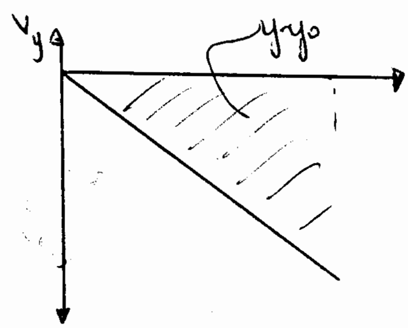
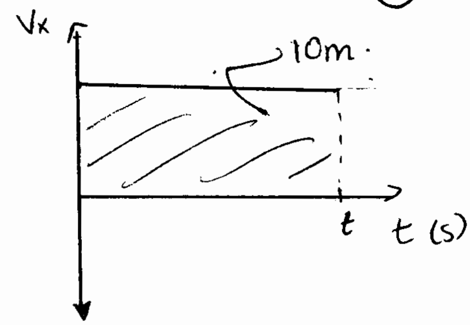
7) 1^{st} analyze projectile motion for $V_{0,x}$

$y = y_0 + \cancel{V_{0,y}t} + \frac{1}{2}a_y t^2$.



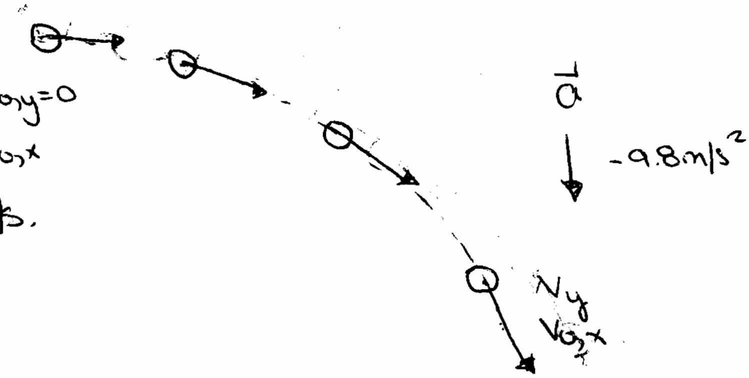


$x = V_{0,x} t$

$$t = \sqrt{\frac{2(y-y_0)}{a_y}}$$

$$= \sqrt{\frac{2(0 - 2.0\,m)}{-9.8\,m/s^2}}$$

$$= 0.64\,s$$



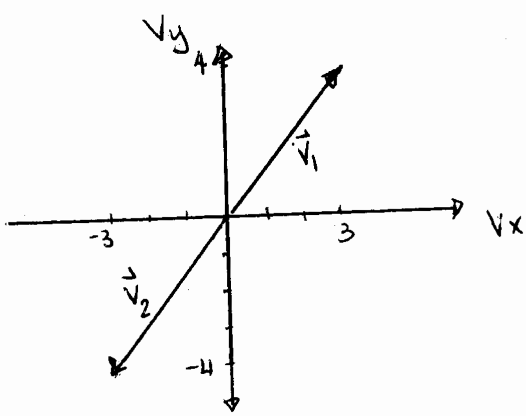
$$V_{0,x} = \frac{x}{t} = \frac{10\,m}{0.64\,s} = 15.6\,m/s.$$

$$a_c = \frac{V^2}{R}$$

$$= \frac{(15.6\,m/s)^2}{1.5\,m} = 1.6 \times 10^2 \ m/s^2$$

30)

a)



velocity has been reversed; takes 3s to reach opposite side of circle. T = 6s. 1pt.

$$V = \frac{2\pi r}{T}$$

$$r = \frac{VT}{2\pi} \quad \text{1pt.}$$

$$a_c = \frac{V^2}{r} = \frac{V^2}{VT/2\pi} = \frac{2\pi V}{T} = \frac{2\pi\left(\sqrt{3^2+4^2}\,m/s\right)}{6\,s}$$

1pt.

$$= \underline{5.24\ m/s^2}.$$

/3

b) $$\overbrace{\vec{a}_{av} = \frac{\vec{V}_2 - \vec{V}_1}{t_2 - t_1}}^{0.5pt.} = \frac{[(-3\hat{i} + -4\hat{j}) - (3\hat{i} + 4\hat{j})]\,m/s}{(5-2)\,s} = \underline{\underline{-2.00\,m/s^2\,\hat{i} - 2.67\,m/s^2\,\hat{j}}}$$

2pts.

if $|a_{av}| =$ $10/3\ m/s^2$ $(3.3\,m/s^2)$ is given: 1pt.

