Answers to Example Problems - Chapter 21

EX A.) 6.25×10^{19} e^-

EX B.) # of atoms = $(1\times10^{-4}\text{ g})(6.02\times10^{23})/(12\text{ g/mole})$
# of atoms = 5.02×10^{19}

of e^- per atom: 6

of e^- = 3.01×10^{19}

EX C.) $F = Cq_1q_2/r^2$
$F = (8.99\times10^{9})(4.816\text{ C})(4.816\text{ C})/(0.12\text{ m})^2$
$F = 1.44 \times 10^{13}$ N

EX D.) $F_{12} = (8.99\times10^{9})(1.0\times10^{-3}\text{ C})(1.5\times10^{-3}\text{ C})/(0.1\text{ m})^2$
$F_{12} = 135\times10^{6}$ N

$F_{13} = 24\times10^{6}$ N

$F_{14} = 100\times10^{6}$ N

$F_x = -111$ N
$F_y = -100$ N

$F = 150\times10^{6}$ N at 48° W of N (138°)

EX F.) a.) The leaves spread out.
b.) the leaves spread out and then fall back
c.) the leaves come closer together
d.) same
e.) leaves fall back together when grounded
f.) the leaves spread apart and stay apart

EX TREE.) When rubbed on hair, it becomes charged by friction. When placed on the wall, it charges the wall by induction and it is attracted to the wall. Since they are both insulators, they do not exchange charges easily, thus they stay attracted for a while. After enough charge is exchanged (conduction), the balloon is not longer attracted and it falls down.

Answers to Example Problems - Chapter 22

EX JUHY.) 1.5×10^3 N/C

EX B.) $F = qE = 1.28 \times 10^{-5}$ N
$F = ma \Rightarrow a = F/m$
$a = 2 \times 10^{-1}$ m/s^2
$v_f = 6 \times 10^{-1}$ m/s

EX C.) When it leaves the plates:

$V_x = V$
$V_y = at$

$a = qE/m$

$t = L/v_x$

$V_y = qEL/mv_x$

$\tan\theta = V_y/V_x = qEL/mv_x^2$

$\tan\theta = h_1/d$

$h_1 = qELd/mv_x^2$

$h_2 = v_yt + (1/2)at^2$
$h_2 = (1/2)(qE/m)(L^2/v_x^2)$

$h = h_1 + h_2$
$h = qEL/mv_x^2(L/2 + d)$

EX RTEF.) $E = Cq/r^2$
$E = (8.99 \times 10^9)(5\text{ C})/(2\text{ m})^2 = 1.12 \times 10^{10}$ N/C

$E_{1/2} = 4.50 \times 10^{10}$ N/C @ 2.83 m

EX D.) $E = Cq/r^2$
$E = (8.99\text{x}10^9)(91)(1.6\text{x}10^{-19})/(3.4\text{x}10^{-15})^2$
$E = 1.125 \times 10^{22}$ N/C

$F = qE = 1799$ N

EX E.) $E_4 = (8.99\text{x}10^9)(4\text{x}10^{-6})/(0.008\text{ m})^2$
$E_4 = 5.6\text{x}10^8$ N/C
$E_{12} = 8.9\text{x}10^8$ N/C
$E_{4x} = 2.8 \times 10^8$

$E_{4y} = 5.0 \times 10^8$
$E_{12x} = -6.3 \times 10^8$
$E_{12y} = 6.3 \times 10^8$

$E_x = -3.5 \times 10^8$
$E_y = 1.1 \times 10^9$

$E = 1.15 \times 10^9$ N/C

$\theta = 107^\circ$

EX IUYT.)

EX UIYH.)

EX TRFD.)

