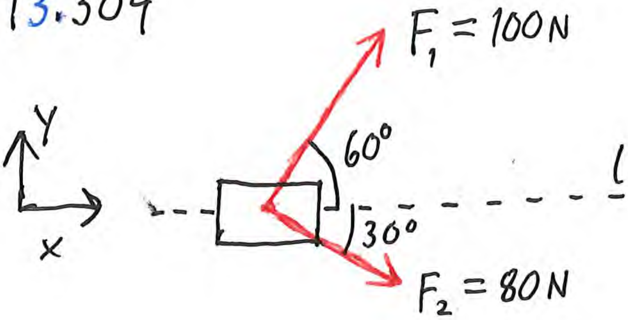
13.304



a) $\sum \vec{F} = 0$ i y-retning

$$\vec{F}_{1y} + \vec{F}_{2y} + \vec{F}_G = 0$$

$$100N \cdot \sin 60^\circ - 80N \cdot \sin 30^\circ + F_G = 0$$

$$F_G = -46{,}60\,N = -47\,N$$

dvs 47N i negativ y-retning. (normalt på l)

b) $\sum F = 0$ i x-retning

$$F_{1x} + F_{2x} + R = 0$$

$$R = -F_{1x} - F_{2x}$$

$$R = -100N \cdot \cos 60^\circ - 80N \cdot \cos 30^\circ = -119{,}2\,N$$

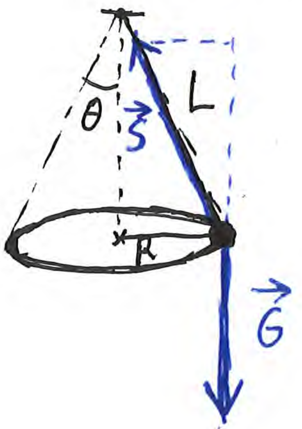
$$= -0{,}12\,kN$$

dvs. i negativ x-retning.

13.311 $m = 0{,}090\,kg$

$L = 0{,}75\,m$

$R = 0{,}30\,m$



a) Snordrag S og tyngde G virker på kula.

b) y: $\sum F = 0$

$$S_y = G$$

$$S \cdot \cos\theta = mg$$

$$S = \frac{mg}{\cos\theta}$$

$$S = \frac{0{,}090\,kg \cdot 9{,}81\,\frac{m}{s^2}}{\cos 23{,}57^\circ} = 0{,}9632\,N$$

$$= 0{,}96\,N$$

$$\sin\theta = \frac{R}{L}$$

$$\theta = \sin^{-1}\left(\frac{R}{L}\right)$$

$$\theta = \sin^{-1}\left(\frac{0{,}30}{0{,}75}\right)$$

$$\theta = 23{,}57^\circ$$

c) x: $\sum F = m \cdot a$

$$S_x = m \cdot a$$

$$S \cdot \sin\theta = ma$$

$$a = \frac{S \cdot \sin\theta}{m} = \frac{0{,}9632N \cdot \sin 23{,}57^\circ}{0{,}090\,kg} = 4{,}279\,\frac{m}{s^2}$$

$$= 4{,}3\,\frac{m}{s^2}$$

13.307 +

$F_L = kv^2 \qquad K = 8{,}7 \cdot 10^{-4}\ \frac{Ns^2}{m^2}$

$m = 8{,}0 \cdot 10^{-3}\ Kg$

a)

$\sum F = 0$

$F_L = G$

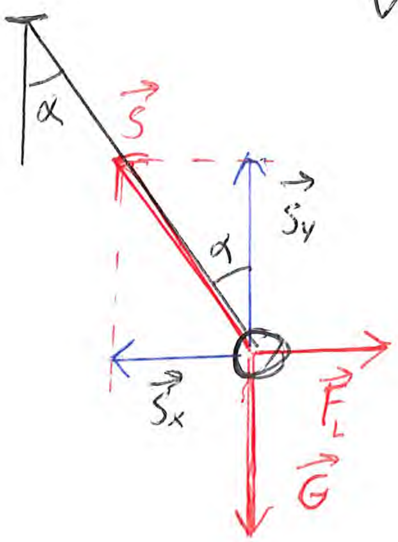
$Kv^2 = mg$

$v^2 = \frac{mg}{K}$

$v = \sqrt{\frac{mg}{K}} = \sqrt{\frac{8{,}0 \cdot 10^{-3}\,Kg \cdot 9{,}81\,\frac{m}{s^2}}{8{,}7 \cdot 10^{-4}\,\frac{Ns^2}{m^2}}}$

$v = 9{,}497\ \frac{m}{s} = \underline{9{,}5\ \frac{m}{s}}$

b)



