Chemistry AP Unit 4 Outline: Thermochemistry and Nuclear Chemistry

Chapter 6: Thermochemistry

Classes	Topics	Suggested Reading	✓	Assignments	✓
1 & 2	Energy, Radiant Energy, Thermal Energy, Chemical Potential Energy, Potential Energy, Thermochemistry, Open System, Closed System, Isolated System, Law of Conservation of Energy (First Law of Thermodynamics), Heat (q), Work (w), Reaction Pathway, State Function (Property), Systems versus Surroundings, Exothermic versus Endothermic, Internal Energy (E), $\Delta E = q + w$, $w = -P\Delta V$, Enthalpy ($H = E + PV$ and $H = n\Delta H_{rxn}$), Energy Diagram and Change in Enthalpy ($\Delta H < 0$ Exothermic, $\Delta H > 0$ Endothermic)	6.1: The Nature of Energy and Types of Energy (pg. 224) 6.2: Energy Changes in Chemical Reactions (pg. 225 to 256) 6.3 Introduction to Thermodynamics (pg. 227 to 232) 6.4 Enthalpy of Chemical Reactions (pg. 232 to 239)		pg. 255 #2, 3, 7 to 11, 13 to 20 pg 255−256 #21, 24 to 28	
3 & 4	Heating Curve, Potential Energy (Phase Changes, $q = n\Delta H_{fus}$, $q = n\Delta H_{vap}$ and $q = n\Delta H_{sub}$ where $\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$), Kinetic Energy (Temperature Change, Specific Heat, $q = mc\Delta T$, Heat Capacity $q = C\Delta T$), Molar Enthalpy of Combustion (ΔH_{comb}), Physical and Chemical Calorimetry (Heat Gained = Heat Lost) using Constant-Volume Calorimter (Bomb Calorimeter) or Constant-Pressure Calorimeter (Styrofoam Calorimeter)	11.8 Phase Changes (pg. 480 to 488) 6.5: Calorimetry (pg. 239 to 245)		pg. 496−499 #62, 63, 67, 75. 77, 78, 80, 83, 84, 129, 135, 137, 140 pg. 256 #29 to 38	
5	Molar Heat of Formation (ΔH_f), Theoretical Molar Enthalpy of Reaction ($\Delta H_{rxn} = \Sigma H_{products} - \Sigma H_{reactants}$), Hess's Law (Adding ΔH), Molar Enthalpy of Solution (ΔH_{sol}), Lattice Energy ($U_{lattice}$), Heat of Hydration (ΔH_{hyd}) Fossil Fuels (Natural Gas, Petroleum, and Coal), Complete and Incomplete Combustions, Fractional Distillation, Cracking and Reforming, Greenhouse Effect (Global Warming), Deforestation, Hydrogen as Fuel, Other Energy Alternatives	6.6: Standard Enthalpy of Formation and Reaction (pg. 246 to 251) 6.7: Heat of Solution and Dilution (pg. 252 to 254) 6.8: Present Sources of Energy and New Energy Sources (extra notes)		pg. 257−259 #39 to 42, 45 to 49, 51, 52, 54 to 56, 58, 60 to 64, 73, 74, 76, 77, 80, 81 pg. 258 #66 to 68, 70	
6	**Lab #8: Heat of Solution and Molar Heat of Fusion (January 13, Friday)**			**Lab Report #8 Due: January 24, Tuesday**	
7	**Lab #9: Heat of Combustion (January 13, Friday)**			**Lab Report #9 Due: January 24, Tuesday**	
8	**Chapter 6 Quiz (January 19, Thursday)**				

