UNIT 3: THERMOCHEMISTRY

VOCABULARY & CONCEPTS

1. Boiling point-
2. Melting point-
3. Solid-
4. Liquid-
5. Gas –
6. Molar heat of fusion –
7. Molar heat of vaporization -
8. Kinetic energy –
9. Potential energy –
10. Endothermic –
11. Exothermic-
12. Law of conservation of energy –
13. Specific heat capacity -
14. Temperature –
15. Heat-
16. Heat of reaction (\(\Delta H\)) –
17. Calorimeter –
18. Insulator –
19. Conductor –
20. POTENTIAL ENERGY DIAGRAM –
21. Activation energy -

STUDENTS SHOULD BE ABLE TO ANALYZE & INTERPRET HEATING CURVE GRAPHS

-Label the 3 phases, label the melting point and boiling point
-Identifying changes or constants in kinetic energy or potential energy
-Define and identify exothermic and endothermic changes and relate to heating curve
STUDENTS SHOULD BE ABLE TO USE THE SPECIFIC HEAT EQUATION \( Q = mc\Delta T \)
- to solve for any variable
- use specific heat to identify unknown metal
- relate specific heat to temperature change and conductive properties

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>MEASUREMENT</th>
<th>UNIT</th>
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<tbody>
<tr>
<td>q</td>
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<td>M</td>
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<td>C</td>
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<td>( \Delta T )</td>
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<td>( T_i )</td>
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<td>( T_f )</td>
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<tr>
<th>SPECIFIC HEAT</th>
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<tbody>
<tr>
<td>WATER 4.18 ( J/(g\cdot{}^\circ C) )</td>
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<td>SAND 0.8 ( J/(g\cdot{}^\circ C) )</td>
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<td>IRON 0.46 ( J/(g\cdot{}^\circ C) )</td>
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<td>SILVER 0.24 ( J/(g\cdot{}^\circ C) )</td>
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<td>BERYLLIUM 1.83 ( J/(g\cdot{}^\circ C) )</td>
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<td>COPPER 0.38 ( J/(g\cdot{}^\circ C) )</td>
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<td>COBALT 0.42 ( J/(g\cdot{}^\circ C) )</td>
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<tr>
<td>MAGNESIUM 1.0 ( J/(g\cdot{}^\circ C) )</td>
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<tr>
<td>NICKEL 0.50 ( J/(g\cdot{}^\circ C) )</td>
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STUDENTS SHOULD BE ABLE TO EXPLAIN HOW TEMPERATURE IS DIFFERENT THEN HEAT.

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINE</th>
<th>EXAMPLE</th>
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<tbody>
<tr>
<td>TEMPERATURE</td>
<td></td>
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<tr>
<td>HEAT</td>
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</tbody>
</table>
22. What is the melting point of SUBSTANCE X? -2 °C
23. What is the boiling point of SUBSTANCE X? 15 °C
24. What phase of matter is the region labeled A? SOLID
25. What phase of matter is the region labeled E? GAS
26. Which regions of the graph does both a solid and liquid exist simultaneously? B
27. Which region of the graph is potential energy changing? B AND D
28. Identify as an endothermic or exothermic change?
   a. solid melting into a liquid ENDOTHERMIC
   b. gas condensing into a liquid EXOTHERMIC
   c. liquid solidifying into a solid EXOTHERMIC
29. Which of the substances would change temperature quickly? METALS such as silver and copper
30. What kind of substances are best to construct a calorimeter? Styrofoam, doesn’t change temperature easily
31. Calculate the quantity of heat needed to heat a 10.66 gram sample magnesium from 32 ° C to 85 °C?
   \[ Q = mc\Delta T \]
   \[ (10.66 \text{ g}) \times (1.0 \text{ J/g•°C}) \times (85 - 32) = 564.98 \text{ J} \]
32. Calculate the change in temperature of a 5.0 gram sample of water that loses 1800 Joules of heat energy?
   \[ Q = mc\Delta T \]
   \[ -1800 \text{ J} = (5 \text{ g}) \times (4.18 \text{ J/g•°C}) \times \Delta T \]
   \[ \Delta T = -86 \text{ °C} \]
33. A 25 gram substance changes temperature from 15 °C to 55 °C. Identify the substance that absorbs 240 Joules of heat energy?
   \[ Q = mc\Delta T \]
   \[ 240 \text{ J} = (25 \text{ g}) \times C \times (55 \text{ °C} - 15 \text{ °C}) \]
   specific heat = 0.24 = silver
34. A 35.66 g sample of copper is heated using 600 J of energy. If the original temperature of the copper is 85 °C, what is its final temperature?

\[ Q = mc\Delta T \]

\[ 600 \text{ J} = (35.66 \text{ g})(0.38 \text{ J/g} \cdot \text{ °C})(t_f - 85 \text{ °C}) \]

\[ t_f = 129.28 \text{ °C} \]

35. A 60.8 g piece of metal at 100 °C is placed into 109.4 mL of water. The temperature of the water increases from 25.3 °C to 27.6 °C. What type of metal was used?