$\alpha = 34^\circ$

$\sum F_x = 0 \qquad \sum F_y = 0$

$S_x = F_L \qquad S_y = G$

$S \cdot \cos\alpha = mg$

$S \cdot \sin\alpha = kv^2 \qquad S = \frac{mg}{\cos\alpha}$

$\frac{mg}{\cos\alpha} \cdot \sin\alpha = kv^2$

$mg \cdot \tan\alpha = kv^2$

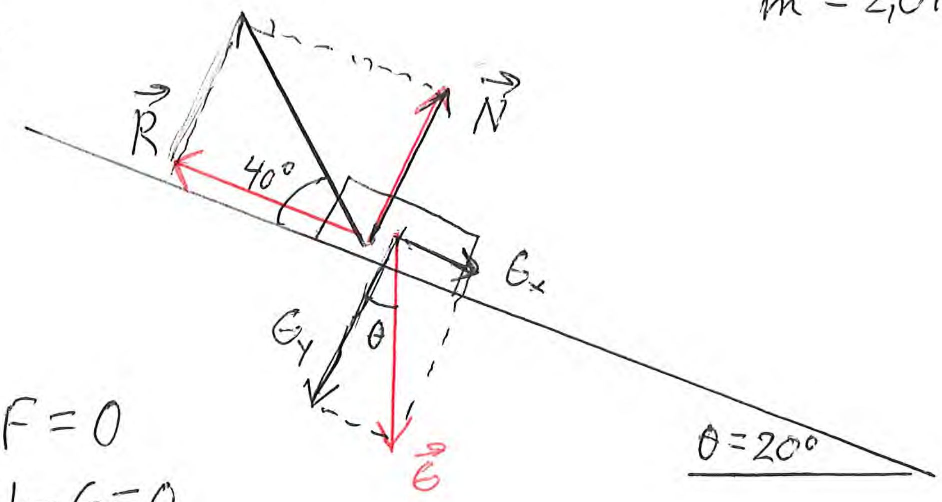
$\frac{mg \cdot \tan\alpha}{K} = v^2$

$v = \sqrt{\frac{mg \cdot \tan\alpha}{K}}$

$v = \sqrt{\frac{8{,}0 \cdot 10^{-3}\,Kg \cdot 9{,}81\,\frac{N}{Kg} \cdot \tan 34^\circ}{8{,}7 \cdot 10^{-4}\,\frac{Ns^2}{m^2}}} = \underline{7{,}8\ \frac{m}{s}}$

13.315 +

$m = 2{,}0\,\text{kg}$



$y: \sum F = 0$

$N - G_y = 0$

$N = G_y$

$N = mg \cdot \cos 20^\circ$

$N = 2{,}0\,\text{kg} \cdot 9{,}81\,\frac{\text{N}}{\text{kg}} \cdot \cos 20^\circ = \underline{18\,\text{N}}$ $(18{,}43\,\text{N})$

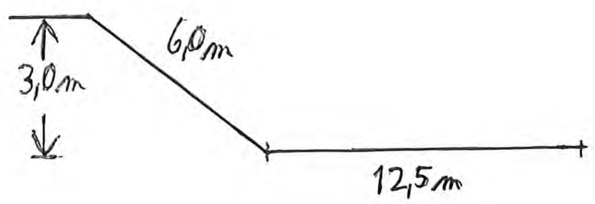
$\tan 40^\circ = \frac{N}{R}$

$R = \frac{N}{\tan 40^\circ}$

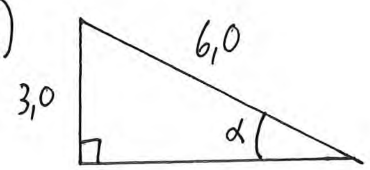
$R = \frac{18{,}43\,\text{N}}{\tan 40^\circ} = \underline{22\,\text{N}}$

13.316+

$\mu = 0{,}15$

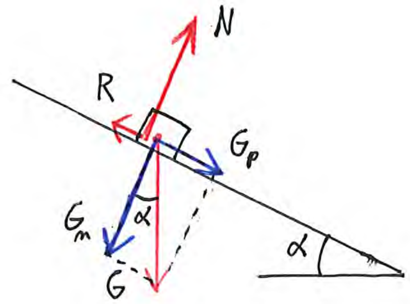


a)



$\sin\alpha = \frac{3{,}0}{6{,}0}$

$\alpha = 30°$



$\sum_p F = ma$

$G_p - R = ma$

$mg\sin\alpha - \mu N = ma$

$\cancel{m}g\sin\alpha - \mu\cancel{m}g\cos\alpha = \cancel{m}a$

$a = g(\sin\alpha - \mu\cos\alpha) = 9{,}81\,\frac{m}{s^2}(\sin 30° - 0{,}15\cdot\cos 30°)$

$= 3{,}630\,\frac{m}{s^2}$

$\sum_n F = 0$

$N = G_n$

$N = mg\cos\alpha$

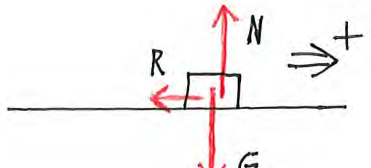
$2as = v^2 - v_0^2$ og $v_0 = 0$

$v = \sqrt{2as} = \sqrt{2\cdot 3{,}630\,\frac{m}{s^2}\cdot 6{,}0\,m} = 6{,}600\,\frac{m}{s} = \underline{6{,}6\,\frac{m}{s}}$

b) $2as = v^2 - v_0^2$ og $v = 0$

$2as = -v_0^2$

$a = \frac{-v_0^2}{2s} = \frac{-(6{,}600\,\frac{m}{s})^2}{2\cdot 12{,}5\,m} = -1{,}7424\,\frac{m}{s^2}$



