① $p = m\Delta v$

$\frac{kg\,m}{s}$

② $F\Delta t = m\Delta v$

applied force ~~over~~ for time period changes velocity (and therefore momentum)

③ Object in motion stays in motion (or at rest) until acted upon by force

force changes momentum

④ $v_i = 2\,m/s$

$m = 500\,kg$

$F = 300\,N$

$t = ?$

$v_f = 0\,m/s$

$F\Delta t = m\Delta v$

$F\Delta t = m(v_f - v_i)$

$\Delta t = \frac{m(v_f - v_i)}{F} = \frac{(500\,kg)(0 - 2\,m/s)}{300\,N}$

$t = 3\,s$ (don't worry about ⊖)

⑤ $m_r = 5.0\,kg$

$v_r = 4.5\,m/s$

$m_o = 7.5\,kg$

$v_o = 0\,m/s$

$m_{rf} = -6.0\,m/s$

$v_{of} = ?$

$m_r v_r + m_o v_o = m_r v_{rf} + m_o v_{of}$

$m_r v_r = m_r v_{rf} + m_o v_{of}$

$v_{of} = \frac{m_r v_r - m_r v_{rf}}{m_o}$

$= \frac{(5.0\,kg)(4.5\,m/s) - (5.0\,kg)(-6.0\,m/s)}{7.5\,kg}$

$= 7.0\,m/s$

⑥ $m_{1+2} = 230\ kg$
$v_i = 0\ m/s$
$m_1 = 21\ kg$
$v_1 = 9.3\ m/s$
$v_2 = ?$
$\Delta x = 51\ m$
$t = ?$

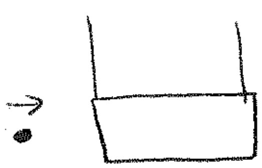
$$(m_1 + m_2) v_i = m_1 v_1 + m_2 v_2$$
$$0 = m_1 v_1 + m_2 v_2$$
$$-m_1 v_1 = m_2 v_2$$
$$v_2 = \frac{-m_1 v_1}{m_2} = \frac{(21\ kg)(9.3\ m/s)}{(230\ kg - 21\ kg)}$$
$$= .93\ m/s$$

$$\Delta x = v_i t + \frac{1}{2} a t^2$$
$$\Delta x = v_i t \qquad t = \frac{\Delta x}{v_i}$$
~~(.93 m/s)~~ $= \frac{51\ m}{.93\ m/s} = 55\ s$

⑦ $m = 2\ kg$

$$\text{area} = F \cdot t = 6\ N \cdot s$$
$$F \cdot t = m \Delta v$$
$$\Delta v = \frac{F \cdot t}{m} = \frac{6\ N \cdot s}{2\ kg} = 3\ m/s$$

⑧



$m_1 = .0030\ kg$
$v_1 = 1.0 \times 10^3\ m/s$

$m_2 = 2.0\ kg$
$v_2 = 0\ m/s$

inelastic collision
$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_f$$
$$m_1 v_1 = (m_1 + m_2) v_f$$
$$v_f = \frac{m_1 v_1}{m_1 + m_2} = \frac{(.0030\ kg)(1.0 \times 10^3\ \frac{m}{s})}{(.0030\ kg + 2.0\ kg)}$$
$$= 1.5\ \frac{m}{s}$$

use energy equations
$$KE = PE$$
$$KE = \frac{1}{2} m v^2$$
$$= \frac{1}{2}(2.0\ kg + .0030\ kg)(1.5\ m/s)^2 = 2.25\ J$$

$$PE = mgh$$
$$h = \frac{PE}{mg} = \frac{2.25\ J}{(2.0030\ kg)(9.8\ m/s^2)} = .11\ m$$