$0\,m/s^2$ 0 pts.

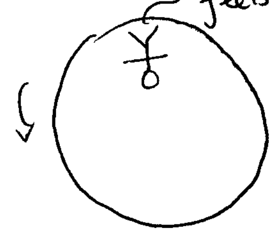
SP7-1)

$F = ma = (0.025\ kg)(1.6 \times 10^2\ m/s^2) = 4.0\ N.$

source: tension.

SP7-2)

feels a $\vec{F}_N = \vec{F}_c$.



a) F_c is directed towards the centre.

b) time for $1/4$ turn: $\sim 15s$.

$T = 60s$.

$V = 2\pi r / T = 2\pi (150m) / 60s = 16\ m/s.$

c) $a_c = v^2/r = (16\ m/s)^2 / 150m = 1.6\ m/s^2.$

$g_{moon} \sim 1/6\ g_{earth} = 9.8/6\ m/s^2 = 1.6\ m/s^2.$

equal!

d) yes $g_{moon} \approx a_c$.

(SP6-3) a) $a_c = V^2/R = (35.05 \times 10^3 \, m/s)^2 / 1.08 \times 10^{11} \, m$

$= 0.0114 \, m/s^2$

$F_c = ma_c = (4.87 \times 10^{24} \, kg)(0.0114 \, m/s^2)$

$= 5.53 \times 10^{22} \, N$

b) Vector pointing towards sun.

c) gravity

d) yes it is exactly that.

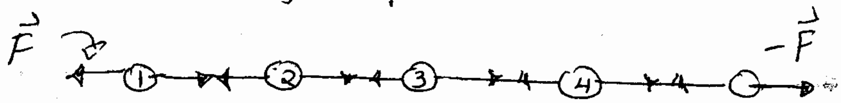
$$F_g = \frac{GMm}{r^2} = \frac{(6.67 \times 10^{-11} \, \frac{Nm^2}{kg^2})(1.989 \times 10^{30} \, kg)(4.871 \times 10^{24} \, kg)}{(1.082 \times 10^{11} \, m)^2}$$

$= 5.5 \times 10^{22} \, N$ ← same magnitude.

(SP7-4)

a) same magnitude at other end

b) atomic-level force pairs



assume $\vec{a}=0$

$\Rightarrow$ atom 1 must experience attractive force from atom #2 of equal magnitude.

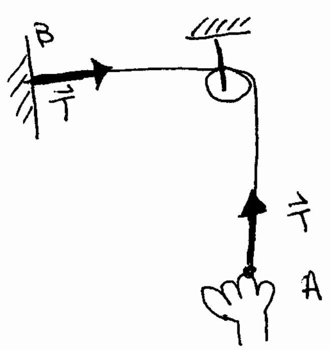
Newton's 3rd Law $\Rightarrow$ 1 must exert similar attractive force on #2, and so forth.

c) the same

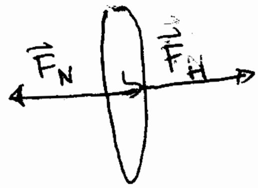
at the atomic level, direction changes are fairly small

$\Rightarrow$ $|\vec{T}|$ doesn't change when string bends.

d)



SP7-6) a)



same magnitude, opposite direction.

b) doesn't change $\vec{F}_N$.

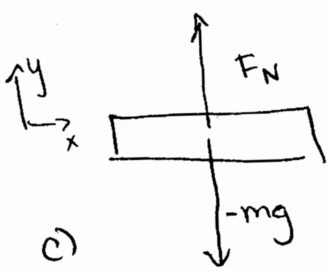
Stretching arises from weaker chemical bonds.

c) same as in (a)

d). no, it doesn't stretch noticeably.

- chemical bonds act like springs
- forces must occur in pairs.

