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

Ch. 1

(18) $\Delta N = 0.2$

(26a) $\gamma = 5/3$ (b) $t_{1/2}(lab) = 3.0\times10^{-8}s$ (c) $N = 1000$ (d) $N = 100$

(46) $u' = -0.994c$

(48a) $u'_x = -v$, $u'_y = c/\gamma$, $u'_z = 0$ (b) $\theta' = \arctan\left(\gamma v/c\right)$ (c) $u' = c$

(50) $f_{obs} = 0.58 f_{sce}$ (a 42% drop)

Ch. 2

(8) $E = 1.02\times10^{-13}J$, 4/5 of the energy is rest energy.

(18) $u = 0.29c$, $m = 1673MeV/c^2 = 2.97\times10^{-27}kg$

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

(24) $\Delta m = 2.42\times10^{-35}kg$, fractional difference = 1.5×10^{-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) $\frac{E_\gamma}{E_{vis}} = 2.2\times 10^6$ *photons*

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

(24) $E_\gamma = 6470V$

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

Ch. 6

(30a) $f_1 = 200Hz$ (b) $f_4 = 800Hz$

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

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

(44a) given (b) $E = Rc^4 / 2G$, $E = pc \approx \hbar c / 2R$, $R \approx \sqrt{G\hbar / c^3}$ (c) $R \simeq 1.6\times 10^{-35} m$ $d_P \sim 10^{20} R$

(46) $\Delta E > 33MeV$

Ch. 7

(18) $E_1 = 8.2 MeV$
$E_2 = 32.7 MeV$
$E_3 = 73.5 MeV$

(32) $P(0 \le x \le a/3) = 0.20$

(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

(20)
$$x = r\sin\theta\cos\phi \qquad r = \sqrt{x^2 + y^2 + z^2} \qquad \theta = \arctan(z/r)$$
$$y = r\sin\theta\sin\phi \qquad \phi = \arctan(y/x)$$
$$z = r\cos\theta$$

(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.
$\psi = R(r)\sin\theta e^{\pm i\phi}$ 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) $\langle r \rangle = 1.5 a_B$

(48) $r_{mp} = a_B$

Ch. 10

18a) $IE_2 = 54.4 eV$ (b) $B = 79.0 eV$

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 ± 1, there are just 3 distinct photon frequencies.

Ch. 12

(14) $R_c = 2.0nm$

(16) $B = 4.67eV$

(30a) valence is 0 (b) valence is 2 (c) BeF_2, BeO, Be_3N_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 (b) conductor (c) insulator

Chapter 15 Even Answers

(8a) $E_{tot} = \frac{3}{2}RT$ (b) $C_V = \frac{3}{2}R = 12.5J/mol \cdot K$

(14a) $\frac{P_{low}}{P_{high}} = e^{2\mu_B B/kT}$ (b) 1.0046 (c) $T = 1.9K$

(34) 2^N (b) $Nk\ln 2$ (c) $\Delta S = Nk\ln 4$

(38a) $N = \frac{k_F^3 a^3}{3\pi^2} \rightarrow E_F = \hbar^2(3\pi^2 N/a^3)/2m$ (b) $4.0eV$