(9) $W = Fd$

units = J

(10) $P = \frac{W}{t}$

units = watts W

(11) 0 J work

$d = 0$

(12) $F = 825\ N$

$d = 20.0\ N$

$W = ?$

$W = Fd$

$= (825\ N)(20.0\ N)$

$= 16500\ J$

(13) $F = 9.00\ N$

$d = .075\ m$

$t = .50\ s$

$P = ?$

$P = \frac{W}{t} = \frac{Fd}{t}$

$= \frac{(9.00\ N)(.075\ m)}{.50\ s}$

$= 1.35\ W$

(14) $F = 150\ N$

$W = 250\ 000\ J$

$d = ?$

$W = Fd$

$d = \frac{W}{F} = \frac{250\ 000\ J}{150\ N} = 1700\ m$

(that's more than 1 mile)

(15) $F = 300.0\ N$

$m = 145\ kg$

$d = 30.0\ m$

$t = 3.00\ s$

$P = ?$

$P = \frac{W}{t} = \frac{Fd}{t}$

$= \frac{(300.0\ N)(30.0\ m)}{3.00\ s} = 3\ 000\ W$

(16) $m = .25\ kg$ $W = Fd$
$d = 1.5\ m$ $= mgd$
$W = ?$ $= (.25\ kg)(9.8\ m/s^2)(1.5\ m)$
$= 3.7\ J$

(17) mechanical energy - kinetic + potential
(not from chemical reactions, nuclear processes, etc)

(18) grav PE - energy due to position $PE_{grav} = mgh$
depends on mass, height, gravity

(19) Elastic PE - energy stored in a spring, elastic band, etc $PE_{elastic} = \frac{1}{2}kx$
depends on distance compressed, spring constant

(20) Kinetic energy - energy of motion $KE = \frac{1}{2}mv^2$
depends on mass, velocity

(21) Energy is neither created nor destroyed, only transferred
A pop up toy is compressed (which has PE elastic)
when it pops up from the table, PEelastic is converted
to KE (energy of motion). At the highest point
in the jump, all that KE is converted to PEgrav.

(22) $m = 1.8\ kg$ $PE = mgh$
$h = 6.7\ m$ $= (1.8\ kg)(9.8\ m/s^2)(6.7\ m)$
$g =$ $= 120\ J$
$PE = ?$

(23) $PE = 120\ J$ $PE = KE = \frac{1}{2}mv^2$
$m = 1.8\ kg$
$v = ?$ $v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(120\ J)}{1.8\ kg}} = 11\ m/s$

(24) $m = 7.3\,kg$
$h = 1.2\,m$

before lifting
$PE = 0$ because $h = 0$

After lifting
$PE = mgh$
$= (7.3\,kg)(9.8\,m/s^2)(1.2\,m)$
$= 86\,J$

(25) $m = 75\,kg$
$v = 15\,m/s$

$KE = \frac{1}{2}mv^2$
$= \frac{1}{2}(75\,kg)(15\,m/s)^2$
$= 8400\,J$

(26) $h = 62\,m$
$v = ?$

PE at top — $PE = mgh$
KE at bottom — $KE = \frac{1}{2}mv^2$

$mgh = \frac{1}{2}mv^2$
$gh = \frac{1}{2}v^2$
$v = \sqrt{2gh} = \sqrt{2(9.8\,m/s^2)(62\,m)}$
$= 35\,m/s$

(27) $F = 9000\,N$
$d = 0$

$W = 0$
$d = 0$

(28) $m = .0030\,kg$
$h_E = 380\,m$
$h_p = 1.5\,m$
$v = ?$

distance penny traveled:
$380\,m - 1.5\,m = 378.5\,m$

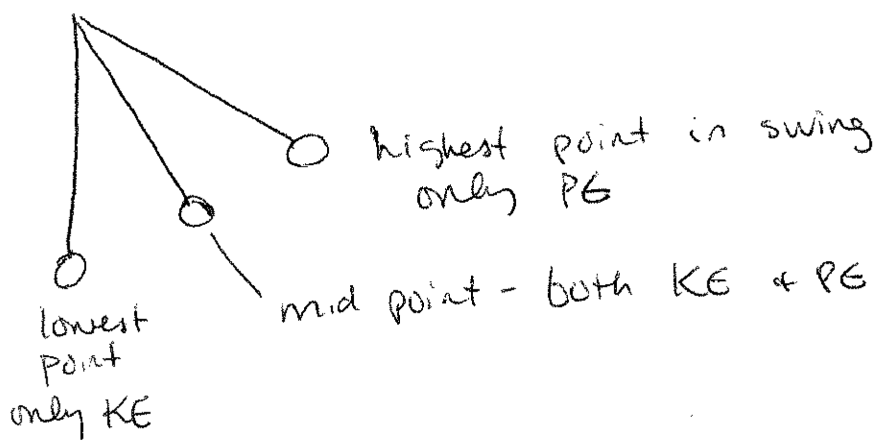
$PE = mgh$
$= (.0030\,kg)(9.8\,m/s^2)(380\,m)$
$= 11.2\,J$