SP7-7)



c)

a) $mg\hat{j} = -0.51\,\text{kg}\cdot 9.8\,\text{N} = -5.0\,\text{N}\,\hat{j}$

b) $5.0\,\text{N}\,\hat{j}$

Ch.6) 1) $\vec{F}_{net} = m\vec{a}$

$|\vec{F}_{net}| = m|\vec{a}| = 1\,\text{kg}\cdot 2.0\,\text{m/s}^2 = 2.0\,\text{N}$.

a) $F_x = |\vec{F}_{net}|\cos 20^\circ = 1.9\,\text{N}$

b) $F_y = |\vec{F}_{net}|\sin 20^\circ = 0.69\,\text{N}$.

c) $\vec{F}_{net} = 1.9\hat{i} + 0.69\,\text{N}\,\hat{j}$

6) a) $\vec{F}_1 = 32N(\cos 30° \hat{i} + \sin 30° \hat{j}) = 28N\hat{i} + 16N\hat{j}$

$\vec{F}_2 = 55N\hat{i}$

$\vec{F}_3 = 41N(\cos -60°)\hat{i} + \sin(-60°)\hat{j} = 20.5N\hat{i} - 35.5N\hat{j}$.

$$\vec{a} = \frac{\vec{F}_1 + \vec{F}_2 + \vec{F}_3}{m} = \frac{(28 + 20.5 + 55)\hat{i} + (16 - 35.5)\hat{j}\ N}{120\ kg}$$

$$= (6.86\ m/s^2)\hat{i} + (-0.16\ m/s^2)\hat{j}$$

b) $$|\vec{a}| = \sqrt{0.86^2 + 0.16^2}\ m/s^2$$

$$= 0.87\ m/s^2$$

c) $$\tan\theta = a_y/a_x$$

$$\theta = \tan^{-1}\left(\frac{-0.16}{0.86}\right) = -10.5°$$ from horizontal.

14) assume horizontal velocity is constant.

$$F_{net} = 0 = F_{W\to S} - f^{kin} = F_{W\to S} - \mu^{kin} N$$

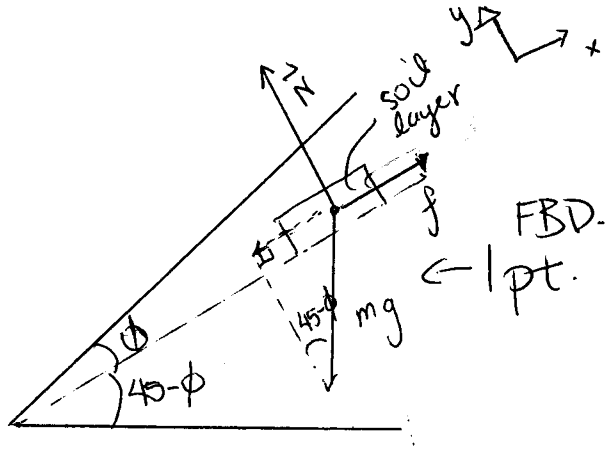
$$= F_{W\to S} - \mu mg.$$

$$F_{W\to S} = \mu mg = 0.80(20kg)(9.8m/s^2)$$

$$= 1.6 \times 10^2\ N.$$

6

16)



$f = mg\sin(45-\phi)$ $\leftarrow$ 1pt
(θ)

$f = \mu F_N = \mu mg\cos(45-\phi)$ $\leftarrow$ 1pt.
(θ)

$\mu\cos(45-\phi) = \sin(45-\phi)$ $\leftarrow$ 1pt.

$\tan(45-\phi) = \mu$.

$45-\phi = \tan^{-1}\mu = \tan^{-1}0.5$

$\phi = 18.4°$ $\leftarrow$ 1pt.

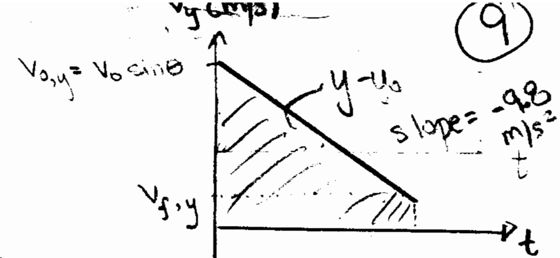
(or $\theta = 45-\phi \approx 27°$ will accept for full credit)

- no justification - partial marks only.

- if final ans. incorrect use scheme to assign pts.

