PHYS 1020 – Physics of Energy — Equation Sheet

Chapter 1: Introduction

$$N = N_0 + rt \qquad N = N_0 e^{rt} \qquad Doubling\ time = t_2 = \frac{\ln(2)}{r} \approx \frac{70\ (unit\ of\ time)}{\%\ growth\ rate}$$

Chapter 2: Motion

$$\Delta x = x_f - x_i \quad Speed = velocity = \frac{displacement}{time} = \frac{\Delta x}{\Delta t} \qquad acceleration = \frac{change\ in\ velocity}{elapsed\ time}$$

$$a = \frac{F_{net}}{m} \quad or \quad Net\ Force = mass \times acceleration \qquad a_g = g = 32\frac{ft}{s^2} = 9.8\frac{m}{s^2}$$

Chapter 3: Energy

$$Work = Force \times displacement \qquad W = \Delta(KE + PE) \qquad W + Q = \Delta(KE + PE + TE)$$

$$PE_G = mass \times g \times height \qquad KE = \frac{1}{2}\, mass \times velocity^2 \qquad Power = \frac{work\ done}{time\ taken} = \frac{energy\ used}{time\ taken}$$

$$1\ watt = \frac{1\ joule}{1\ second} \qquad Energy\ used = power \times time\ in\ use$$

Chapter 4: Conservation of Energy

If the system is isolated (no outside influences), then

$$0 = \Delta E \quad \rightarrow \quad E_{in} = E_{out} \quad \rightarrow \quad KE_f + PE_f = KE_i + PE_i \qquad (E = KE + PE + TE + \cdots)$$

$$Efficiency = \frac{useful\ energy\ or\ work\ output}{total\ energy\ input} \times 100\% \qquad Overall\ efficiency = eff_1 \times eff_2 \times \ldots$$

Chapter 5: Heat and Work

1st Law of Thermodynamics: $W + Q = \Delta E \qquad Q_H = W + Q_C \quad \rightarrow \quad W = Q_H - Q_C$

$$Q = mc(T_f - T_i) \qquad Q = mL$$

$$T^{\circ F} = \frac{9}{5}T^{\circ C} + 32 \qquad T^{\circ C} = \frac{5}{9}\left(T^{\circ F} - 32\right) \qquad T^K = T^{\circ C} + 273$$

$$\frac{Q}{t} = \frac{A(T_2 - T_1)}{R} \qquad R = \frac{thickness}{thermal\ conductivity} \qquad R_{total} = R_1 + R_2 + R_3 + \cdots$$

$$Eff = \frac{Q_H - Q_C}{Q_H} \times 100\%$$

Maximum Efficiency: $Eff_{max} = \left(\frac{T_H - T_C}{T_H}\right) \times 100\%$ (T is in K)

Chapter 7: Solar Energy: Characteristics and Heating

$$v = \lambda f \quad Intensity = \frac{Power}{Area}$$

Chapter 11: Electricity

Charge of one electron: $1.6 * 10^{-19} C$

$$V = IR \qquad P = IV \qquad P_{loss} = I^2 R$$

Chapter 12: Electromagnetism and the Generation of Electricity

$$P_{in} = P_{out} \qquad \frac{N_s}{N_p} = \frac{V_s}{V_p}$$

Chapter 13: Electricity from Solar, Wind, and Hydro

$$v = \lambda f \qquad E = hf \qquad h = 6.63 * 10^{-34}\, J \cdot s = 4.136 * 10^{-15} eV \cdot s$$

$$P = 0.000283\, D^2 v^3 \;\; kW \;\; \left(D \text{ in meters}, v \text{ in} \frac{m}{s}\right) \quad = 0.00000236\, D^2 v^3 \;\; kW \;\; (D \text{ in ft}, v \text{ in } mph)$$

$$PE = mgh \qquad Energy\ Density = \frac{PE}{m} = gh$$

$$Power\ Output = Energy\ Density * Flow\ Rate * efficiency$$

Chapter 15: The Atom and its Nucleus

$$1u = 1.66 * 10^{-27} kg \qquad E = mc^2 \qquad c^2 = \left(3 * 10^8 \frac{m}{s}\right)^2 = 931.494 \frac{MeV}{u}$$

$$N = N_0 e^{-\lambda t} \qquad Half\ Life = t_{1/2} = \frac{\ln(2)}{\lambda} \approx \frac{70\ (unit\ of\ time)}{\%\ growth\ rate}$$