- \[ Q_{\text{metal}} = + Q_{\text{water}} \]
- \[ (60.8 \text{ g})c(27.6 \text{ °C} - 100 \text{ °C}) = + (109.4 \text{ mL})(4.18)(27.6 \text{ °C} - 25.3 \text{ °C}) \]

\[ C_{\text{metal}} = 0.24 \text{ J/(g} \cdot \text{ °C)} \text{, which is silver} \]

*note the energy the water gains is equal to the energy the metal lost

**the density of water is 1 g/mL, therefore mass in grams = volume in mL for water only

*** \[ t_{\text{water}} = t_{\text{metal}} \] due to thermal equilibrium, heat energy will move from a warm object to a cooler object until thermal equilibrium is reached, until they have the same temperature.

36. Label as exothermic or endothermic reaction?

a) \[ \text{CH}_4 + 3 \text{ F}_2 \rightarrow \text{CHF}_3 + 3 \text{ HF} + 1452 \text{ kJ} \text{ EXOTHERMIC} \]
b) \[ \text{HCN (g) + 2 H}_2\text{(g) } \rightarrow \text{CH}_3\text{NH}_2\text{(g)} \text{ } \Delta H = -138 \text{ KJ EXOTHERMIC} \]
c) \[ \text{SnO}_2\text{(g) + 2C(s) } \rightarrow \text{Sn(s) + 2 CO}_2\text{(g)} \text{ } \Delta H = +360.0 \text{ kJ ENDO THERMIC} \]

37. How much energy is required to melt 15 g ice?

\[ \Delta H_{\text{fus}} = \text{MOLES} \times \text{CONSTANT} = (0.83333\text{mol})(6.01 \text{ kJ/mol}) = 5.0 \text{ kJ is required} \]

\[ 15 \text{ g H}_2\text{O} \times \frac{1 \text{ mole}}{18 \text{ g H}_2\text{O}} = 0.83333333 \text{ moles} \]

\[ 18 \text{ is the molar mass of water} \]

38. How much energy is absorbed lost when 15 grams of water vapor condenses?

\[ \Delta H_{\text{vap}} = \text{MOLES} \times \text{CONSTANT} = (0.83333\text{mol})(-40.7 \text{ kJ/mol}) = -33.9 \text{ kJ is removed} \]

\[ 15 \text{ g H}_2\text{O} \times \frac{1 \text{ mole}}{18 \text{ g H}_2\text{O}} = 0.83333333 \text{ moles} \]

UNIT 4: REACTION RATES AND EQUILIBIRIUM

VOCABULARY & CONCEPTS

39. solvent–
40. solute-
41. Concentration –
42. Molarity –
43. Molality –
44. Freezing point depression –
45. Boiling point elevation -
46. Saturated –
47. Unsaturated -
48. Supersaturated -
49. Catalyst –
50. Activation energy –
51. Equilibrium –
52. Forward reaction –
53. Reverse reaction -
54. Temperature –
55. Pressure –
56. LeChatelier’s principle –
STUDENTS SHOULD BE ABLE TO CALCULATE MOLARITY AND MOLALITY
STUDENTS SHOULD BE ABLE TO CALCULATE FREEZING POINT DEPRESSION & BOILING POINT ELEVATION
STUDENTS SHOULD BE ABLE TO INTERPRET SOLUBILITY CURVES

STUDENTS SHOULD BE ABLE TO DESCRIBE HOW A CATALYST AFFECTS A CHEMICAL REACTION
STUDENTS SHOULD BE ABLE TO DESCRIBE FACTORS THAT AFFECT REACTION RATE

STUDENTS SHOULD KNOW THE CHARACTERISTICS OF ENDOThERMIC AND ENThERMIC REACTIONS

<table>
<thead>
<tr>
<th>Define</th>
<th>ΔH</th>
<th>Example Reactions</th>
<th>Potential Energy Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXOTHERMIC</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ENDOThERMIC</td>
<td></td>
<td></td>
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</tbody>
</table>