Chapter 18: Spontaneity, Entropy, and Free Energy

Classes	Topics	Suggested Reading	✓	Assignments	✓
1	Spontaneous Process, Entropy (S), Positional Probability, Change in Entropy ($\Delta S = S_{final} - S_{initial}$)	18.2: Spontaneous Process (pg. 784 to 785) 18.3: Entropy (pg. 785 to 790)		pg. 810 #1 to 6	
2	Second Law of Thermodynamics ($\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$), Spontaneous ($\Delta S_{univ} > 0$), Non-Spontaneous ($\Delta S_{univ} < 0$), Entropy of the Surrounding $\left(\Delta S_{surr} = \frac{-\Delta H}{T}\right)$, Third Law of Thermodynamics, Free Energy (G), Change in Entropy in Chemical Reactions ($\Delta S_{rxn} = \Sigma S_{products} - \Sigma S_{reactants}$), Qualitative Analysis of ΔS_{rxn} base on State, Moles and Complexities	18.4: Second Law of Thermodynamics (pg. 790 to 795)		pg. 810 #7 to 14	
3	Gibbs Free Energy (G), Change in Free Energy ($\Delta G = \Delta H - T\Delta S$), Cases for Spontaneity, Free Energy of a Chemical Reaction ($\Delta G_{rxn} = \Sigma G_{products} - \Sigma G_{reactants}$), Free Energy at Equilibrium ($\Delta G = 0$), Standard Free Energy of Formation ($\Delta G°_f$)	18.5: Gibbs Free Energy (pg. 796 to 803)		pg. 811–813 #17 to 20, 42, 44, 51, 52, 54, 56 to 61	
4	**Lab #10: Enthalpy of Vaporization of Water (January 20, Friday)**			**Lab Report #10 Due: February 7, Tuesday**	
5	**Chapter 18 Quiz (January 27, Friday)**				

Chapter 23: Nuclear Chemistry

Classes	Topics	Suggested Reading	✓	Assignments	✓
1 & 2	Nucleons (Neutrons and Protons), Nuclear Transmutation, Elementary Particles (proton ($_1^1p$ or $_1^1\text{H}$), neutron ($_0^1n$), electron or beta particle ($_{-1}^0e$ or $_{-1}^0\beta$), positron ($_{+1}^0e$ or $_{+1}^0\beta$), alpha particle ($_2^4\text{He}$ or $_2^4\alpha$) and gamma $\left(\gamma \text{ or } {}_0^0\gamma\right)$ ray), Balancing Nuclear Equations, Thermodynamic and Kinetic Stability, Radioactive Decay, Neutron-to-Proton Ratio (n/p), Zone of Stability, Positron Emission and Electron Capture, Mass Defect (Δm), Nuclear Binding Energy ($\Delta E = \Delta mc^2$)	23.1: The Nature of Nuclear Reactions (pg. 968 to 969) 23.2: Nuclear Stability (pg. 970 to 975)		pg. 994–995 #1 to 6; pg. 996 #55 pg. 995 #7, 8, 11, 12, 14, 16, 18 to 20; pg. 998 #80	
3 & 4	Radioactive Decay Series, Kinetics of Radioactive Decay, Rate of Decay, Rate Constant of Decay (k), $\ln\left(\frac{N}{N_0}\right) = -kt$, Half-Life $\left(t_{1/2} = \frac{\ln 2}{k}\right)$, Radioactive Dating (Carbon-14 and Urananium-238 Dating), Transuranium Elements, Particle Accelerator (Cyclotrons and Linear Accelerators)	23.3: Natural Radioactivity (pg. 975 to 978) 23.4: Nuclear Transmutation (pg. 978 to 980)		pg. 995 #21, 23 to 26, 28, 29; pg. 997–998 #66 to 68, 85 pg. 996 #33 to 36	
4	Nuclear Fission, Spontaneous Fission, Nuclear Chain Reaction (Subcritical, Critical, and Supercritical), Critical Mass, Atomic Bomb, Nuclear Fission Reactors (Reactor Core, Moderator, and Control Rods) and their Hazards, Light Water vs. Heavy Water Reactors, Breeder Reactors, Nuclear Fusion, Thermonuclear Reactions, Experimental Fusion Reactors, Hydrogen (Thermonuclear) Bomb, Radiotracers, Geiger-Müller (Geiger) Counter, Scintillation Counter, Measuring Radioactivity and Intensity (*curie* and *rad*), Natural and Man-made Radiations, Radicals, Effects of Radiation (Somatic and Genetic Damages) – Energy, Penetration ability and Ionization ability	23.5 & 23.6: Nuclear Fission and Nuclear Fusion (pg. 981 to 989) 23.7 & 23.8: Uses of Isotopes and Biological Effects of Radiation (pg. 989 to 994)		pg. 996 #38, 40, 41, 44 to 46 pg. 996 #50	
4	**Unit 4 Test (February 3, Friday)**				