

PHYS 1020 – Physics of Energy

Equation Sheet

Chapter 1: Introduction

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

Chapter 2: Motion

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

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

Chapter 3: Energy

$$\text{Work} = \text{Force} \times \text{displacement} \quad W = \Delta(KE + PE) \quad W + Q = \Delta(KE + PE + TE)$$

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

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

Chapter 4: Conservation of Energy

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

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

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

Chapter 5: Heat and Work

$$\text{1}^{\text{st}} \text{ Law of Thermodynamics:} \quad W + Q = \Delta E \quad Q_H = W + Q_C \quad \rightarrow \quad W = Q_H - Q_C$$

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

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

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

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

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

Chapter 7: Solar Energy: Characteristics and Heating

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

Chapter 11: Electricity

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

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

Chapter 12: Electromagnetism and the Generation of Electricity

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

Chapter 13: Electricity from Solar, Wind, and Hydro

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

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

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

$$\text{Power Output} = \text{Energy Density} * \text{Flow Rate} * \text{efficiency}$$

Chapter 15: The Atom and its Nucleus

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

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

Legend:

- Metals
- Metalloids
- Nonmetals

Element Properties:

- Atomic number:** The number above the element symbol.
- Symbol:** The element symbol.
- Atomic mass:** The number below the element symbol.

Groupings:

- Transition Metals:** A horizontal row of elements between groups 3 and 12.
- Lanthanides:** A series of 15 elements (La-Lu) located below the main table.
- Actinides:** A series of 15 elements (Ac-Th) located below the Lanthanides.

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|---------------------|---------------------|----------------------|--------------------|--------------------|---------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|-------------------|---------------------|---------------------|---------------------|-------------------|-------------------|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | |
| 1 H 1.008 | 4 Be 9.012 | 11 Na 22.99 | 12 Mg 24.30 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.88 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.39 | 31 Ga 69.72 | 32 Ge 72.61 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 19 K 39.10 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo (97.91) | 43 Tc 101.1 | 44 Ru 102.9 | 45 Rh 106.4 | 46 Pd 107.9 | 47 Ag 112.4 | 48 Cd 114.8 | 49 In 118.7 | 50 Sn 121.8 | 51 Sb 127.6 | 52 Te 126.9 | 53 I 131.3 | 54 Xe 131.3 | | | |
| 55 Cs 132.9 | 56 Ba 137.3 | 71 Lu 175.0 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.8 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209.0 | 84 Po (209.0) | 85 At (210.0) | 86 Rn (222.0) | | | |
| 87 Fr (223.0) | 88 Ra (226.0) | 103 Lr (262.1) | 104 Rf (267) | 105 Db (268) | 106 Sg (271) | 107 Bh (272) | 108 Hs (270) | 109 Mt (276) | 110 Ds (281) | 111 Rg (280) | 112 Cn (285) | () | () | () | () | () | () | | | |

Lanthanides:

| | | | | | | | | | | | | | |
|-------------------|-------------------|-------------------|---------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 57 La 138.9 | 58 Ce 140.1 | 59 Pr 140.9 | 60 Nd (144.9) | 61 Pm 150.4 | 62 Sm 152.0 | 63 Eu 157.2 | 64 Gd 157.2 | 65 Tb 158.9 | 66 Dy 162.5 | 67 Ho 164.9 | 68 Er 167.3 | 69 Tm 168.9 | 70 Yb 173.0 |
|-------------------|-------------------|-------------------|---------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|

Actinides:

| | | | | | | | | | | | | | |
|---------------------|-------------------|-------------------|------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------------|----------------------|----------------------|
| 89 Ac (227.0) | 90 Th 232.0 | 91 Pa 231.0 | 92 U 238.0 | 93 Np (237.0) | 94 Pu (244.1) | 95 Am (243.1) | 96 Cm (247.1) | 97 Bk (251.1) | 98 Cf (252.1) | 99 Es (257.1) | 100 Fm (258.1) | 101 Md (259.1) | 102 No (259.1) |
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