072                | 0.0144               | 1.88E+21             | 3.429E-05            | 8.37E-05             | 0.3 psec             |
| Wave energy of opera singer's B-flat Adagio (88 bpm) whole note      | 10                   | 0.0095               | 0.0024               | 0.00048              | 6.25E+19             | 1.14E-06             | 2.78E-06             | 10 fsec              |
| Energy released on fission of a uranium nucleus                      | 3.00E-11             | 2.85E-14             | 7.17E-15             | 1.40E-15             | 1.88E+08             | 3.41E-18             | 8.33E-18             | 3E-26 sec            |
| Energy released in electron-positron pair annihilation               | 1.60E-13             | 1.52E-16             | 3.82E-17             | 7.80E-18             | 1022000              | 1.82E-20             | 4.44E-20             | 1.6E-28 sec          |
| Energy to ionize a hydrogen atom                                     | 2.20E-18             | 2.09E-21             | 5.26E-22             | 1.00E-22             | <input type="text"/> | 2.50E-25             | 6.11E-25             | 2.2E-33 sec          |
| Energy of a typical photon (light particle) from the sun             | 3.20E-19             | 3.04E-22             | 7.64E-23             | 1.50E-23             | 2                    | 3.64E-26             | 8.89E-26             | 3.2E-34 sec          |
| Minimum work needed per bit of correlation information at 72°F       | 2.80E-21             | 2.66E-24             | 6.69E-25             | 1.30E-25             | 0.0175               | 3.19E-28             | 7.78E-28             | 2.8E-36 sec          |