STUDENTS SHOULD BE ABLE TO INTERPRET POTENTIAL ENERGY DIAGRAMS
- Identify as endothermic or exothermic
- Calculate ΔH and activation energy of forward and reverse reactions

STUDENTS SHOULD BE ABLE TO CONVERT BETWEEN ENERGY & MASS USING BALANCED EQUATIONS

STUDENTS SHOULD BE ABLE TO EXPLAIN COLLISION THEORY

STUDENTS SHOULD BE ABLE TO APPLY LECHATELIER’S PRINCIPLE TO CHANGES MADE TO A CHEMICAL REACTION AT EQUILIBRIUM

STUDENTS SHOULD BE ABLE TO CALCULATE RATE FROM GIVEN DATA AND CALCULATE AMOUNT OF REACTANTS USED OR PRODUCTS MADE.

\[
A_2 + B_2 \rightarrow 2AB
\]

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Time (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.100</td>
<td>0</td>
</tr>
<tr>
<td>0.088</td>
<td>10</td>
</tr>
<tr>
<td>0.065</td>
<td>20</td>
</tr>
<tr>
<td>0.049</td>
<td>30</td>
</tr>
<tr>
<td>0.022</td>
<td>40</td>
</tr>
</tbody>
</table>
PRACTICE TEST QUESTIONS

57. What mass of KNO₃ will dissolve at 62 °C? **110g**

58. At what temperature will 8 grams of KCLO₃ dissolve? **20 °C**

59. Which compound dissolves the least at 40°C? **Ce₂(SO₄)₃**

60. How much NH₃ would saturate 100g of H₂O at 20°C? **53 g NH₃**

61. 115 g NaNO₃ dissolves in 100g of H₂O at 40° C, is this solution super saturated or unsaturated? **SUPER SATURATED**

62. What is the molarity of a solution containing 8.6 moles NaCl dissolved in 2.6 L of H₂O ?

\[ M = \frac{\text{moles}}{\text{Liter}} = \frac{8.6 \text{ mol NaCl}}{2.6 \text{ L}} = 3.3 \text{ M} \]

63. What is the molality of a solution containing 6.88 moles C₆H₁₂O₆ per 1.2 kg of solvent.

\[ m = \frac{\text{moles}}{\text{kg}} = \frac{6.88 \text{ mol C₆H₁₂O₆}}{1.2 \text{ kg}} = 5.7 \text{ m} \]

64. A copper chloride solution is made from dissolving 75.66 grams CuCl₂ into 0.19 L of water. What is the molarity of the solution?

\[ M = \frac{0.56 \text{ moles CuCl₂}}{0.19 \text{ L H₂O}} = 2.97 \text{ M} \]

65. What is the freezing point depression of a 0.5m NaCl solution?

\[ \Delta T = k_f m = (1.86°C/m)(0.5m)(2) = 1.86°C \]

66. What is the boiling point of a solution made from dissolving 260 grams C₆H₁₂O₆ into 1.2 kg of acetic acid.

\[ \Delta T = k_b m = (3.07°C/m)(1.2m) = 3.684°C \]

67. Endothermic reactions absorb energy? **TRUE**

68. A catalyst will lower the activation energy of a chemical reaction. **TRUE**

69. The AH of exothermic reactions is positive. **FALSE**

70. A catalyst will cause a chemical reaction rate to increase. **TRUE**

71. Energy flows from a substance of high temperature to low temperature. **TRUE**
Use potential energy diagram to answer the next 4 questions.

72. What are the reactants of the forward reaction?  
O₃ & O

73. What is the activation energy of the reverse reaction?  
250 – 50 = 200 kJ

74. What type of reaction is the forward reaction?  
EXOTHERMIC

75. What is the ΔH of the reverse reaction?  
ΔH = 150-50 = +100 KJ

76. What is the ΔH of this reaction?  
Ca(OH)₂(s) + CO₂(g) → H₂O(g) + CaCO₃(s) + 69.1 kJ

77. Consider the reaction:  
C₆H₁₂O₆ + 6 O₂ → 6 CO₂ + 6 H₂O  ΔH = -2808 KJ  
What mass of oxygen will be used to produce 3000 KJ of energy?  
-3000 KJ x 6 moles O₂ x 32 grams O₂ = 205.13 grams O₂  
-2808 KJ  1 moles O₂

