Modern Physics

A. Atomic Physics and Quantum Effects *(Ch 27 & 28)*

Photons and the Photoelectric Effect:
Students should know the properties of photons so they can:
- Relate the energy of a photon in Joules or electron-volts to its wavelength or frequency. *(27.1)*
- Relate the linear momentum of a photon to its energy or wavelength, and apply linear momentum conservation to simple processes involving the emission, absorption, or reflection of photons. *(27.7)*
- Calculate the number of photons per second emitted by a monochromatic source of specific wavelength and power. *(27.1)*

Students should understand the photoelectric effect so they can:
- Describe a typical photoelectric effect experiment, and explain what experimental observations provide evidence for the photon nature of light. *(27.2)*
- Describe qualitatively how the number of photoelectrons and their maximum kinetic energy depend on the wavelength and intensity of the light striking the surface, and account for this dependence in terms of a photon model of light. *(27.2)*
- Determine the maximum kinetic energy of photoelectrons ejected by photons of one energy or wavelength, when given the maximum kinetic energy of photoelectrons for a different photon energy or wavelength. *(27.2)*
- Sketch or identify a graph of stopping potential versus frequency for a photoelectric effect experiment, determine from such a graph the threshold frequency and work function, and calculate an approximate value of h/e. *(27.2)*

Atomic Energy Levels:
Students should understand the concept of energy levels for atoms so they can:
- Calculate the energy or wavelength of the photon emitted or absorbed in a transition between specified levels, or the energy or wavelength required to ionize an atom. *(28.3)*
- Explain qualitatively the origin of emission or absorption spectra of gases. *(28.2 – 28.3)*
- Calculate the wavelength or energy for a single-step transition between levels, given the wavelengths or energies of photons emitted or absorbed in a two-step transition between the same levels. *(28.3)*
- Draw a diagram to depict the energy levels of an atom when given an expression for these levels, and explain how this diagram accounts for the various lines in the atomic spectrum. *(28.3)*

Wave-Particle Duality:
Students should understand the concept of DeBroglie wavelength so they can:
- Calculate the wavelength of a particle as a function of its momentum. *(27.7)*
- Describe the Davisson-Germer experiment, and explain how it provides evidence for the wave nature of electrons. *(27.7)*

Nature and Production of X-rays:
Students should understand the nature and production of x-rays so they can:
- Calculate the shortest wavelength of x-rays that may be produced by electrons accelerated through a specified voltage. *(27.3)*

A. Atomic Physics and Quantum Effects *(Ch 27 & 28)* - CONT

Compton Scattering:
Students should understand Compton scattering so they can:
♦ Describe Compton's experiment, and state what results were observed and by what sort of analysis these results may be explained. *(27.5)*
♦ Account qualitatively for the increase of photon wavelength that is observed, and explain the significance of the Compton wavelength. *(27.5)*

Equations – Atomic Physics & Quantum Effects *(Ch 27 & 28)*:

$$E = h \cdot f = p \cdot c \qquad\qquad K_{max} = h \cdot f - \phi \qquad\qquad \lambda = \frac{h}{p}$$

B. Nuclear Physics *(Ch 29)*

Half-Life in Radioactive Decay:
Students should understand the significance of half-life in radioactive decay so they can:
♦ Sketch or identify a graph to indicate what fraction of a radioactive sample remains as a function of time, and indicate the half-life on such a graph. *(29.3)*
♦ Determine, for an isotope of specified half-life, what fraction of the nuclei have decayed after a given time has elapsed. *(29.3)*

Nuclear Reactions (Including Conservation of Mass Number and Charge):
Students should understand the significance of the mass number and charge of nuclei so they can:
♦ Interpret symbols for nuclei that indicate these quantities. *(29.1)*
♦ Use conservation of mass number and charge to complete nuclear reactions. *(29.6)*
♦ Determine the mass number and charge of a nucleus after it has undergone a specified decay process. *(29.4)*
Students should know the nature of the nuclear force so they can:
♦ Compare its strength and range with those of the electromagnetic force. *(29.1)*
Students should understand nuclear fission so they can:
♦ Describe a typical neutron-induced fission and explain why a chain reaction is possible. *(30.1)*

Mass-Energy Equivalence:
Students should understand the relationship between mass and energy so they can:
♦ Qualitatively relate the energy released in nuclear processes to the change in mass. *(29.4)*
♦ Apply the relationship $\Delta E = (\Delta m) \cdot c^2$ in analyzing nuclear processes. *(29.6)*

Equations – Nuclear Physics *(Ch 29)*:

$$\Delta E = (\Delta m) \cdot c^2$$