$\sum F = ma$

$-R = ma$

$-\mu N = ma$

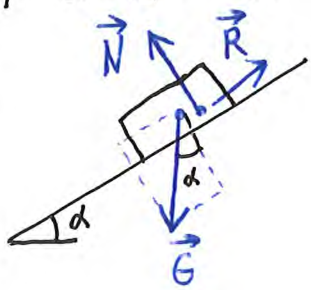
$-\mu\cancel{m}g = \cancel{m}a$

$\mu = \frac{-a}{g} = \frac{-(-1{,}7424\,\frac{m}{s^2})}{9{,}81\,\frac{m}{s^2}} = 0{,}1776 = 0{,}18$

dvs μ er noe større enn før

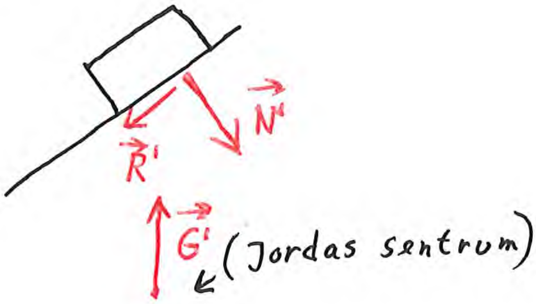
13.319 $\alpha = 20^\circ$ $m = 0{,}150\,\text{kg}$

a)



b) $\sum \vec{F} = 0$

c)



d) $\alpha = 0^\circ$

$\sum F = 0$ fordi $\vec{G}$ ikke har noen komponent parallellt med planet.

Dette gir $\underline{R = 0}$

$\alpha = 20^\circ$

$\sum F = 0$ fordi klossen er i ro.

$R = G \cdot \sin\alpha$

$R = mg \cdot \sin\alpha = 0{,}150\,\text{kg} \cdot 9{,}81\,\frac{\text{m}}{\text{s}^2} \cdot \sin 20^\circ$

$= 0{,}5032\,\text{N} = \underline{0{,}50\,\text{N}}$

opp skråplanet.

$\alpha = 30^\circ$ $\sum F = 0$ $v = \text{konst.}$

$R = mg\sin\alpha = 0{,}150\,\text{kg} \cdot 9{,}81\,\frac{\text{m}}{\text{s}^2} \cdot \sin 30^\circ$

$= 0{,}7357\,\text{N} = \underline{0{,}74\,\text{N}}$

opp skråplanet.

$\alpha = 45^\circ$ $\sum F = ma$

Vet at: $R = \mu N = 0{,}7357\,\text{N}$

$\mu \cdot mg \cdot \cos 30^\circ = mg\sin 30^\circ$

$\mu = \tan 30^\circ$

$\mu = 0{,}5773$

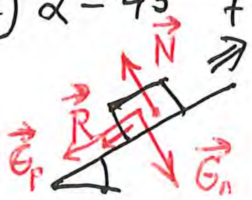
$R = \mu N$

$R = \mu \cdot mg\cos\alpha$

$R = 0{,}5773 \cdot 0{,}150\,\text{kg} \cdot 9{,}81\,\frac{\text{m}}{\text{s}^2} \cdot \cos 45^\circ$

$= 0{,}6006\,\text{N} = \underline{0{,}60\,\text{N}}$ oppover skråplanet.

e) $\alpha = 45^\circ$ +



$\sum F = ma$ i parallellretningen (langs planet)

$-R - G_p = ma$

$\sum F = -R - mg\sin\alpha = -0{,}6006\,\text{N} - 0{,}150\,\text{kg} \cdot 9{,}81\,\frac{\text{m}}{\text{s}^2} \cdot \sin 45^\circ$

$= -1{,}641\,\text{N} = \underline{-1{,}6\,\text{N}}$ (ned planet)

13.319 e) $V_0 = 16\,\frac{m}{s}$

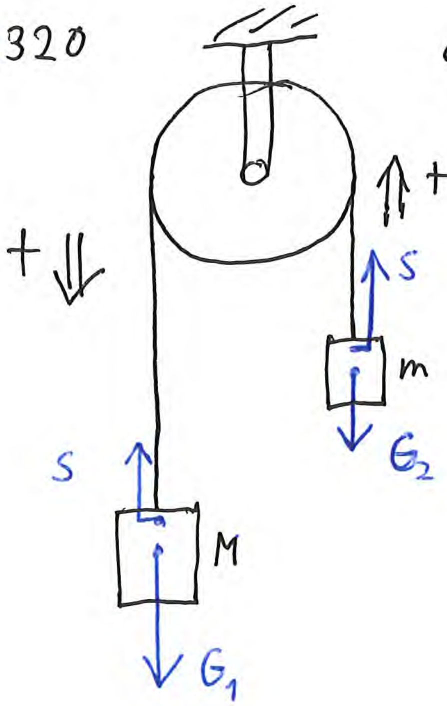
$$s = v_0 t + \tfrac{1}{2} a t^2$$

$$\Sigma F = ma$$

$$a = \frac{\Sigma F}{m} = \frac{-1{,}641\,N}{0{,}150\,kg} = -10{,}94\,\frac{m}{s^2}$$

$$s = 16\,\frac{m}{s} \cdot 1{,}0\,s + \tfrac{1}{2} \cdot \left(-10{,}94\,\frac{m}{s^2}\right) \cdot (1{,}0\,s)^2 = 10{,}53\,m = \underline{11\,m}$$