UNIT 7 HW after version 3

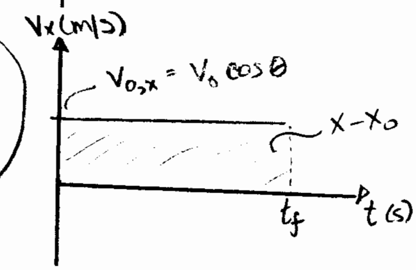
Ch.5) 12) a)



$$y = y_0 + v_{0,y} t + \tfrac{1}{2} a_y t^2$$

$$x = v_{0,x} t + \cancel{x_0}^{\,0}$$

$$\rightarrow y = \cancel{y_0}^{\,0} + v_{0,y}\left(\frac{x}{v_{0,x}}\right) + \tfrac{1}{2} a_y \left(\frac{x}{v_{0,x}}\right)^2$$



$$v_{0,x} = |\vec{v}_0| \cos\theta$$

$$v_{0,y} = |\vec{v}_0| \sin\theta$$

$$\rightarrow y = \tan\theta \cdot x + \tfrac{1}{2} a_y \left(\frac{x}{v_0 \cos\theta}\right)^2$$

$$= \tan 40^\circ \cdot 22\,\text{m} + \tfrac{1}{2}(-9.8\,\text{m/s}^2)\left(\frac{22\,\text{m}}{25\,\text{m/s} \cos 40^\circ}\right)^2$$

$$= 12.0\,\text{m}$$

b)

$$v_x = v_{0,x} = v_0 \cos\theta = (25\,\text{m/s})\cos 40^\circ = 19.2\,\text{m/s}$$

$$v_y = v_{0,y} + a_y t = v_{0,y} + a_y\left(\frac{x}{v_{0,x}}\right)$$

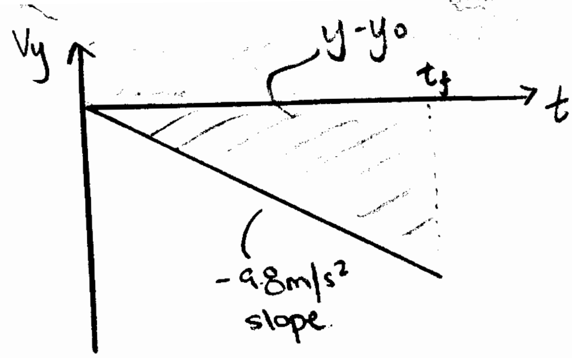
$$= 25\,\text{m/s} \sin 40^\circ + (-9.8\,\text{m/s})\left(\frac{22\,\text{m}}{25\,\text{m/s} \cos 40^\circ}\right)$$

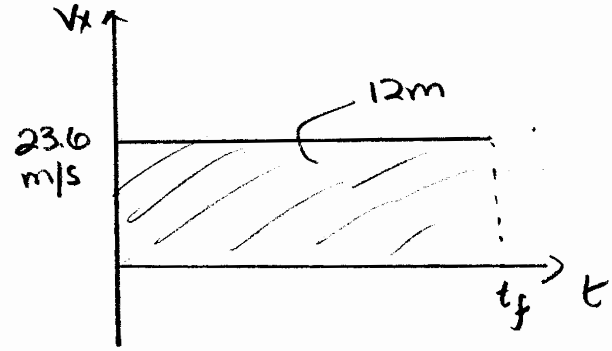
$$= 4.81\,\text{m/s}$$

c) $V_{f,y}$ is positive; it hasn't reached its highest point

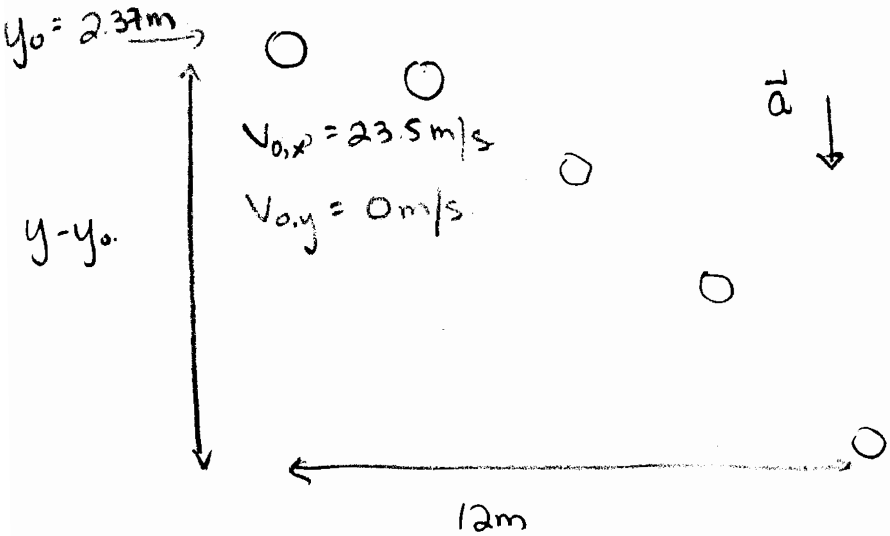
22)

a)





