Chapter 16 Answers (assigned)

(1) When negative charge is removed from your hair, each hair becomes slightly positively charged. Thus each hair is repelled from the others and "stands up" in an attempt to get as far away as possible from the others.

(3a) $\vec{F}_1 = \boxed{9\times10^{-6}\,N}$ to the right (b) $\vec{F}_1 = \boxed{9\times10^{-6}\,N}$ to the left (Newton's 3rd Law).

(4) $\vec{F} = \boxed{(8.146\times10^{-24}\,N, -3.374\times10^{-24}\,N)} = \boxed{8.817\times10^{-24}\,N \text{ @ } -22.5^\circ}$

(5) $q = \boxed{\pm 2.357\,\mu C}$ {i.e., you can't determine whether the charges are positive or negative}

(7) $q = \boxed{\dfrac{3.33\times10^{-10}}{Q}}$

(8) $E = \boxed{3{,}000\,N/C}$

(9) $a = \boxed{6.0\,m/s^2}$

(10) $\vec{E} = \boxed{6.44\times10^{6}\,N/C}$ upward.

(13) $E = \boxed{10{,}208\,N/C}$

(14) $q = \boxed{1.25\times10^{-7}\,C}$

(18a) $F_{Na,Cl} = \boxed{2.65\times10^{-9}\ N}$ (b) $\vec{p} = \boxed{9.1\,D}$ {pointing from Cl to Na}

(21a) $F_{O,O} = \boxed{2.34\times10^{-10}\ N}$ (b) $\vec{p} = \boxed{(-0.745, -1.29)\,D}$ or $\vec{p} = \boxed{1.49\,D \text{ @ } 240^\circ}$

(23) $F_{net\ on\ Na} = \boxed{2.54\times10^{-9}\ N}$ {attractive toward the oxygen}

Chapter 17 Answers (assigned)

(2a) $U_i = \boxed{5.76\times10^{-25}J}$ $U_f = \boxed{3.21\times10^{-25}J}$ (b) $\Delta U = \boxed{-2.55\times10^{-25}J}$ (c) $W_{ext} = \boxed{-2.55\times10^{-25}J}$

(5a) $U = \boxed{-4.36\times10^{-18}J}$ (b) $\Delta U = \boxed{3.27\times10^{-18}J}$; only the radius matters.

(7a) $U = \boxed{375\mu J}$ (b) $V = \boxed{23.3V}$

(8a) $\Delta U = \boxed{4.8\times10^{-15}J}$ (b) A is at higher potential ($V_A = 40kV; V_B = -10kV$)

(12a) $V_{right\ most} = \boxed{-300V}$ (b) $V_A = \boxed{250V}; V_B = \boxed{0V}; V_C = \boxed{0V}; V_A = \boxed{-200V}$
(c) $\bar{E}_A \sim \boxed{10,000V/m}$; $\bar{E}_B$ = can't tell; $\bar{E}_C \sim \boxed{5,000V/m}$; $\bar{E}_D \sim \boxed{5,500V/m}$

(13a) $\Delta U = \boxed{3.2\times10^{-17}J}$ (b) $\Delta U = \boxed{0J}$

(15) $E_{origin} = \boxed{6,000V/m}$ downward

(16a) $\Delta U = \boxed{-2.4\times10^{-16}J}$ (b) $v = \boxed{2.3\times10^{7}m/s}$

(17a) $\Delta K = \boxed{-2.09\times10^{-16}J}$ (b) $\Delta U = \boxed{2.09\times10^{-16}J}$ (c) $\Delta V = \boxed{1,300V}$
(d) $\bar{E} = \boxed{373V/m}$

(18a) $C = \boxed{1.77pF}$ (b) $V = \boxed{4,240V}$ (c) $C = \boxed{0.885pF}$

(19a) $U = \boxed{2.7mJ}$ (b) $Q = \boxed{900\mu C}$

(20) $A = \boxed{3\times10^{12}m^2}$

(21a) $U = \boxed{364.5J}$ (b) $Q = \boxed{0.405C}$ (c) $\bar{P} = \boxed{66.3GW}$

(22a) $V_{finger} - V_{knob} = \boxed{14,000V}$ (b) $C = \boxed{1.79pF}$

Chapter 18 Answers (assigned)

(1a) $R = \boxed{1.9m\Omega}$ (b) $I = \boxed{4,762A}$ {theoretically…but as it turns out a 9V battery can't actually provide this much current}