PE ~~at~~ when hits pedestrian
$PE = mgh$
$= (.0030\,kg)(9.8\,m/s)(1.5\,m)$
$= .044\,J$

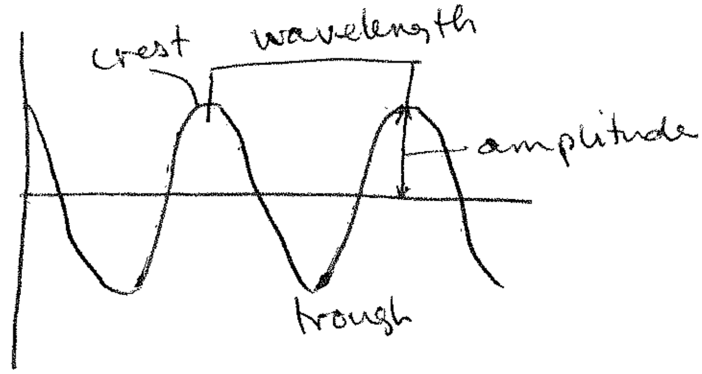
$11.2\,J - .044\,J = 11.2\,J$ converted to KE

$KE = \frac{1}{2}mv^2$
$v = \sqrt{\frac{2\,KE}{m}} = \sqrt{\frac{2(11.2\,J)}{.0030\,kg}} = 86\,m/s$

(29)



(30)



(31) $\lambda = 4.0 m$

(32) amplitude = .2 m

(33) $T = 2.5 s$ $\quad f = \frac{1}{T} = \frac{1}{2.5s} = .40 \text{ Hz}$

(34) $f = 192 \text{ Hz}.$

$T = ?$

$f = \frac{1}{T}$

$T = \frac{1}{f} = \frac{1}{192 \text{ Hz}} = .00521 s$

(35) $f = 510 \text{ Hz}$

$v = 343 m/s$

$\lambda = ?$

$\lambda = \frac{v}{f} = \frac{343 m/s}{510 \text{ Hz}} = .67 m$

(36) $\lambda = 550 m$

$f = 1600 kHz$

$= 1.6 \times 10^6 \text{ Hz}$

$v = ?$

$v = \lambda f =$ ~~(550 m)(1600 Hz)~~ =

$= (550 m)(1.6 \times 10^6 \text{ Hz}) = 8.8 \times 10^8 m/s$

(37) Doppler effect: frequency shifts caused by movement of source and/or observer

(38) Ambulance is moving away from you - sound/pitch is lower, frequency decreases

Ambulance moving toward - pitch is higher, frequency increases

(39) $m_{sun} = 1.99 \times 10^{30}$ kg

$m_{jupiter} = 1.90 \times 10^{27}$ kg

$r = 7.78 \times 10^{11}$ m

$$F = \frac{G m_1 m_2}{r^2}$$

$$= \frac{(6.67 \times 10^{-11} \frac{Nm^2}{kg^2})(1.99 \times 10^{30} kg)(1.90 \times 10^{27} kg)}{(7.78 \times 10^{11} m)^2}$$

$$= 4.2 \times 10^{23} \text{ N}$$

(40) 2 negatively charged spheres - repulsive force

1 negative + 1 positive - attractive

(41) $q_A = 2.0 \times 10^{-4}$ C

$q_B = 8.0 \times 10^{-4}$ C

$r = 25$ cm $= .25$ m

$F = ?$

$$F = \frac{k q_A q_B}{r^2}$$

$$= \frac{(9.0 \times 10^9 \, Nm^2/C^2)(2.0 \times 10^{-4} C)(8.0 \times 10^{-4} C)}{(.25 \, m)^2}$$