10



again $y = y_0 + \cancel{V_{0,y}\left(\frac{x}{V_{0,x}}\right)}^{0} + \frac{1}{2}a_y\left(\frac{x}{V_{0,x}}\right)^2$

$= 2.37m + \frac{1}{2}(-9.8\,m/s^2)\left(\frac{12\,m}{23.6\,m/s}\right)^2$ } ← 1pt.

$= 1.10\,m$ ← 1pt.

$y_f > 0.90m \rightarrow$ ball clears it

b) $d = 1.10 - 0.90\,m = 0.20m$ ← 1pt.

c) figure out motion diagrams - only difference is $V_{0,y} = V_0 \sin\theta$, $V_{0,x} = V_0 \cos\theta$.

1pt. $\left\{ y = y_0 + V_{0,y}\left(\frac{x}{V_{0,x}}\right) + \frac{1}{2}a_y\left(\frac{x}{V_{0,x}}\right)^2 \right.$

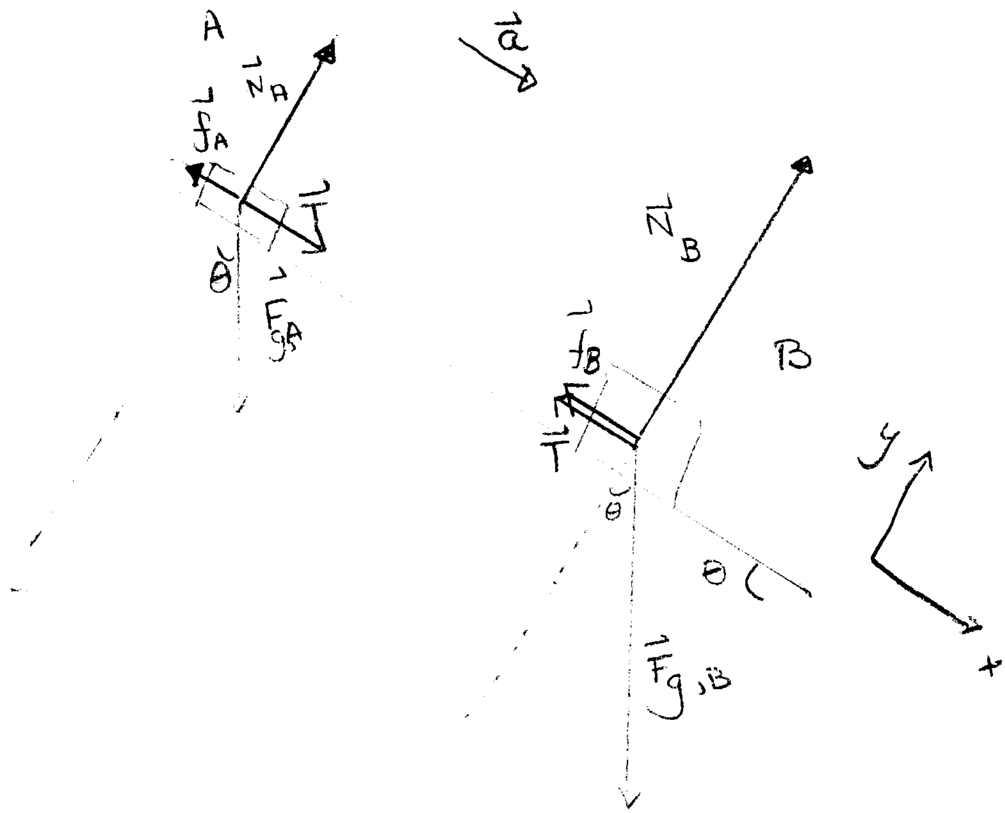
$= 2.37m + \tan(-5°) \cdot 12m + \frac{1}{2}(-9.8\,m/s^2)\left(\frac{12\,m}{23.5\,m/s \cos -5°}\right)^2$

1pt. $= 0.03\,m$ ball doesn't clear the net.