(3) $\Delta V = \boxed{120V}$

(5) $Q = \boxed{444C}$

(6a) $R_f = \boxed{0.2624\Omega}$ (b) $\rho = \boxed{3.608\times10^{-8}\Omega\cdot m}$ (c) $\sigma = \boxed{2.772\times10^{7}S}$
(d) $\ell = \boxed{5.71m}$

(7) $R = \boxed{1.20\Omega}$

(8) $T = \boxed{1,131^{\circ}C}$

(9) $I = \boxed{18.75A}$

(10a) $I = \boxed{0.33A}$ (b) $R = \boxed{360\Omega}$

(11a) $R_{eq} = \boxed{60\Omega}$ (b) $I = \boxed{0.2A}$ (c) $P_1 = \boxed{0.4W}$; $P_2 = \boxed{0.8W}$; $P_3 = \boxed{1.2W}$
(d) $\Delta V_1 = \boxed{2V}$; $\Delta V_2 = \boxed{4V}$; $\Delta V_3 = \boxed{6V}$ {See how the voltages add to the battery voltage?}

(12a) $R_{eq} = \boxed{5.45\,\Omega}$ (b) $I_1 = \boxed{1.2A}$; $I_2 = \boxed{0.6A}$; $I_3 = \boxed{0.4A}$
(c) $P_1 = \boxed{14.4W}$; $P_2 = \boxed{7.2W}$; $P_3 = \boxed{4.8W}$ (d) $\Delta V_1 = \Delta V_2 = \Delta V_3 = \boxed{12V}$

(13) $R = \boxed{75\Omega}$

(14) $R = \boxed{100\Omega}$

(19a) $P = \boxed{10.1W}$ (b) $P = \boxed{7.2W}$

(20a) $I_{100W} = \boxed{2.67A}$; $I_{60W} = \boxed{1.33A}$ (b) $P_{100W} = \boxed{52.6\,W}$; $P_{60W} = \boxed{127\,W}$ (c) $P = \boxed{0W}$

(21a) $I = \boxed{17.5A}$ (b) $I = \boxed{30A}$ (c) Yes, circuit is overloaded. (d) No, $I = \boxed{22.5A}$

(22) $R_{eq} = \boxed{22.5\Omega}$

(23) $R_{eq} = \boxed{2.33\Omega}$

(24a) $I_{left} = \boxed{0.5A}$ {each resistor on the left}; $I_{right} = \boxed{2A}$ {single resistor on the right}

(b) $P_{supplied} = \boxed{25\,W}$

(27) $R_1 = R_2 = \boxed{1.2A}$; $R_3 = \boxed{2.4A}$

(28) $I_1 = 0.5A$ (down left branch); $I_2 = 1.5A$ (up middle branch); $I_3 = 1.0A$ (down right branch)

(29) $I_{left} = \boxed{2A}$; $I_{right} = \boxed{2A}$; $\Delta V = \boxed{40V}$

Chapter 19 Answers

(1) $v = \boxed{40,000 m/s}$

(2a) Out of the page (b) ½ as large because $\sin 30^\circ = 0.5$

(3) $q = \boxed{3e}$

(4a) $F = \boxed{3.51\times10^{-19} N}$ (b) $a = \boxed{3.85\times10^{11} m/s^2}$

(5a) down (b) into the page (c) into the page (d) right
(e) up & to the right

(6a) $F = \boxed{0.395N}$ (b) The force points down and into the page (at an angle of 18.4°)

(7) $B = \boxed{3.3T}$

(8a) $\ell = \boxed{2.0m}$ (b) Force is up

(9a) $F = \boxed{4.24N}$ (b) Force is out of the page

(10) Calling out of the page positive and into the page negative, the sum of the forces is:
$F_{net} = +Ib\sin 150^\circ + (-Ib\sin 30^\circ) + Ia\sin 60^\circ + (-Ia\sin 120^\circ) = 0$

(11) $B_A = \boxed{2.5\times10^{-5}T}$ out of the page; $B_B = \boxed{5.0\times10^{-5}T}$ into the page

(12) $B_A = \boxed{2.0\times10^{-5}T}$ to the left; $B_B = \boxed{1.0\times10^{-5}T}$ up

(13) $I = \boxed{1.0A}$ into the page

(14) $B_A = \boxed{1.6\times10^{-5}T}$ up; $B_B = \boxed{2.13\times10^{-5}T}$ up; $B_C = \boxed{1.28\times10^{-5}T}$ down

(15a) $F_{left\ wire} = \boxed{12\mu N}$ to the left (b) $F = \boxed{1.6\times10^{-4}T}$ to the left

(16) Putting a wire $3.33cm$ to the right of the wire carrying $2A$.