$$= 23\,000 \text{ N}$$

(42) when distance is doubled, $\frac{1}{4}F$

$$F = \frac{k q_A q_B}{(2r)^2} = \frac{1}{4} \cdot \frac{k q_A q_B}{r^2} = \frac{1}{4}F$$

when distance is quadrupled, $\frac{1}{16}F$

$$F = \frac{k q_A q_B}{(4r)^2} = \frac{1}{16} \cdot \frac{k q_A q_B}{r^2} = \frac{1}{16}F$$

when one charge is tripled, 3F

$$F = \frac{k q_A (3 q_B)}{r^2} = 3 \cdot \frac{k q_A q_B}{r^2} = 3F$$

(43)

$q' = 5.0\,\mu C = 5.0\times10^{-6}\,C$

$F = 2.0\times10^{-4}\,N$

$E = ?$

$E = \frac{F}{q'} = \frac{2.0\times10^{-4}\,N}{5.0\times10^{-6}\,C}$

$= 40.\,N/C$

(44)

$W = ?$

$q = 4.0\times10^{-3}\,C$

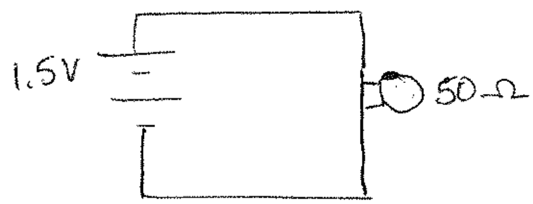
$\Delta V = 6.0\,V$

$\Delta V = \frac{W}{q}$

$W = \Delta V\, q$

$= (6.0\,V)(4.0\times10^{-3}\,C) = 2.4\times10^{-2}\,J$

(45)



$\Delta V = 1.5\,V$

$R = 50\,\Omega$

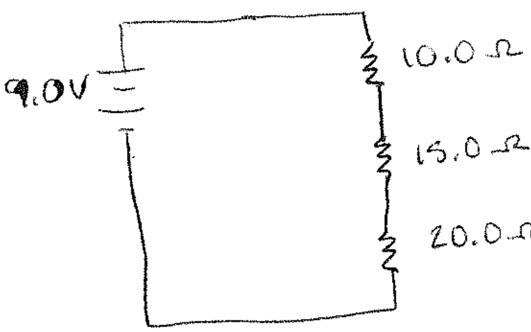
$V = IR$

$I = \frac{V}{R}$

$= \frac{1.5\,V}{50\,\Omega}$

$= .03\,A$

(46)



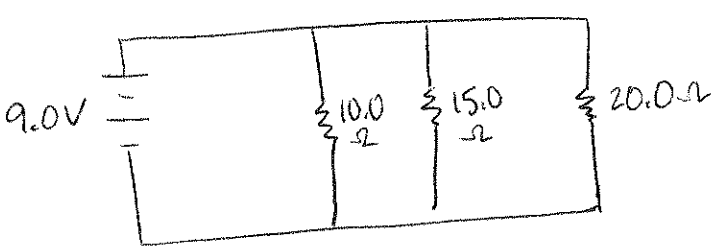
$R_{eq} = R_1 + R_2 + R_3$

$= 10.0\,\Omega + 15.0\,\Omega + 20.0\,\Omega$

$= 45.0\,\Omega$

$I = \frac{V}{R_{eq}} = \frac{9.0\,V}{45.0\,\Omega} = .20\,A$

(47)



$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R_{eq}} = \frac{1}{10.0\,\Omega} + \frac{1}{15.0\,\Omega} + \frac{1}{20.0\,\Omega}$

$R_{eq} = 4.62\,\Omega$

$I = \frac{V}{R_{eq}} = \frac{9.0\,V}{4.62\,\Omega} = 2.0\,A$