16

d) $d = 0.90m - 0.03\ldots = 0.87\ldots$ 1pt.

Ch6 36) (11)



a)

$$m_A g\sin\theta - f_A + T = m_A a_x$$

$$N_A - m_A g\cos\theta = 0$$

$$m_B g\sin\theta - f_B - T = m_B a_x$$

$$N_B - m_B g\cos\theta = 0$$

$$a_x = \frac{m_A g\sin\theta - f_A + T}{m_A} = \frac{m_B g\sin\theta - f_B - T}{m_B}$$

$$\cancel{g\sin\theta} - \mu_A^k g\cos\theta + \frac{T}{m_A} = \cancel{g\sin\theta} - \mu_B^k g\cos\theta - T/m_B$$

$$\frac{T}{m_A} + \frac{T}{m_B} = g\cos\theta\left(-\mu_B^k + \mu_A^k\right)$$

$$T = \frac{m_A m_B}{m_B + m_A}(g\cos\theta)(\mu_A^k - \mu_B^k) = \frac{(1.65\,kg)(3.30\,kg)}{(1.65+3.30)\,kg}(9.8\,m/s^2)\cos 30^\circ(0.226 - 0.113)$$

$$= 1.05\,N$$

b) $$a_x = \frac{m_A g \sin\theta - \mu_A^k m_A g \cos\theta + T}{m_A}$$

$$= g\left(\sin\theta - \mu_A^k \cos\theta\right) + T/m_A$$

$$= 9.8\,m/s^2\left(\sin 30° - 0.226 \cos 30°\right) + \frac{1.05\,N}{1.65\,kg}$$

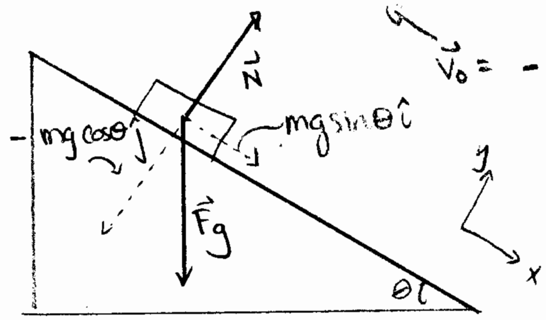
$$= 3.62\,m/s^2$$

c) switch A | B. labels in above equations.

a. $\therefore$ $T = -1.05N$ magnitude is the same but rod is compressed, not stretched.

b. $a_x = 3.62\ m/s^2$ still.

58)



$\vec{V}_0 = -3.50\,m/s\,\hat{i}$

13

$F_{net,x} = ma_x = mg\sin\theta$

$a_x = g\sin\theta$

a) $\cancel{V_{f,x}^2}^{\,0} = V_{0,x}^2 + 2a_x(x - \cancel{x_0}^{\,0})$

$-V_{0,x}^2 = 2a_x X$

$$X = \frac{-V_{0,x}^2}{2a} = -\frac{(-3.50\,m/s)^2}{2(9.8\,m/s^2)\sin 32.0°}$$

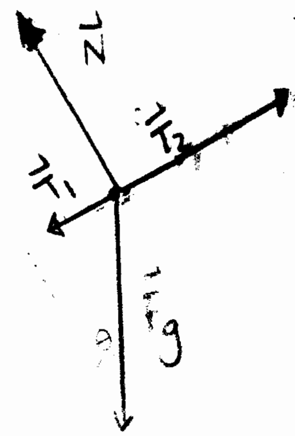
$= -1.18\,m$

1.16m up plane

b) $V_{f,x} = V_{0,x} + a_x t$

$$t = \frac{-V_{0,x}}{a} = \frac{-(-3.50\,m/s)}{9.8\,m/s^2 \cdot \sin 32°} = 0.67\,s$$

63)



$T_2 - T_1 - mg\sin\theta = ma_x$

$T_2 - T_1 = m(a_x + g\sin\theta)$

$= 2800\,\text{kg}\,(0.81\,\text{m/s}^2 + 9.8\sin 35°)$

$=$