(17a) $B = \boxed{8.88\times10^{-6}T}$ down (b) $B = \boxed{1.78\times10^{-5}T}$ down (c)
$B = \boxed{0T}$

(18a) $B = \boxed{2.41\times10^{-8}T}$ (b) This is 4.8×10^{-4} of Earth's field.

(19) $I = \boxed{39.8A}$

(20) $N = \boxed{1{,}137\ turns}$

(21) $I = \boxed{60.9A}$

(22) $B_{inner} = \boxed{1.36T}$ (b) $B_{inner} = \boxed{0.68T}$

(23) $\vec{B} = \boxed{2.11\times10^{-6}T}$ at 135° to the positive x-axis.

Chapter 20 Answers

(1) $\Phi_B = \boxed{0.001\,Wb}$

(2) $\theta = \boxed{60^\circ}$

(3a) $\varepsilon = \boxed{25\,mV}$ (b) $I = \boxed{0.25\,A}$

(4a) $\Phi_B = \boxed{-0.020\,Wb}$ (b) $\Phi_B = \boxed{+0.0035\,Wb}$

(5) $A = \boxed{3m^2}$

(6a) Into the page (b) It will start to decrease (rapidly!) (c) Clockwise

(7a) Counterclockwise (b) zero (c) An induced current begins to flow clockwise

(8a) $\Phi_B(t) = \pi(0.2\,m)^2 0.3\sin(2\pi(60)t) = \boxed{0.0377\sin(377t)\,Wb}$

(b) $\varepsilon_{max} = \omega B_{max}\pi r^2 = 2\pi(60\,Hz)(0.0377\,Wb) = \boxed{14.2\,V}$

(9) $I = \boxed{1.42A}$

(10) $L = \boxed{14.2H}$

(11a) $L = \boxed{17.8\,H}$ (b) $t = \boxed{5.2\,s}$

(12a) $U_L = \boxed{49.5kJ}$ (b) $t = \boxed{3{,}300s}$

(13) $R = \boxed{0.011\Omega}$

(14a) $RC = \boxed{56.4ns}$ (b) $Q = \boxed{9.0\,pC}$

(15) $RC = 3.69s$ and $C = 0.0278F$, so $R = \boxed{133\,\Omega}$

(16a) $Q = \boxed{3.57\times10^{-4}C}$ (b) $I = \boxed{0.0325A}$ (c) $U_C = \boxed{2.9\times10^{-4}\,J}$

(d) $P = \boxed{0.053W}$

(17) $R = \boxed{4.7\ \Omega}$, $C = \boxed{42.5\ \mu F}$

(18a) $C = \boxed{1.33\ F}$ (b) $R = \boxed{0.93\ \Omega}$

(19) $C = \boxed{40\ nF}$

(20a) $f = \boxed{145\ Hz}$ (b) $I_{max} = \boxed{22.7\ mA}$ (c) $U = \boxed{14.2\ \mu J}$

(21) $C = \boxed{0.74\ nF}$, $L = \boxed{23.8\ H}$

(25a) $\Delta V_{pole} = \boxed{1600\ V}$ (b) $N_s / N_p = \boxed{3/40}$

(26a) $P = \boxed{135\ W}$ (b) $I_{outlet} = \boxed{1.12\ A}$ (c) $N_s / N_p = \boxed{19/120}$

(27) $I_{house} = \boxed{1.1\ A}$, $I_{TV\ circuit} = \boxed{5.28\ mA}$

Ch. 21a (AC circuits) Answers

(1a) $170V$; $0V$ (b) $V_{rms} = \boxed{120V}$ (c) $I_{rms} = \boxed{16.0A}$

(2a) $V_{\max} = \boxed{0.47V}$ (b) $V_{rms} = \boxed{0.33V}$

(3) $V_{\max} = \boxed{311V}$ and $T = \boxed{0.02s}$

(4) By using AC, the electric company can transmit power at very high voltage – and thus, very low current, which reduces I^2R losses along the transmission lines.

(5a) $N_s / N_p = \boxed{9/114}$ (b) $N_s = \boxed{0.48}$

(6) $P = \boxed{18kW}$ (b) $P = \boxed{1.8MW}$ (c) $I = \boxed{1.5A}$

Ch. 22 Answers

(1) It does not require a medium in which to travel and is composed of oscillating electric and magnetic fields.