13.320



a) $M = 8{,}0\,kg$ $\quad m = 2{,}0\,kg$

$$\Sigma F = Ma \qquad\qquad \Sigma F = ma$$

$$G_1 - S = Ma \qquad\qquad S - G_2 = ma$$

$$\frac{S - mg}{m} = a$$

$$G_1 - S = M \cdot \frac{(S - mg)}{m}$$

$$Mg - S = \frac{M}{m} \cdot S - Mg$$

$$2Mg = \left(1 + \frac{M}{m}\right) \cdot S$$

$$\frac{2Mg}{\left(1 + \frac{M}{m}\right)} = S$$

$$S = \frac{2 \cdot 8{,}0\,kg \cdot 9{,}81\,\frac{m}{s^2}}{\left(1 + \frac{8{,}0\,kg}{2{,}0\,kg}\right)} = \frac{16{,}0\,kg}{5{,}0} \cdot 9{,}81\,\frac{m}{s^2}$$

$$= 31{,}39\,N = \underline{31\,N}$$

b) $G_1 - S = Ma$

$$S = G_1 - Ma \quad \text{og} \quad S - G_2 = ma$$

gir: $\quad G_1 - Ma - G_2 = ma$

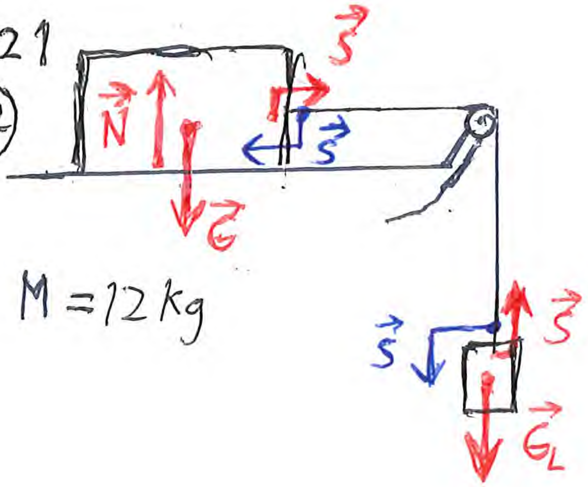
$$G_1 - G_2 = (M + m) \cdot a$$

$$a = \frac{G_1 - G_2}{(M + m)} = \frac{Mg - mg}{(M + m)}$$

$$\underline{a = \frac{(M - m)}{(M + m)} \cdot g}$$

13.321

a)



$M = 12\,kg$

$a = 1{,}4\,\frac{m}{s^2}$

b) $\sum F = ma$

$S = 12\,kg \cdot 1{,}4\,\frac{m}{s^2} = 16{,}8\,N$

$= \underline{17\,N}$

$\sum F = ma$

$G_L - S = ma$

$mg - S = ma$

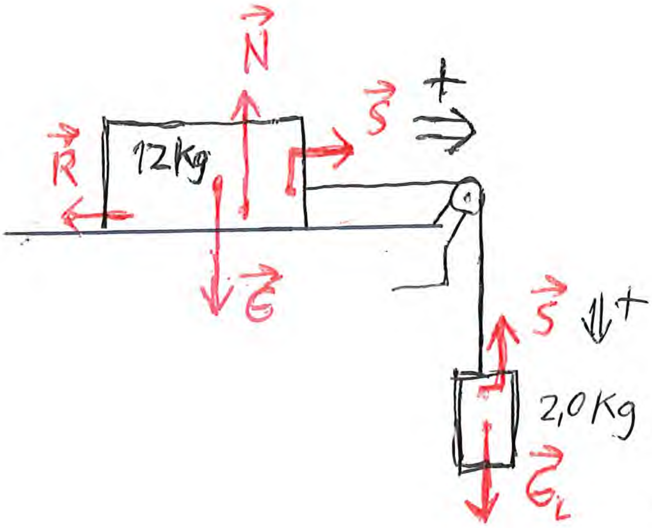
$m(g-a) = S$

$m = \frac{S}{(g-a)} = \frac{16{,}8\,N}{(9{,}81 - 1{,}4)\frac{m}{s^2}}$

$= 1{,}997\,kg$

$= \underline{2{,}0\,kg}$

c)