78. Consider the reaction:  
HCN (g) + 2 H₂(g) → CH₃NH₂(g)  ΔH = -138 kJ/mole  
What amount of energy is released when 25 grams of H₂ is consumed?  
25 g H₂ x 1 moles H₂ x -138 KJ = -862.5 KJ H₂  
2 g H₂  2 moles H₂

79. Consider the reaction  
2 C₂H₆ (g) + 7 O₂ (g) → 4 CO₂ (g) + 6 H₂O (g)  H = -808 KJ/mole  
If 54.66 grams of oxygen gas was reacted, how much energy will be released to the surroundings?  
54.66 grams O₂ x 1 moles O₂ x -808 kJ  = -197.17 grams O₂  
32 g O₂  7 moles O₂

80. Given the following reaction at equilibrium:  
12.6 kcal + H₂(g) + I₂(g) ↔ 2 HI(g)  
Which way will the equilibrium shift when the following changes are made?  

a) Increasing temperature  SHIFT RIGHT  
b) Decreasing temperature  SHIFT LEFT  
c) Increasing pressure  NO CHANGE  
d) Decreasing pressure  NO CHANGE  
e) increasing H₂ concentration  SHIFT RIGHT  
f) increasing I₂ concentration  SHIFT RIGHT  
g) increasing HI concentration  SHIFT LEFT  
h) decreasing HI concentration  SHIFT RIGHT

81. Consider the following reaction:  
N₂(g) + 3 H₂(g) ↔ 2NH₃(g) + 22.0 kcal  
What changes will increase the amount of NH₃ made?  
DECREASING NH₃ CONCENTRATION  INCREASE PRESSURE  
INCREASING N₂ CONCENTRATION  DECREASE TEMPERATURE  
INCREASING H₂ CONCENTRATION
A student performs the following chemical reaction using $0.200 \, \text{M}$ of $\text{NH}_4^+$ and $0.0100 \, \text{M}$ of $\text{NO}_2^-$. The concentration of $\text{NH}_4^+$ is monitored and recorded in the data table below.

\[
\text{NO}_2^- (aq) + \text{NH}_4^+ (aq) \rightarrow \text{N}_2 (g) + 2 \text{H}_2\text{O}(l)
\]

<table>
<thead>
<tr>
<th>TIME (seconds)</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>$[\text{NH}_4^+]$ (mol/L)</td>
<td>0.099</td>
<td>0.088</td>
<td>0.065</td>
<td>0.055</td>
<td>0.050</td>
</tr>
</tbody>
</table>

82. What formula is used to calculate the rate of disappearance of $\text{NH}_4^+$?

\[\Delta \text{Molarity} \over \Delta \text{Time}\]

83. If the initial rate of production of $\text{N}_2$ gas is $0.068 \, \text{mol/L} \times \text{s}$, what is the rate of consumption of $\text{NH}_4^+$?

\[
0.068 \, \text{mol} \, \text{N}_2 \times \frac{1 \, \text{mole} \, \text{NH}_4^+}{1 \, \text{mole} \, \text{N}_2} = 0.068 \, \text{mol} \, \text{NH}_4^+
\]

84. If the initial rate of production of $\text{H}_2\text{O}$ is $0.044 \, \text{mol/L}$, what is the rate of loss of $\text{NO}_2^-$?

\[
0.044 \, \text{mol} \, \text{H}_2\text{O} \times \frac{1 \, \text{mole} \, \text{NO}_2^-}{2 \, \text{mole} \, \text{H}_2\text{O}} = 0.022 \, \text{mol} \, \text{NO}_2^-
\]

85. What is concentration of $\text{NO}_2^-$ remaining at 120 seconds?

\[
0.099 - 0.050 = 0.049 \, \text{mole} \, \text{NH}_4^+\text{used}
\]

\[
0.049 \, \text{mole} \, \text{NH}_4^+ \times \frac{1 \, \text{mole} \, \text{NO}_2^-}{1 \, \text{mole} \, \text{NH}_4^+} = 0.049 \, \text{mole} \, \text{NO}_2^-\text{used}
\]

\[
0.100 \, \text{M} \, \text{NO}_2^- - 0.049 \, \text{mole} \, \text{NO}_2^- = 0.51 \, \text{mole} \, \text{NO}_2^\text{leftover/remaining}
\]

86. Which will cause a reaction rate to increase? (circle all that apply)

a. \text{increasing temperature} \\
b. \text{increasing activation energy} \\
c. \text{decreasing kinetic energy} \\
d. \text{agitation} \\
e. \text{decreasing pressure}