(2) $d = \boxed{30cm}$

(3) $\Delta t \sim \boxed{170{,}000\ yr}$

(4) They all travel at the speed of light in vacuum.

(5) As energy increases, the frequency increases and the wavelength *decreases*.

(6) The wave will travel in the negative *z*-direction (according to the RHR).

(7) $n = 1.42$

(8a) $\lambda_n = \boxed{260\ nm}$ (b) At this wavelength the light is not visible to the human eye.

(9) $\Delta t = \boxed{1.44\ \mu s}$

(10a) $\overline{I} = \boxed{7.96\, W/m^2}$ (b) $E_0 = \boxed{77.4\, V/m}$

(11) $\theta = \boxed{33.2^{\circ}}$

(12) $I/I_0 = 0.933$, so 0.067 or $\boxed{6.7\%}$ is blocked.

(13a) $B_0 = \boxed{8.33\mu T}$ (b) $U = \boxed{27.7\ pJ}$

(14) $u_{EM} = \boxed{\dfrac{B_0^2}{2\mu_0}}$

(15) The SI units of intensity are energy per unit time per unit area or: W/m^2

(16a) $P_{sun} = \boxed{3.6\times10^{26} W}$ (b) $\overline{I}_{@\,Pluto} = \boxed{0.82 W/m^2}$

(17a) $\overline{I} = \boxed{3.75\times10^{6} W/m^2}$ (b) $U = \boxed{0.3\ J}$ (c) $E_0 = \boxed{5.3\times10^{4}\ V/m}$

(18a) $p = \boxed{2.0\times10^{-8} kg\cdot m/s}$ (b) $P = \boxed{0.025 N/m^2}$ (c) $\bar{F} = \boxed{1.25\times10^{-4} N}$

(19a) $A = \boxed{10^7 m^2}$ {if square, about $3.16 km$ on a side!} (b) $a = \boxed{8.0\times10^{-6} m/s^2}$

(20a) $\bar{I} = \boxed{3{,}183 W/m^2}$ () $P = \boxed{1.06\times10^{-5} N/m^2}$ (c) $\bar{F} = \boxed{1.27\times10^{-10} N}$

(21) $\bar{I} = \boxed{9.1\times10^{7}\ W/m^2}$

(22a) $v = \boxed{1.76\times10^{8}\ m/s}$ (b) $n = \boxed{1.7}$ (c) $\varepsilon = \boxed{9.6\times10^{-11}\ N\cdot m^2/C^2}$

(23) Less than one octave (a little more than ¾ of one).

Chapter 23 Answers

(1) $\theta_{exit} = \boxed{30^\circ}$

(2) $\theta = \boxed{12^\circ}$

(3) $\theta = \boxed{4^\circ}$

(4a) $\theta_i = \boxed{70^\circ}$ (b) $y = \boxed{19cm}$

(5a) $\theta_i = \boxed{90^\circ}$ (b) $\theta_r = \boxed{48.8^\circ}$

(6) $H = 2d \tan\theta_c = \boxed{2.28d}$

(7a) $\theta_i = \boxed{30^\circ}$ (b) $\theta_i = \boxed{15.1^\circ}$ (c) $h = \boxed{1.347cm}$

(8) After three reflections inside the beam has traveled $L = \boxed{18.7cm}$ into the rod.

(9) $\theta_{blue} = \boxed{37.398^\circ}$; $\theta_{red} = \boxed{38.471^\circ}$

(10) $\theta = \boxed{18.8^\circ}$

(11) $\theta = \boxed{8.0^\circ}$; *meaning it nearly exits nearly straight out the top (table).*

(12) $x = \boxed{0.2365\ cm}$

(13) $h = \boxed{0.606\ in}$

(14) $x = \boxed{11.3\ cm}$

Chapter 24 Answers

(1a) $q = \boxed{60cm}$; $M = \boxed{-3}$. (b) The image is real and inverted.

(2a) $f = \boxed{-5cm}$; (b) Image is located $3.33cm$ behind the mirror ($q = \boxed{-3.33cm}$).

(3) You should see 5 images in addition to the object.

(4a) $p = \boxed{45cm}$; (b) The image is upright and virtual.

(5) The fish appears closer to the side of the bowl than it really is.

(6a) The image appears on the same side as the object (front, that is).
(b) $M = 1.5$, so image is $\boxed{6.0cm}$ tall. (c) Image is upright since $M > 0$

(7) $q = \boxed{-15cm}$, $p = \boxed{60cm}$ (i.e., the image appears on the same side as the object)

(8) The second converging lens should be placed $\boxed{160cm}$ to the right of the first lens.