$\sum F = Ma$

$S - R = Ma$

$S - \mu N = Ma$

$S - \mu G = Ma$

$S - \mu Mg = Ma$

$S = Ma + \mu Mg$

$S = M(a + \mu g)$

$\sum F = ma$

$G_L - S = ma$

$G_L - M(a + \mu g) = ma$

$mg - M(a + \mu g) = ma$

$mg - Ma - M\mu g = ma$

$mg - M\mu g = (M+m)a$

$(m - \mu M)g = (M+m)a$

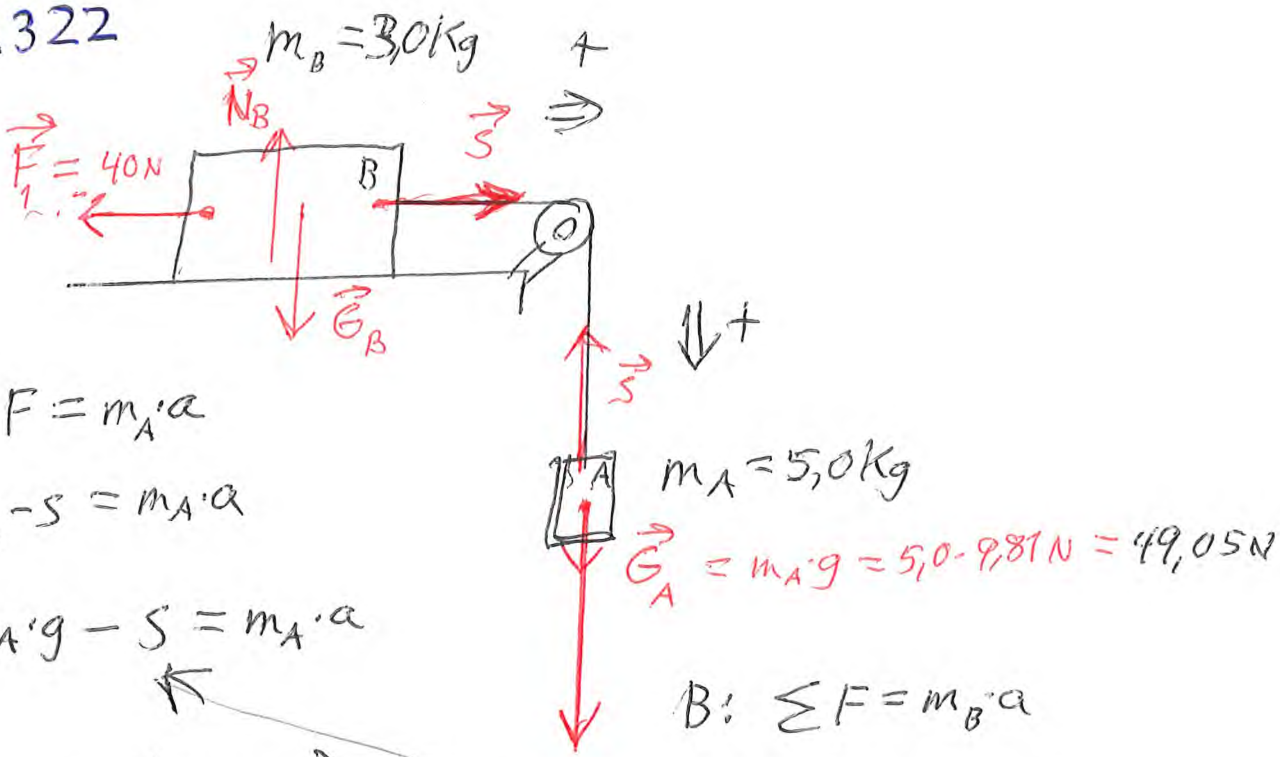
$a = \frac{(m - \mu M)g}{(M+m)}$

$a = \frac{(2{,}0 - 0{,}10 \cdot 12)\,kg}{(12 + 2{,}0)\,kg} \cdot 9{,}81\frac{m}{s^2}$

$a = 0{,}5605\,\frac{m}{s^2}$

$= \underline{0{,}56\,\frac{m}{s^2}}$

13.322



A: $\sum F = m_A \cdot a$

$G_A - S = m_A \cdot a$

$m_A \cdot g - S = m_A \cdot a$

B: $\sum F = m_B \cdot a$

$S - F_1 = m_B \cdot a$

$S = F_1 + m_B \cdot a$

$m_A \cdot g - (F_1 + m_B \cdot a) = m_A \cdot a$

$m_A \cdot g - F_1 - m_B \cdot a = m_A \cdot a$

$m_A \cdot g - F_1 = m_A \cdot a + m_B \cdot a$

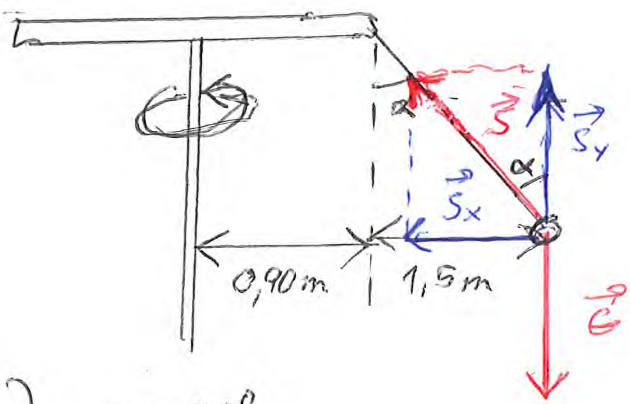
$m_A \cdot g - F_1 = (m_A + m_B) \cdot a$

$$a = \frac{m_A \cdot g - F_1}{(m_A + m_B)} = \frac{5{,}0\,kg \cdot 9{,}81\,\frac{m}{s^2} - 40\,\cancel{N}\ \left(kg \cdot \frac{m}{s^2}\right)}{(5{,}0 + 3{,}0)\,Kg}$$

$a = 1{,}131\,\frac{m}{s^2}$

$\underline{a = 1{,}1\,\frac{m}{s^2}}$ nedover

13.326 a)



$r = 0{,}90\,m + 1{,}5\,m$
$= 2{,}4\,m$

b) $\alpha = 36°$
$v = ?$

y: $\sum F = 0$

$S_y = G$

$S \cdot \cos\alpha = mg$

$S = \dfrac{mg}{\cos\alpha}$

x: $\sum F = ma$

$S_x = m\dfrac{v^2}{r}$

$S \cdot \sin\alpha = m\dfrac{v^2}{r}$

$\dfrac{\cancel{m}g \cdot \sin\alpha}{\cos\alpha} = \cancel{m}\dfrac{v^2}{r}$

$g \cdot \tan\alpha = \dfrac{v^2}{r}$

$gr \cdot \tan\alpha = v^2$

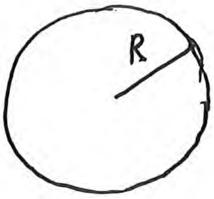
$v = \sqrt{gr \cdot \tan\alpha}$

$v = \sqrt{9{,}81\,\frac{m}{s^2} \cdot 2{,}4\,m \cdot \tan 36°}$

$v = 4{,}135\,\frac{m}{s}$

$v = \underline{4{,}1\,\frac{m}{s}}$

13.327 $R = 900m$



$$a = \frac{v^2}{R} = g \quad \text{og} \quad v^2 = \left(\frac{2\pi R}{T}\right)^2$$