UNIT 5: NUCLEAR CHEMISTRY

VOCABULARY & CONCEPTS

87. Alpha – 
88. Beta – 
89. Gamma – 
90. Half life – 
91. Radioactivity – 
92. Fission - 
93. Fusion – 
94. Transmutation – 
95. Solar radiation – 
96. Electromagnetic spectrum – 
97. Wavelength – 
98. White dwarf – 
99. Super giant - 
100. Red giant - 
101. Supernova –
102. Black hole –
103. Big bang theory –
104. Telescope –
105. Stellar nebula –
106. Neutron star –
107. Main sequence –

**STUDENTS SHOULD BE ABLE TO COMPARE/CONTRAST NUCLEAR CHANGE, CHEMICAL CHANGE, AND PHYSICAL CHANGE**

<table>
<thead>
<tr>
<th>Type of change</th>
<th>Description</th>
<th>Example Reaction</th>
<th>Temperature Changes</th>
</tr>
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<tbody>
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**STUDENTS SHOULD BE ABLE TO INTERPRET PROPER NUCLEAR NOTATION**

241

\[ ^{95}Am \]

**STUDENTS SHOULD BE ABLE TO IDENTIFY RADIOACTIVE ELEMENTS**

Above which atomic number are all elements radioactive?

**STUDENTS SHOULD BE ABLE TO BALANCE A NUCLEAR EQUATION INCLUDING IDENTIFYING THE MISSING COMPONENT**

**STUDENTS SHOULD BE ABLE TO COMPARE/CONTRAST FISSION AND FUSION**

<table>
<thead>
<tr>
<th>Type of nuclear change</th>
<th>Define</th>
<th>Sample Reaction</th>
<th>Used For?</th>
</tr>
</thead>
<tbody>
<tr>
<td>FISSION</td>
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<td></td>
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<tr>
<td>FUSION</td>
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</table>

**STUDENTS SHOULD BE ABLE TO COMPARE/CONTRAST THE TYPES OF RADIOACTIVITY: ALPHA, BETA, GAMMA**

<table>
<thead>
<tr>
<th>Type of Radioactive Decay</th>
<th>Symbol</th>
<th>Size</th>
<th>Can be stopped by? (Penetrative Power)</th>
<th>Example Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALPHA</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>BETA</td>
<td></td>
<td></td>
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<tr>
<td>GAMMA</td>
<td></td>
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</tbody>
</table>
STUDENTS SHOULD BE ABLE TO PERFORM HALF LIFE CALCULATIONS

STUDENTS SHOULD BE ABLE TO DESCRIBE THE BIG BANG THEORY

STUDENTS SHOULD BE ABLE TO DESCRIBE THE NUCLEAR PROCESSES OCCURING IN THE SUN AND HOW SOLAR RADIATION AFFECTS EARTH.

STUDENTS SHOULD BE ABLE TO DESCRIBE THE ELECTROMAGNETIC SPECTRUM AND WHAT ITS USED FOR

STUDENTS SHOULD BE ABLE TO LIST THE STAGES IN THE STAR CYCLE AND RELATE TO OUR SUN

PRACTICE TEST QUESTIONS

Label the following as: NUCLEAR CHANGE, CHEMICAL CHANGE, OR PHYSICAL CHANGE

108. Temperature change of 1,000 °C  CHEMICAL CHANGE
109. A new element is formed  NUCLEAR CHANGE
110. Mg(s) + O_2(g) → MgO  CHEMICAL CHANGE
111. Same substance on reactant and product side of equation, just a different phase of matter  PHYSICAL
112. Temperature change of 100 °C  PHYSICAL CHANGE
113. H_2O (g) → H_2O (l)  PHYSICAL CHANGE

114. Label the atomic number and the atomic mass for:  \[ \frac{238}{92}U \]  ATOMIC MASS  \[ \frac{92}{2}U \]  ATOMIC NUMBER

Balance the following nuclear reactions by writing in the missing component.