EX F.) $(1+ x)^3 = 1 + 3x + 3x^2 + x^3$

1st order: 1 + 0.75 = 1.75
2nd order: 1 + 0.75 + 0.1875 = 1.9375
3rd order: 1 + 0.75 + 0.1875 + 0.015625 = 1.953125

actual: 1.953125

EX G.) $x^6(1 + y/x)^6 + x^3(1 + y/x)^3$

$x^6[1 + 6y/x + ...] + x^3[1 + 3y/x + ...]$

$7529536[1 + 6y/x] + 2744[1 + 3y/x]$

$7529536 + 3226944y + 2744 + 588y = 16781312$

$3227532y = 9249032$

$y = 2.86$ (pretty close...)

EX H.) $E = E_+ - E_-$

$E = Cq/r_+^2 - Cq/r_-^2$

$E = Cq(1/r_+^2 - 1/r_-^2)$

$E = Cq\{1/(z-d/2)^2 - 1/(z+d/2)^2\}$

$E = Cq/z^2\{(1-d/2z)^{-2} - (1+d/2z)^{-2}\}$

expand...

$E = Cq/z^2\{(1+d/z+3d^2/4z^2+...) - (1-d/z+3d^2/4z^2+...)\}$

$E = Cq/z^2\{2d/z\}$

$E = qd/2\pi\varepsilon_\circ z^3$

$E = p/2\pi\varepsilon_\circ z^3$

EX I.) It would produce torques around the center, with $\Sigma F=0$, thus it would rotate to match the field lines:

$\Sigma T = F_+ a\sin\theta + F_- a\sin\theta$

$\Sigma T = 2qEa\sin\theta$

$\Sigma T = pE\sin\theta$

Answers to Example Problems - Chapter 23

EX B.) $\Delta U = -W = qEd = 8.64 \times 10^{-19}$ J

EX C.) $\Delta V = -Ed\cos\theta = -1.425 \times 10^{-18}\cos 180°$
$\Delta U = 1.2 \times 10^{-18}$ J
$\Delta V = 2.5$ V

EX D.) $\Delta V_1 = -Ed = -(8\text{ N/C})(0.1)\cos 30° = -0.69$ V
$\Delta V_2 = -Ed = -(8\text{ N/C})(0.04)\cos 135° = 0.23$ V
$\Delta V_3 = -Ed = 0$
$\Delta V_4 = -Ed = -(8\text{ N/C})(0.15)\cos 180 = 0.12$ V
$\Delta V = -0.34$ V

EX E.) $V_A = Cq/r = 5.4 \times 10^{11}$ V
$V_B = Cq/r = 1.0 \times 10^{12}$ V

$\Delta V = V_A - V_B = 4.6 \times 10^{11}$ V

EX F.) a.) $T_i = T_f + \Delta U$
$0 = (0.5)mv^2 + Cq_1q_2/r$
$v = \text{sqr}(-2Cq_1q_2/mr) = \text{sqr}(3.7 \times 10^8)$
$v = 1.9 \times 10^4$ m/s

b.) $T_i = T_f + \Delta U + \text{Push}$
$T_i = (0.5)mv^2 = 9.4 \times 10^6$ J
$T_f = (0.5)m(9)v^2 = 8.5 \times 10^7$ J
$\Delta U = U_Q - U_P = -1.4\text{x}10^7$ J $+ 9.4\text{x}10^6$ J $= -4.6\text{x}10^6$ J
$\text{Push} = -7.1 \times 10^7$ J

c.) $W = \Delta T$
$Fd = -(0.5)mv_i^2$
$F = 1.6 \times 10^{11}$ N

EX DD.) $V_1 = Cq_1/r = 6.7 \times 10^9$ V
$V_2 = Cq_2/r = 6.0 \times 10^9$ V
$V = V_1 + V_2 = 1.27 \times 10^{10}$ V

Answers to Example Problems - Chapter 24

EX G.) Lorentz force out of the page

EX H.) 384 N down the page

EX I.) $qvB = mv^2/r$
$r = mv/qB$

EX J.) Particles that go up are positive, down are negative
Tight spirals are either slow or light particles

