

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

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

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

Chapter 3: Energy

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

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

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

Chapter 4: Conservation of Energy

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

$$0 = \Delta E \quad \rightarrow \quad E_{\text{in}} = E_{\text{out}} \quad \rightarrow \quad \text{KE}_f + \text{PE}_f = \text{KE}_i + \text{PE}_i \quad (E = \text{KE} + \text{PE} + \text{TE} + \dots)$$

$$\text{Efficiency} = \frac{\text{useful energy or work output}}{\text{total energy input}} \times 100\% \quad \text{Overall efficiency} = \text{eff}_1 \times \text{eff}_2 \times \dots$$

Chapter 5: Heat and Work

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

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

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

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

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

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

Chapter 7: Solar Energy: Characteristics and Heating

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

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

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

$$P_{in} = P_{out} \quad \frac{N_s}{N_p} = \frac{V_s}{V_p}$$
$$v = \lambda f \quad E = hf \quad h = 6.63 * 10^{-34} J \cdot s = 4.136 * 10^{-15} eV \cdot s$$

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

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

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

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

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

<div><div></div>Metals</div> <div><div></div>Metalloids</div> <div><div></div>Nonmetals</div>																		<div><div>40</div><div>Zr</div><div>91.22</div></div> <div><div>Atomic number</div><div>Symbol</div><div>Atomic mass</div></div>																			
1																		18																			
<div>1</div> <div>H</div> <div>1.008</div>	2											13	14	15	16	17	<div>2</div> <div>He</div> <div>4.003</div>																				
<div>3</div> <div>Li</div> <div>6.941</div>	<div>4</div> <div>Be</div> <div>9.012</div>	Transition Metals										<div>5</div> <div>B</div> <div>10.81</div>	<div>6</div> <div>C</div> <div>12.01</div>	<div>7</div> <div>N</div> <div>14.01</div>	<div>8</div> <div>O</div> <div>16.00</div>	<div>9</div> <div>F</div> <div>19.00</div>	<div>10</div> <div>Ne</div> <div>20.18</div>																				
<div>11</div> <div>Na</div> <div>22.99</div>	<div>12</div> <div>Mg</div> <div>24.30</div>	3	4	5	6	7	8	9	10	11	12	<div>13</div> <div>Al</div> <div>26.98</div>	<div>14</div> <div>Si</div> <div>28.09</div>	<div>15</div> <div>P</div> <div>30.97</div>	<div>16</div> <div>S</div> <div>32.07</div>	<div>17</div> <div>Cl</div> <div>35.45</div>	<div>18</div> <div>Ar</div> <div>39.95</div>																				
<div>19</div> <div>K</div> <div>39.10</div>	<div>20</div> <div>Ca</div> <div>40.08</div>	<div>21</div> <div>Sc</div> <div>44.96</div>	<div>22</div> <div>Ti</div> <div>47.88</div>	<div>23</div> <div>V</div> <div>50.94</div>	<div>24</div> <div>Cr</div> <div>52.00</div>	<div>25</div> <div>Mn</div> <div>54.94</div>	<div>26</div> <div>Fe</div> <div>55.85</div>	<div>27</div> <div>Co</div> <div>58.93</div>	<div>28</div> <div>Ni</div> <div>58.69</div>	<div>29</div> <div>Cu</div> <div>63.55</div>	<div>30</div> <div>Zn</div> <div>65.39</div>	<div>31</div> <div>Ga</div> <div>69.72</div>	<div>32</div> <div>Ge</div> <div>72.61</div>	<div>33</div> <div>As</div> <div>74.92</div>	<div>34</div> <div>Se</div> <div>78.96</div>	<div>35</div> <div>Br</div> <div>79.90</div>	<div>36</div> <div>Kr</div> <div>83.80</div>																				