$$\Downarrow$$

$$\frac{\frac{4\pi^2 R^2}{T^2}}{R} = g$$

$$\frac{4\pi^2 R^2}{T^2} = gR \quad | :R$$

$$4\pi^2 R = gT^2$$

$$\frac{4\pi^2 R}{g} = T^2$$

$$T = \sqrt{\frac{4\pi^2 R}{g}} = 2\pi\sqrt{\frac{R}{g}}$$

$$T = 2\pi\sqrt{\frac{900m}{9,81\frac{m}{s^2}}} = 60,18s$$

$$\underline{T = 60,2s}$$

13.330 $r = 0,25m$

a) 20 omdr. per sek. $\quad a = \frac{v^2}{r}$

$$v = \frac{s}{t} = \frac{20 \cdot 2\pi r}{t} = \frac{40\pi \cdot 0,25m}{1,00s} = 31,41\frac{m}{s}$$

$$a = \frac{v^2}{r} = \frac{(31,41\frac{m}{s})^2}{0,25m} = 3946\frac{m}{s^2}$$

$$\underline{= 3,9 \cdot 10^3 \frac{m}{s^2}}$$

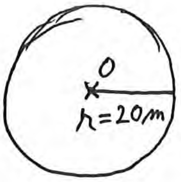
b) $m = 0,100kg$

$$\Sigma F = ma$$

$$F = m \cdot a = 0,100kg \cdot 3,946 \cdot 10^3 \frac{m}{s^2}$$

$$\underline{= 3,9 \cdot 10^2 N}$$

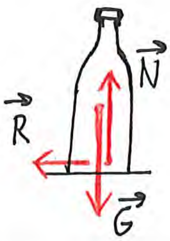
13.331+



$v = 20\,\frac{km}{h} = 20 \cdot \frac{1000\,m}{3600\,s} = 5{,}555\,\frac{m}{s}$

$m = 0{,}50\,kg$

a)



b) $R = \mu N$

$R = \mu m g$

$\sum_x F = m a_x$

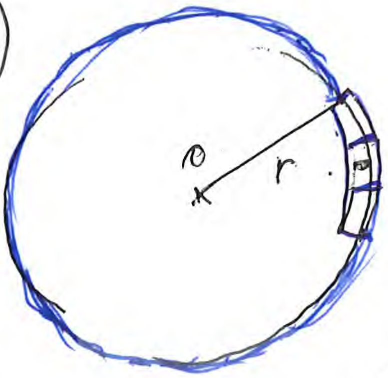
$R = m\frac{v^2}{r}$

$\mu \cancel{m} g = \cancel{m}\frac{v^2}{r}$

$\mu = \frac{v^2}{rg} = \frac{(5{,}555\,\frac{m}{s})^2}{20\,m \cdot 9{,}81\,\frac{m}{s^2}}$

$= \underline{0{,}16}$

13.332 a)

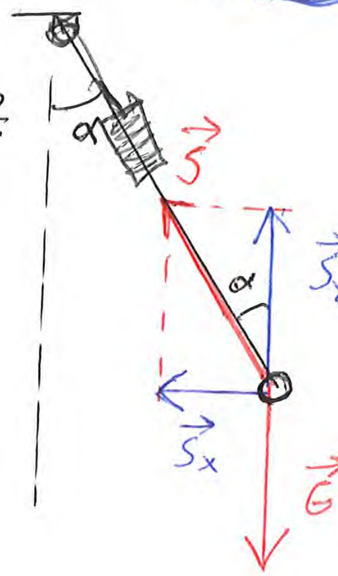


$r = 260\,m$

$V = 82\,\frac{km}{h} = 22{,}77\,\frac{m}{s}$

$m = 0{,}50\,kg$

$\alpha = ?$



$y: \sum F = 0$

$S_y = G$

$S \cdot \cos\alpha = mg$

$S = \frac{mg}{\cos\alpha}$

$x: \sum F = ma$

$S_x = m\frac{V^2}{r}$

$S \cdot \sin\alpha = m\frac{V^2}{r}$

$\downarrow$

$\frac{\cancel{m}g \cdot \sin\alpha}{\cos\alpha} = \cancel{m}\frac{V^2}{r}$

$g \cdot \tan\alpha = \frac{V^2}{r}$

$\tan\alpha = \frac{V^2}{gr}$

$\alpha = \tan^{-1}\left(\frac{V^2}{gr}\right)$

$\alpha = \tan^{-1}\left(\frac{(22{,}77\,\frac{\cancel{m}}{\cancel{s}})^2}{9{,}81\,\frac{\cancel{m}}{\cancel{s^2}} \cdot 260\,\cancel{m}}\right)$