Answers to Example Problems - Chapter 25

EX W.) $B = 1.2 \times 10^{-5}$ T
12% of earth's magnetic field

EX X.) $i = 2\pi rB/\mu_o = 3.2 \times 10^9$

EX Y.) $F = iLB\sin\theta = 1.74$ N into the page

EX Z.) $F/L = \mu_o i_1 i_2/2\pi d$
$i^2 = 1.875 \times 10^5$ A^2
$i = 433$ A

EX AA.) $\Sigma F = 0$
$F - mg = 0$
$L\mu_o i_1 i_2/2\pi d = mg$

$i_2 = 2\pi^2 d\rho r^2 g/\mu_o i_1$

$i_2 = 1.1 \times 10^7$ A
(antiparallel)

Answers to Example Problems - Chapter 26

EX D.) Current is unaffected by obstacles.

EX F.) Current is affected by branches in the wires.

EX K.) 3 ohms

EX U.) Through the 10 ohm resistor: i = 0.6 Amps
Through the 2 ohm resistor: i = 3 Amps

EX E.) A.) It would add a lot of resistance to the circuit, and measure zero.
B.) It would siphon off a lot of the current, since it is low resistance and would measure its own current.

Answers to Example Problems - Chapter 27

EX R.) $6\ V - iR = 0$
$i = 0.6\ A$

EX J.) $6\ V - 9i = 0$
$i = 0.43\ A$

$V = iR = 2.15\ V$

EX V.) $3\ V - 9i - 4\ V - 12i = 0$
$-21i = 1\ V$
$i = -0.05\ A$ (note: negative)

EX C.) $6\ V - 5i = 0$
$i_5 = 1.2\ A$

$6\ V - 9i = 0$
$i_9 = 0.67\ A$

EX O.) $i = i_1 + i_2 = 1.87\ A$

EX F.) $6\ V - 9i = 0$
$i_9 = 0.67\ A$

$6\ V - 15i - 5\ V = 0$
$1\ V = 15i$
$i_{15} = 0.07\ A$

$i = i_1 + i_2 = 0.74\ A$

EX I.) $-6i_1 + 9i_2 = 0$
$i_2 = (6/9)i_1$

$i_1 + i_2 = 5.15$

$i_2 = 2.06\ A$
$i_1 = 3.09\ A$

$-12i_3 + 9i_4 = 0$
$i_3 = (9/12)i_4$

$i_3 + i_4 = 5.15\ A$

$i_3 = 2.2\ A$
$i_4 = 2.95\ A$

EX M.) $i_2R_2 = i_1R_1$

$i_2 = i - i_1$

$(i - i_1)R_2 = i_1R_1$

$iR_2 - i_1R_2 = i_1R_1$

$iR_2 = i_1(R_1 + R_2)$

$i_1 = R_2i/(R_1 + R_2)$

$V = i_1R_1$

$V = \{R_2i/(R_2 + R_1)\}R_1$

$V = \{R_1R_2/(R_1 + R_2)\}i$

$R_{eq} = R_1R_2/(R_1 + R_2)$

reduces to:

$1/R_{eq} = 1/R_1 + 1/R_2$

EX Q.) $1/6 + 1/9 = 0.278$

$R = 3.6\ \Omega$

EX H.) $1/5 + 1/6 = 1/R$

$R_1 = 2.7\ \Omega$

$1/3 + 1/6 = 2\ \Omega$

$R = 12\ \Omega + 2\ \Omega + 2.7\ \Omega$

EX X.) $R_{eq} = 3\ \Omega + 4\ \Omega + 5.625\ \Omega = 12.625\ \Omega$

$i = V/R = 0.713$ A

$i_3 = 0.713$ A

$V_3 = iR = 2.1$ V

$i_4 = 0.713$ A

$V_4 = iR = 2.85$ V

$V_9 = V_{15} = 9$ V $- 2.1$ V $- 2.85$ V $= 4.05$ V

$i_9 = V/R = 0.45$ A

$i_{15} = 0.27$ A

Answers to Example Problems - Chapter 28

EX D.) $P = iV = 60$ W
$E = Pt = (60\text{ W})(86400\text{ s}) = 5.18 \times 10^6$ J