(9) The insect should be placed $p = \boxed{5cm}$ from the lens.

(10) A diverging lens should be used so rays entering the eye focus further back at the retina.

(11) Final image is located $\boxed{60cm}$ to the right. The overall magnification is $\boxed{-4}$, meaning the image is inverted. The effective focal length is $f_{eff} = \boxed{12cm}$.

(12) Without the diverging lens, the image is located $\boxed{30cm}$ to the right (half as far as in problem 11). That is, with the diverging lens, the image is moved further back (as in, towards the retina).

(13) The final image is located $\boxed{157.5cm}$ to the right of lens. The overall magnification is $\boxed{0.75}$, meaning the image is upright, but slightly smaller.

(14) The bottom left- and right-hand corners are located at $26.25cm$ and $15.0cm$ to the left of the lens. The top left- and right-hand corners have the same horizontal locations but they have difference magnifications (since each point is a different distance from the lens.) The top right corner appears $6cm$ tall, and the top left corner appears $7.5cm$ tall. Thus, the image is distorted and no longer appears to be a square. This is called *spherical aberration* and is something a camera lens manufacturer works to overcome.

(15a) $f_{eye} = \boxed{1.85\,cm}$ for objects at the near point, (b) $f_{eye} = \boxed{2.00\,cm}$ for objects at infinity.

Chapter 25 Answers (assigned problems)

(1) $d = \boxed{0.29\,mm}$

(3) Need path-length difference ($\pi R - 2R$) to be at least ½ a wavelength. $R = \boxed{192.7\,nm}$

(5a) $d = \boxed{2.466\times 10^{-6}\ m}$ (b) $\boxed{416\,nm}$, $\boxed{441\,nm}$, $\boxed{496\,nm}$, $\boxed{681\,nm}$ {using $\sin\theta \sim y/L$ }

$\boxed{410\,nm}$, $\boxed{434\,nm}$, $\boxed{486\,nm}$, $\boxed{656\,nm}$ {no approximation}

(7a) $t_{min} = \boxed{107.8\,nm}$ (b) $\lambda_{transmitted} = \boxed{297.5\,nm}$

(8) $t_{min} = \boxed{139.5\,nm}$

(11) $\lambda = \boxed{440\,nm}$

(12) $s = \boxed{2,030\,m}$ {arc length distance apart}

(13) $R = \boxed{21.4\,m}$ {using rectangular slit} *or* $R = \boxed{17.6\,m}$ {using circular aperture}

The actual value would be somewhere in between since the feline pupil is bi-convex in shape.

(15) $s = \boxed{0.183\,m}$

(17) $\boxed{565\,dpi}$ {if diffraction was the only limitation – there are other limitations}

(20) $\lambda = \boxed{420\,nm}$

Chapter 27 Answers (assigned problems)

(1a) $P = \boxed{3.85\times10^{-7}\ W}$ (b) $f = \boxed{4.88\times10^{14}\ Hz}$ (c) $N = \boxed{1.19\times10^{12}\ photons}$ per second.

(2) $visible\ fraction \sim 41/101 = \boxed{40.6\%}$

(4) $T = \boxed{1.5\ K}$

(7a) $E = \boxed{27.56\ eV}$ (b) $v_{max} = \boxed{2.94\times10^{6}\ m/s}$

(9) $\phi = \boxed{3.68\ eV}$

(11) $\theta = \boxed{41.85^{\circ}}$

(12a) $\lambda = \boxed{1.29982\ nm}$ {longer wavelengths don't shift much!} (b) $f = \boxed{2.308\times10^{17}\ Hz}$

(15) *It's not possible, since the shortest wavelength corresponds to* $13.6\ eV$, $\lambda = \boxed{91.18\ nm}$.

(17a) $n = \boxed{5}$ (b) $n_f = 3$ so, $\lambda_{emitted} = \boxed{1282\ nm}$ {*infrared*}

(19) $\lambda_{min} = \boxed{364.7\ nm}$

(21a) $n = \boxed{6}$ (b) $\lambda_{emitted} = \boxed{93.78\ nm}$ {UV}

(22) *At least in the* $n = \boxed{3}$ *level.*

(23a) Beryllium has four protons. Removing $\boxed{3}$ electrons makes it Be^{3+}.

(b) $E_1 = \boxed{-217.6\ eV}$ (b) You must add $\boxed{217.6\ eV}$ (c) $\lambda = \boxed{5.71\ nm}$

(24) $Z = \boxed{5}$ {Boron}