$\alpha = 11{,}49^\circ$

$\underline{\alpha = 11^\circ}$

b) Vekta viser snordraget

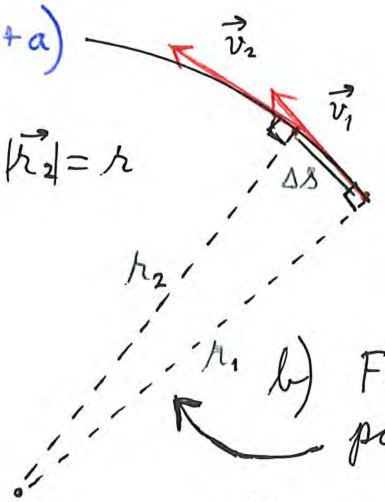
$S = \frac{mg}{\cos\alpha}$

$S = \frac{0{,}50\,kg \cdot 9{,}81\,\frac{N}{kg}}{\cos 11{,}49^\circ}$

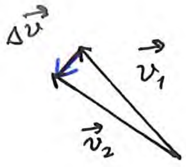
$S = 5{,}005\,N$

$\underline{S = 5{,}0\,N}$

13,333 + a)



$|\vec{r}_1| = |\vec{r}_2| = r$



Vi ser at $\Delta\vec{v}$ står nesten vinkelrett på både $\vec{v}_1$ og $\vec{v}_2$. Når Δt går mot null vil $\Delta\vec{v}$ dermed peke mot sentrum i sirkelen.

$|\vec{v}_1| = |\vec{v}_2| = v$

b) Fartstrekanten er formlik med posisjonstrekanten fordi $\vec{r}_1 \perp \vec{v}_1$ og $\vec{r}_2 \perp \vec{v}_2$

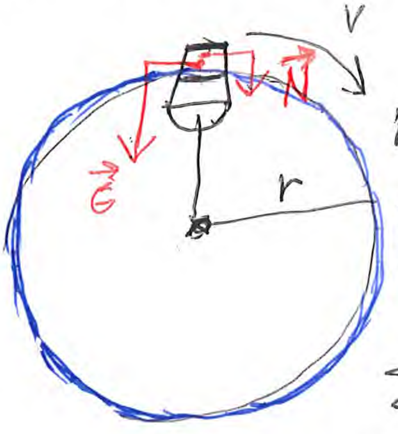
Dette gir
$$\frac{\Delta v}{v} = \frac{\Delta s}{r}$$
$$\Delta v = \frac{v}{r} \cdot \Delta s$$
$$\frac{\Delta v}{\Delta t} = \frac{v}{r} \cdot \frac{\Delta s}{\Delta t}$$
som gir $a = \frac{v}{r} \cdot v = \frac{v^2}{r}$ når $\Delta t \to 0$

Dermed blir $\sum F = ma$

til $\sum F = \frac{mv^2}{r}$

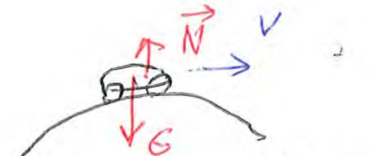
og $v = \frac{\text{omkrets}}{\text{periode}} = \frac{2\pi r}{T}$ gir $\sum F = \frac{m}{r} \cdot \left(\frac{2\pi r}{T}\right)^2 = \frac{4\pi^2 m r}{T^2}$

13,336



$r = 1{,}00\,m$

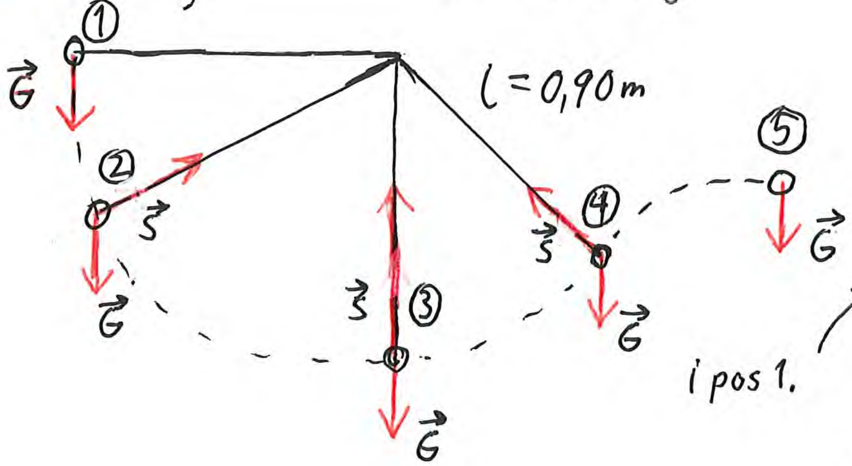
$N = 0$
$\Downarrow$ svever
vannet faller ut av bøtta



$N = 0 \Rightarrow$ bilen hopper

$$\sum F = ma$$
$$N + G = m\frac{v^2}{r}$$
$$0 + mg = m\frac{v^2}{r} \quad | : m$$
$$g = \frac{v^2}{r}$$
$$gr = v^2$$
$$v = \sqrt{gr} = \sqrt{9{,}81\,\tfrac{m}{s^2} \cdot 1{,}00\,m}$$
$$\underline{v = 3{,}13\,\tfrac{m}{s}}$$

13.338 a) $m = 0{,}210\,kg$



b) $S = 0$ i posisjon 1

$E_{p0} = E_K$ i bunnen, 3.

i pos 1.

$mgh = \frac{1}{2}mv^2$

$\cancel{m}gl = \frac{1}{2}\cancel{m}v^2$

$2gl = v^2$

$\sum F = m\frac{v^2}{R}$ i bunnen, 3

$G = mg = 0{,}210\,kg \cdot 9{,}81\,\frac{m}{s^2}$

$= 2{,}060\,N = \underline{2{,}1\,N}$

rett ned over alt.