$P = 0.06$ kW
$E = Pt = (0.06\text{ kW})(24\text{ hr}) = 1.44$ kW.hr

EX K.) $P = iV = V^2/R = 9$ W
$E = Pt = (9\text{ W})(3600\text{ s}) = 32400$ J

$E = mc\Delta t = (1000\text{ g})(4.18\text{ J/g°C})\Delta t$
$\Delta t = 7.75°$ C

EX T.) $P = iV = 400$ W
$E = Pt = 12000$ J

$E_{out} = (Eff)(E_{in}) = 7200$ J

$E = (1/2)mv^2$
$v = 3.1$ m/s

EX D.) $E = mgh = (500\text{ kg})(9.8)(6\text{ m})(\sin 30°)$
$E = 14700$ J
$P = E/t = 24500$ W needed
$P = V^2/R$
$R = V^2/P = 0.59\ \Omega$

EX M.) In series:

$V = iR = i(10\ \Omega)$
$i_4 = i_6 = 1.2$ A

$V_4 = iR_4 = 4.8$ V
$V_6 = iR_6 = 7.2$ V

$P_6 = iV = 8.64$ W
$P_4 = iV = 5.76$ W

In parallel:

$V_4 = V_6 = 12$ V

$P_4 = V^2/R_4 = 36$ W
$P_6 = V^2/R_6 = 24$ W

Answers to Example Problems - Chapter 29

EX AEIOU.)

A.) $K = 2\pi/\lambda = 0.785\ m^{-1}$

b.) $V=f\lambda$ $f = v/\lambda = 31.25$ Hz

c.) $\omega = 2\pi f = 196$ Hz

d.) $Y(t) = (0.25)\sin(0.785x-196t)$

EX HHJU.)

A.) -0.028 m

b.) -0.121 m

c.) $(0.16)\sin(111 - 5t)$

EX VFVFVV.)

$K=2\pi/\lambda = 1.26\ m^{-1}$

$f=v/\lambda=400$ Hz

$\omega=2\pi f=2513$ Hz

find φ

$0.000014 = (0.0002)\sin[(1.26)(2)+(2513)(1.5)+\varphi)$

$0.07 = \sin(3772+\varphi)$

$0.07 = 3772+\varphi$

$\varphi=3771.93$

$y(t)=(0.0002)\sin[(1.26)x+(2513)t+3771.93]$

EX HYTG.)

$(5.3\ m)\sin(1.7x-9t+4.57)$

Answers to Example Problems - Chapter 30

EX DFRE.)

W1 = 0.3216 m (note x = -60 m)
W2 = 0.386 m

Total = 0.708 m

EX UYHGT.)

$A=2A\cos(\varphi/2)=2.4\cos(\pi/12)$
A = 2.3 m

EX HYGTF.)

$\lambda 1$ = 240 cm, f1=3.16 Hz
$\lambda 2$ = 120 cm, f2=6.33 Hz
$\lambda 3$ = 80 cm, f3=9.5 Hz
$\lambda 4$ = 60 cm, f4=12.66 Hz
$\lambda 5$ = 48 cm, f5=15.8 Hz

$\lambda = 2L/n$

EX OPINU.)

λ=140 cm
$f=v/\lambda$=2.4 Hz

λ=100 cm
$f=v/\lambda$=3.4 Hz

EX NMJB.)

Closed Pipe
$\lambda 1$=6 m, f1=57 Hz
$\lambda 2$=2 m, f2=150 Hz
$\lambda 3$=1.2 m, f3=283 Hz
$\lambda 4$=0.86 m, f4=395 Hz
$\lambda 5$=0.67 m, f5= 507 Hz

Open Pipe
$\lambda 1$=3 m, f1=113 Hz
$\lambda 2$=1.5 m, f2=227 Hz
$\lambda 3$=1 m, f3=340 Hz
$\lambda 4$=0.75 m, f4=453 Hz
$\lambda 5$=0.6 m, f5=566 Hz