Even Answers from Modern Physics by Taylor, Zafiratos, and Dubson

Ch. 1

(18) $\Delta N = 0.2$

(26a) $\gamma = 5/3$  \hspace{1cm} (b) $t_{1/2}(\text{lab}) = 3.0 \times 10^{-8}$ s \hspace{1cm} (c) $N = 1000$ \hspace{1cm} (d) $N = 100$

(46) $u' = -0.994c$

\[ u_x' = -v \]

(48a) $u_y' = c / \gamma$ \hspace{1cm} (b) $\theta' = \arctan \left( \frac{\gamma v}{c} \right)$ \hspace{1cm} (c) $u' = c$

\[ u_z' = 0 \]

(50) $f_{\text{obs}} = 0.58 f_{\text{xce}}$ (a 42% drop)

Ch. 2

(8) $E = 1.02 \times 10^{-13} \text{ J}$, 4/5 of the energy is rest energy.

(18) $u = 0.29c, \ m = 1673 \text{ MeV} / c^2 = 2.97 \times 10^{-27} \text{ kg}$

(20) $u = 447c$ (classical), $\beta \simeq 0.99999999995$

(24) $\Delta m = 2.42 \times 10^{-35} \text{ kg}$, fractional difference = $1.5 \times 10^{-8}$

(40) $\beta = 0.27$
Ch. 4

(4c) \( P = 71W \)

(14a) \( n \approx 10^{19} / s \) (b) \( N = 6 \times 10^{10} / s \) (c) 8 orders of magnitude greater

(16a) \( E = 25MeV \) (b) \( \frac{E_\gamma}{E_{\text{vis}}} = 2.2 \times 10^6 \text{ photons} \)

(18a) \( f_0 = 1.1 \times 10^{15} \text{ Hz} \) (b) \( K_{\text{max}} = 1.6eV \) (c) \( K_{\text{max}} = -0.5eV \) {no electrons emitted}

(24) \( E_\gamma = 6470V \)

(28a) \( p = \frac{p_0mc}{(mc + 2p_0)} \) (b) Result is the same in letting \( \theta = 180^\circ \) in Compton formula

Ch. 6

(30a) \( f_1 = 200Hz \) (b) \( f_1 = 800Hz \)

(34) \( \Delta x = a / \sqrt{6} \)

(42a) \( 0.85MeV \) (b) \( 2.5MeV \)

\[ E = \frac{Rc^4}{2G} \]

(44a) given (b) \( E = pc \approx \frac{hc}{2R} \) (c) \( R = 1.6 \times 10^{-33} m \) \( d_p \approx 10^{20} R \)

\[ R \approx \sqrt{\frac{Gh}{c^3}} \]

(46) \( \Delta E > 33MeV \)
Ch. 7

\[ E_1 = 8.2\text{MeV} \]
(18) \[ E_2 = 32.7\text{MeV} \]
\[ E_3 = 73.5\text{MeV} \]
(32) \[ P(0 \leq x \leq a/3) = 0.20 \]

(36a) Sketch of a parabola showing energy vs. \( x \), where for a given energy there are two values of \( x \) indicating classical turning points.
(b) \[ x = \pm \sqrt{2E/K} \]
(c) Increases by factor of \( \sqrt{2} \)

(44a) Linear plot of \( U(x) = mgx \)
(b) The ground state wavefunction does not have a node (cross the \( x \)-axis). Each higher state has one additional node.

Ch. 8

\[ x = r \sin \theta \cos \phi \]
(20) \[ y = r \sin \theta \sin \phi \]
\[ z = r \cos \theta \]
\[ r = \sqrt{x^2 + y^2 + z^2} \]
\[ \theta = \arctan \left( \frac{z}{r} \right) \]
\[ \phi = \arctan \left( \frac{y}{x} \right) \]

(30) If \( \ell = m = 1 \), we have
\[ \frac{1}{\sin \theta} \frac{d}{d\theta} \left( \sin \theta \frac{d\Theta}{d\theta} \right) = \left( \frac{1}{\sin^2 \theta} - 2 \right) \Theta \]
Using \( \Theta = \sin \theta \), the equation is satisfied.
\[ \psi = R(r) \sin \theta e^{i\phi} \] so \( |\psi|^2 \) is a maximum when \( \theta = \pi/2 \)

(38a) Three possible states with \( \ell = 2, 3, \) or 4
(b) \( n - |m| \) possible states.

(42) \[ \langle r \rangle = 1.5a_B \]

(48) \[ r_{ap} = a_B \]

Ch. 10

18a) \[ IE_2 = 54.4eV \]
(b) \[ B = 79.0eV \]
Ch. 11

(24) There are 8 possible transitions that obey the selection rule \( \Delta \ell = \pm 1 \)

(28) Draw transitions from \( \ell' = 1, m_\ell = \{-1,0,1\} \) to \( \ell = 2, m_\ell = \{-2,-1,0,1,2\} \) states. There should be 7 distinct values of \( E - E' \). Since the only allowed values of \( m - m' \) are 0 and \( \pm 1 \), there are just 3 distinct photon frequencies.

Ch. 12

(14) \( R_c = 2.0 \text{nm} \)

(16) \( B = 4.67 \text{eV} \)

(30a) valence is 0 \hspace{1cm} (b) valence is 2 \hspace{1cm} (c) BeF\(_2\), BeO, Be\(_3\)N\(_2\)

(34) Three lowest energies: \( 0.14eV, 0.43eV, 0.72eV \)

Ch. 13 Even Answers

(12) Six nearest neighbor sodium ions at a distance of \( 2r_0 \)

(16) Number of states is: \( 2(2\ell + 1)N \)

(34a) insulator \hspace{1cm} (b) conductor \hspace{1cm} (c) insulator

Chapter 15 Even Answers

(8a) \( E_{\text{tot}} = \frac{1}{2} RT \) \hspace{1cm} (b) \( C_V = \frac{7}{2} R = 12.5 J / \text{mol} \cdot K \)

(14a) \( \frac{P_{\text{low}}}{P_{\text{high}}} = e^{\frac{2\mu B}{kT}} \) \hspace{1cm} (b) 1.0046 \hspace{1cm} (c) \( T = 1.9 K \)

(34) \( 2^N \) \hspace{1cm} (b) \( Nk \ln 2 \) \hspace{1cm} (c) \( \Delta S = Nk \ln 4 \)

(38a) \( N = \frac{k_\ell a^3}{3\pi^2} \rightarrow E_\nu = \frac{\hbar^2 (3\pi^2 N / a^3)}{2m} \) \hspace{1cm} (b) 4.0eV