115. \[ \frac{2}{1}H + \frac{3}{1}H \rightarrow \frac{4}{2}He + 1 \frac{1}{0}n \]

116. \[ \frac{241}{95}Am + \frac{4}{2}He \rightarrow \frac{243}{93}Np + 2 \frac{1}{0}n \]

117. \[ \frac{187}{75}Re + \frac{2}{1}H \rightarrow \frac{188}{75}Re + \frac{1}{1}H \]
118. \( \frac{10}{5} B + \frac{4}{2} He \rightarrow \frac{13}{7} N + 1^0 n \)

119. Which of the following isotopes are radioactive? (circle all that apply)

\[ \text{Cl} \quad \text{U} \quad \text{Ra} \quad \text{Sm} \quad \text{Sb} \quad \text{Bk} \]

120. Rank alpha, beta, gamma by increasing size? \text{Gamma, beta, alpha}

121. Rank alpha, beta, gamma by decreasing penetrative power? \text{Gamma, beta, alpha}

122. Identify as alpha, beta, or gamma decay.

a) \( \frac{226}{88} Ra \rightarrow \frac{4}{2} He + \frac{222}{86} Rn \) \quad \text{ALPHA DECAY}

b) \( \frac{37}{18} Ar + 0^- e \rightarrow \frac{\gamma}{17} Cl \) \quad \text{GAMMA DECAY}

c) \( \frac{238}{92} U \rightarrow \frac{234}{90} U + \frac{4}{2} He \) \quad \text{ALPHA DECAY}

d) \( \frac{234}{91} Pa \rightarrow 0^- e + \frac{234}{92} U \) \quad \text{BETA DECAY}

123. Identify as fission or fusion

a) \( \frac{235}{92} U + n \rightarrow \frac{139}{56} Ba + \frac{94}{36} Kr + 3\,1^0 n \) \quad \text{FISSION}

b) \( \frac{1}{1} H + \frac{1}{1} H + \frac{1}{1} H + \frac{1}{1} H \rightarrow \frac{4}{2} He + 2\,0^+ e \) \quad \text{FUSION}

c) \( \frac{3}{1} H + \frac{2}{1} H \rightarrow \frac{4}{2} He + 1^0 n \) \quad \text{FUSION}

d) \( \frac{235}{92} U + n \rightarrow \frac{90}{38} Sr + \frac{143}{54} Xe + 3\,1^0 n \) \quad \text{FISSION}

e) \quad \text{FISSION}

f) \quad \text{FUSION}
124. The half life of Ra-22 is 4 days. How much of a 125 gram sample remains after 12 days?  
   \[ 12 \text{ days} = 3 \times 4 \text{ days} \]
   \[ 125 \cdot (0.5)^3 = 15.625 \text{ grams} \]
   
   \[ 125 \cdot (0.5)(0.5)(0.5) = 15.625 \text{ grams remaining} \]

125. How much of a 100 gram sample of \(^{198}\text{Au}\) is left after 13.5 days? The half life if Au-198 is 2.70 days. 
   \[ 13.6 \text{ days} = 5 \times 2.70 \text{ days} \]
   \[ 100 \cdot (0.5)^5 = 3.125 \text{ grams remaining} \]
   
   \[ 100 \cdot (0.5)(0.5)(0.5)(0.5)(0.5) = 3.125 \text{ grams remaining} \]

126. What is the half life of K-42 if 16.8 grams of a 268.8 gram sample are remaining after 49.6 hours? 

   \[ \frac{268.8}{2} = 134.4 \text{ grams} \]
   4 half lives occurred

   \[ \frac{49.6 \text{ hours}}{4} = 12.4 \text{ hours} \]

   \[ \frac{134.4}{2} = 67.2 \text{ grams} \]
   
   \[ \frac{67.2}{2} = 33.6 \text{ grams} \]
   
   \[ \frac{33.6}{2} = 16.8 \text{ grams} \]

   Half life of K-42 is 12.4 hours

127. List two effects of solar radiation? 
   - Source of vitamin D
   - Sunburn
   - Source of energy for our planet
   - Source of energy for photosynthesis

128. How are the dark lines of the spectrum different then the colored lines? 
   - Dark lines show wavelengths of energy that are absorbed
   - Colorful lines show wavelengths of energy that are released

129. What is the length & color of the shortest wavelength in the visible spectrum? Does this color contain more or less energy than yellow (550nm)? 
   - The shortest wavelength is violet, about 400 nm. Violet contains more energy than yellow.
   - The shorter the wavelength, the more energy. Longer wavelengths contain less energy.

130. What is the first stage of the star cycle? 
   - Protostar

131. What is the last stage of the star cycle? 
   - Black hole, or neutron star if high mass star
   - Black dwarf if low mass star

132. List the life cycle of a massive star? 
   - Protostar, main sequence massive star, super red giant, supernova, black hole or neutron star

133. List the life cycle of a smaller star? 
   - Protostar, main sequence star, red giant, planetary nebula, white dwarf, black dwarf

134. What is the fuel for fusion in stars? 
   - Hydrogen