<div>37</div> <div>Rb</div> <div>85.47</div>	<div>38</div> <div>Sr</div> <div>87.62</div>	<div>39</div> <div>Y</div> <div>88.91</div>	<div>40</div> <div>Zr</div> <div>91.22</div>	<div>41</div> <div>Nb</div> <div>92.91</div>	<div>42</div> <div>Mo</div> <div>95.94</div>	<div>43</div> <div>Tc</div> <div>(97.91)</div>	<div>44</div> <div>Ru</div> <div>101.1</div>	<div>45</div> <div>Rh</div> <div>102.9</div>	<div>46</div> <div>Pd</div> <div>106.4</div>	<div>47</div> <div>Ag</div> <div>107.9</div>	<div>48</div> <div>Cd</div> <div>112.4</div>	<div>49</div> <div>In</div> <div>114.8</div>	<div>50</div> <div>Sn</div> <div>118.7</div>	<div>51</div> <div>Sb</div> <div>121.8</div>	<div>52</div> <div>Te</div> <div>127.6</div>	<div>53</div> <div>I</div> <div>126.9</div>	<div>54</div> <div>Xe</div> <div>131.3</div>																				
<div>55</div> <div>Cs</div> <div>132.9</div>	<div>56</div> <div>Ba</div> <div>137.3</div>	<div>71</div> <div>Lu</div> <div>175.0</div>	<div>72</div> <div>Hf</div> <div>178.5</div>	<div>73</div> <div>Ta</div> <div>180.9</div>	<div>74</div> <div>W</div> <div>183.8</div>	<div>75</div> <div>Re</div> <div>186.2</div>	<div>76</div> <div>Os</div> <div>190.2</div>	<div>77</div> <div>Ir</div> <div>192.2</div>	<div>78</div> <div>Pt</div> <div>195.1</div>	<div>79</div> <div>Au</div> <div>197.0</div>	<div>80</div> <div>Hg</div> <div>200.6</div>	<div>81</div> <div>Tl</div> <div>204.4</div>	<div>82</div> <div>Pb</div> <div>207.2</div>	<div>83</div> <div>Bi</div> <div>209.0</div>	<div>84</div> <div>Po</div> <div>(209.0)</div>	<div>85</div> <div>At</div> <div>(210.0)</div>	<div>86</div> <div>Rn</div> <div>(222.0)</div>																				
<div>87</div> <div>Fr</div> <div>(223.0)</div>	<div>88</div> <div>Ra</div> <div>(226.0)</div>	<div>103</div> <div>Lr</div> <div>(262.1)</div>	<div>104</div> <div>Rf</div> <div>(267)</div>	<div>105</div> <div>Db</div> <div>(268)</div>	<div>106</div> <div>Sg</div> <div>(271)</div>	<div>107</div> <div>Bh</div> <div>(272)</div>	<div>108</div> <div>Hs</div> <div>(270)</div>	<div>109</div> <div>Mt</div> <div>(276)</div>	<div>110</div> <div>Ds</div> <div>(281)</div>	<div>111</div> <div>Rg</div> <div>(280)</div>	<div>112</div> <div>Cn</div> <div>(285)</div>	113	114	115	116	117	118																				
Lanthanides																																					
<div>57</div> <div>La</div> <div>138.9</div>	<div>58</div> <div>Ce</div> <div>140.1</div>	<div>59</div> <div>Pr</div> <div>140.9</div>	<div>60</div> <div>Nd</div> <div>144.2</div>	<div>61</div> <div>Pm</div> <div>(144.9)</div>	<div>62</div> <div>Sm</div> <div>150.4</div>	<div>63</div> <div>Eu</div> <div>152.0</div>	<div>64</div> <div>Gd</div> <div>157.2</div>	<div>65</div> <div>Tb</div> <div>158.9</div>	<div>66</div> <div>Dy</div> <div>162.5</div>	<div>67</div> <div>Ho</div> <div>164.9</div>	<div>68</div> <div>Er</div> <div>167.3</div>	<div>69</div> <div>Tm</div> <div>168.9</div>	<div>70</div> <div>Yb</div> <div>173.0</div>																								
Actinides																																					
<div>89</div> <div>Ac</div> <div>(227.0)</div>	<div>90</div> <div>Th</div> <div>232.0</div>	<div>91</div> <div>Pa</div> <div>231.0</div>	<div>92</div> <div>U</div> <div>238.0</div>	<div>93</div> <div>Np</div> <div>(237.0)</div>	<div>94</div> <div>Pu</div> <div>(244.1)</div>	<div>95</div> <div>Am</div> <div>(243.1)</div>	<div>96</div> <div>Cm</div> <div>(247.1)</div>	<div>97</div> <div>Bk</div> <div>(247.1)</div>	<div>98</div> <div>Cf</div> <div>(251.1)</div>	<div>99</div> <div>Es</div> <div>(252.1)</div>	<div>100</div> <div>Fm</div> <div>(257.1)</div>	<div>101</div> <div>Md</div> <div>(258.1)</div>	<div>102</div> <div>No</div> <div>(259)</div>																								