Useful Information
Physics 1150

General Conversions and Constants:

1000 m = 1 km = 0.62mi 1mile = 1609m 1inch = 2.54cm 1 Newton (N) = 0.22 pounds = 1 $\frac{kg \cdot m/sec}{sec}$

1 Hz = 1 cycle/sec 1in = 2.54cm liter = 1000 cm^3 area of a sphere = $4\pi r^2$ area of a circle = πr^2

1 atom mass unit (u) = $1.67X10^{-27}$kg 42 gallons = 1 barrel of oil 1 m^3 = 264.2 gallons

kilo(k) = 10^3 mega(M) = 10^6 giga(G) = 10^9 tera(T) = 10^{12} exa(E) = 10^{18}

centi = 10^{-2} milli(m) = 10^{-3} micro(μ) = 10^{-6} nano(n) = 10^{-9} pico(p) = 10^{-12}

Energy and Power Units: g = 10 N/kg c = $3X10^8$ m/sec mass m^3 of water = 1000kg

Unit	Definition	Joules
Joule	energy gained if 1 newton acts over 1 meter	1.0
calorie	energy needed to raise 1 gram of 1 water 1 °C	4.18
Calorie	Dietary calorie – 1000 calories	4180
BTU	British Thermal Unit - energy needed to raise 1 lb of water 1 °F	1055
Quad	1 Quadrillion (10^{15}) BTU	$1.055 X 10^{18}$
Therm	100,000 BTU	10^8
kWhr	Kilowatt-hour – energy from 1000 watts of power over 1 hours	$3.6 X 10^6$
BOE	Barrel of Oil Equivalent – amount of energy in a barrel of oil	$6.1 X 10^9$
Megaton	Energy form explosion of million tons of TNT	$4.18 X 10^{15}$
eV	Electron-Volt – energy of 1 electron after passing through a potential of 1 volt	$1.6 X 10^{-19}$

Unit	Definition	Watts
Watts	Power of 1 joule per second	1.0
HP	Horsepower – power from the average horse	745.7

Mechanics:

Work / Power: $W = (F_{parallel})\Delta x = \Delta KE$

$P = \frac{\Delta E}{\Delta t}$ $Weight = mg$

Kinetic /Potential Energy:

$KE = \frac{1}{2}mv^2$ $GPE = mgh$

Energy / Conservation of Energy:

$E = KE + GPE$ $E_{final} = E_{initial}$

Energy Content		
Material	**MJ/kg**	**Other**
Natural Gas	55	30 kWh/$100ft^3$
Coal	29	$37 X 10^9$ J/m^3
Oil	43	138 kBtu/gal
Gasoline	44	$1.3 X 10^8$ J/gal
Hydrogen	142	320 Btu /ft^3
8% Enriched U	7,090,000	1,980 GWh/tonne

Wind:

$Power = area*(\frac{1}{2}\rho v^3)$

Hydro:

$Power = (Flow\ rate)*\rho*g*h$

Temperature, Heat & Thermodynamics:

Temperature Conversion: $T(K) = T(°C) + 273$

$T(°F) = T(°C)*9/5 + 32°$ $T(°C) = (T(°F) - 32°)*5/9$

CO2 Emissions	
Material	**kg/GJ**
Natural Gas	50
Coal	90
Oil	50
Gasoline	70

(units and constants are in straight text, *variables are in italics*) ("Δ" means "change in…", "Σ" means "add all the ….up")

Heat via Radiation:

$\sigma = 5.67\times10^{-8}$ W/m^2/K^4 $P_{rad} = \varepsilon_o * \sigma * T^4 * area$ $v = \lambda * f = \lambda / Period$ $\lambda_{max} = \frac{2.9\text{mm K}}{T}$

Intensity = $\frac{Power}{Area}$ $I_{above} = S = 1364$ W/m^2 $S_{eff} / 4 = \varepsilon_o * \sigma * T^4$

$I_{Chicago} = 160$ W/m^2 $I_{Tucson} = 240$ W/m^2

Insulation Value (k)	
Material	**W/m C**
Copper	401
Stainless Steel	14
Glass	1.0
Concrete	0.8
Pine (wood)	0.11
Sheet Rock	0.10
Fiberglass Insul	0.048
Dry Air	0.026
Foam Insulation	0.024

Heat via Conduction for single layer:

$$Power = k * \frac{area * (T_H - T_C)}{thickness} \qquad R = \sum \frac{thickness}{k}$$

$$Efficiency = \varepsilon = \frac{what\ you\ want\ out}{what\ you\ put\ in} = \frac{W}{Q_H} \le \frac{T_H - T_c}{T_H} = 1 - \frac{T_C}{T_H}$$

$$COP(air\ conditioner) = \frac{Q_C}{W} \le \frac{T_C}{T_H - T_C}$$

$$COP(heat\ pump) = \frac{Q_H}{W} \le \frac{T_H}{T_H - T_C}$$

$Q_{net} = \Delta E_{int} + W$ $Q = mc\Delta T$ $Q = mL$

Specific Heat (c)	
Material	**J/kg C**
Aluminum	901
Stainless Steel	502
Glass	753
Concrete	880
Liquid Water	4184
Ice	2050

Electricity:

1 Ampere (A) = 1 Coulomb/sec e = 1.6 X 10^{-19} Coulomb
1 Watt (W) = 1 Volt (V) * 1 Ampere (A)

$V = IR$ $P = VI$ $P_{lost} = I^2R$

Transformers:

$V_{prim} I_{prim} = V_{sec} I_{sec}$ $I_{prim} N_{prim} = I_{sec} N_{sec}$ $\frac{V_{prim}}{N_{prim}} = \frac{V_{sec}}{N_{sec}}$

Latent Heat of Water (L) kJ/kg	
Evaporation	2257
Fusion	333

Nuclear physics and Radiation:

Unit	Definition
Bequerel (Bq)	Number of decays per second – 1 decay per second
Curie (Ci)	Number of decays from 1 gram of radium – 3.7X10^{10} Bq
Gray (Gy)	Energy absorbed by matter - 1 Joule of energy absorbed per kilogram
Rad	0.01 Gray
Roentgen (R)	Radiation which ionizes 2.58X10^{-4} C per kg of air (~0.877Rad)
Sivert (Sv)	Effect of radiation on a human – Q*Gy
Roentgen equivalent man (REM)	Effect of radiation on a human – Q*Rad (0.01 Sv)

$E = mc^2$ ${}^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}X + \alpha$ ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}X + \beta^-$ 100mSv gives ~ 1/100 increase in cancer

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