P125 Energy in the 21st Century

EQUATIONS AND CONVERSION FACTORS

2nd Law

\[ F_{\text{net}} = ma \]

Work

\[ W = Fd \]

Power

\[ P = \frac{W}{t} \]

Mech Energy

\[ KE = \frac{1}{2}mv^2 \]

\[ PE = mgh \]

\[ ME = KE + PE = constant \]

ME + Th E

\[ E_{\text{total}} = KE + PE + ThE = constant \]

Ohm's Law

\[ V = IR \]

Electric Power

\[ P = VI \]

Power Losses

\[ P = \frac{V^2}{R} = \frac{V^2}{R} \]

Doubling Time

\[ t_{\text{doubling}} = \frac{\ln(2)}{\ln(1 + \text{growth rate})} \]

Growth Factor

\[ F(t) = F(0)(1 + \text{growth rate})^t \]

\[ e = \text{Useful Energy Out} / \text{Total Energy In} \]

\[ e = \frac{F_{\text{useful}}}{F_{\text{total}}} = \frac{W}{W_{\text{in}}} = \frac{(Q_1 - Q_2)}{Q_1} \]

\[ e_{\text{max}} = \frac{e_{\text{max}}}{e_{\text{max}}} = \frac{(T_2 - T_1)}{T_2} \]

\[ F_{\text{waste}} = Q_e = \frac{W(1 - e)}{e} \]

Conversion Factors

1 mile = 1600 meters
1 hour = 3600 seconds
1 ton = 2000 pounds
1 kcal = 4186 joules = 1 food calorie
1 Btu = 1055 joules
1 kW-hr = 3.6 × 10^6 joules
1 J = 1 Nm
1 W = 1/6

Constants

\[ g = 9.8 \text{ m/sec}^2 = 32 \text{ ft/sec}^2 \]

\[ c_{\text{water}} = 1.0 \text{ kcal/(kg°C)} \]

Energy Equivalents

- gasoline: \( 1.3 \times 10^3 \text{ J/gallon} \)
- oil: \( 6.1 \times 10^3 \text{ J/lb} \)
- natural gas: \( 1.1 \times 10^6 \text{ Jeu./ft} \)
- bitumen coal: \( 2.8 \times 10^7 \text{ J/ton} \)

Atomic Weights

- Hydrogen (H) = 1
- Carbon (C) = 12
- Oxygen (O) = 16
- Sulfur (S) = 32