$S - mg = m\frac{v^2}{R}$

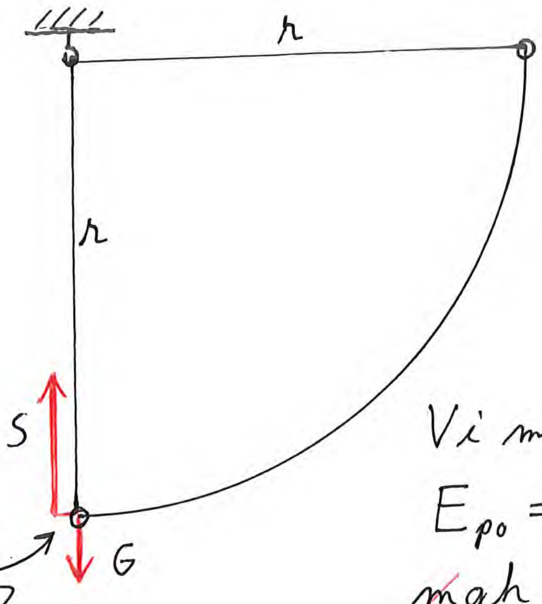
$S = m\left(g + \frac{v^2}{l}\right)$

$= m\left(g + \frac{2gl}{l}\right) = m(g + 2g) = 3mg = 3 \cdot 0{,}210\,kg \cdot 9{,}81\,\frac{m}{s^2}$

$= 6{,}180\,N = \underline{6{,}2\,N}$ i pos ③

$S = 0$ i pos. ⑤

13.339+



$S = 3 \cdot G$?

$\sum_y F = ma_y$ i bunnen

$S - G = ma_y$

$S - mg = m\frac{v^2}{r}$

$S = m\left(g + \frac{v^2}{r}\right)$

Vi må finne v.

$E_{p0} = E_k$

$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$

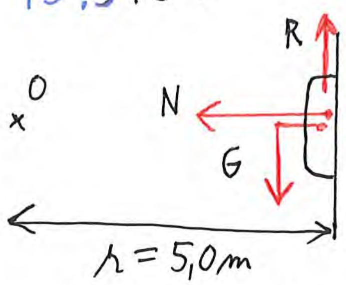
$gr = \frac{1}{2}v^2$

$v^2 = 2gr$

Dette gir: $S = m\left(g + \frac{2gr}{r}\right) = m(g + 2g) = 3mg$

$\underline{= 3 \cdot G}$ i bunnen.

13.340+



$T = 2{,}0\,s$

a) $\sum_y F = 0$

$R = G$

$R = mg$

$R = 60\,kg \cdot 9{,}81\,\frac{N}{kg}$

$= 588{,}6\,N$

$= \underline{0{,}59\,kN}$

b) $\sum_x F = m a_x$

$N = m\frac{v^2}{r}$

$N = m\frac{v^2}{r}$ og $v = \frac{2\pi r}{T}$

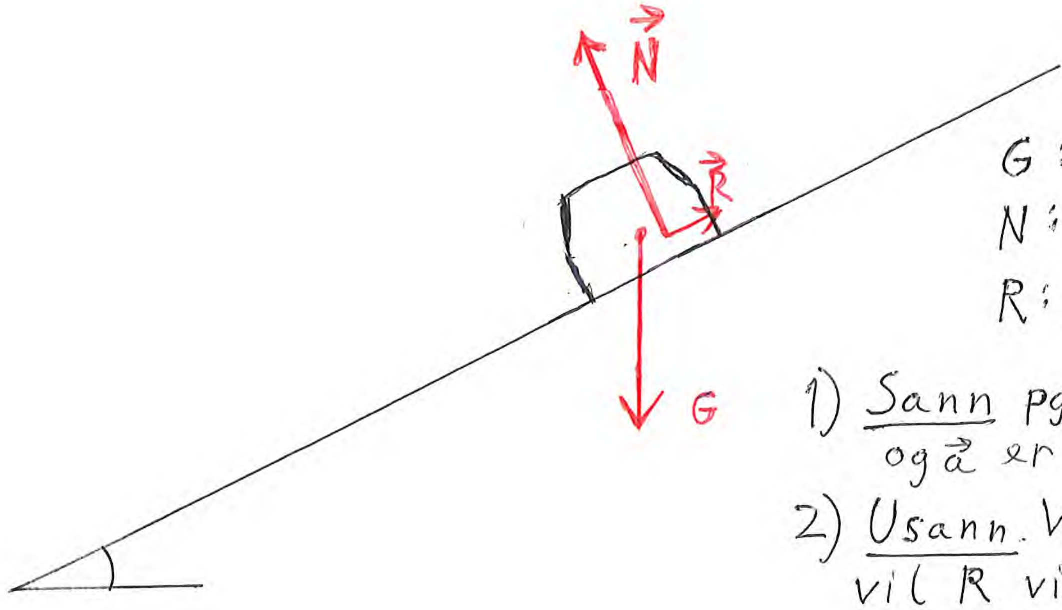
$v = \frac{2\pi \cdot 5{,}0\,m}{2{,}0\,s} = 15{,}70\,\frac{m}{s}$

$N = 60\,kg \cdot \frac{(15{,}70\,\frac{m}{s})^2}{5{,}0\,m} = 2957\,N$

$\mu = \frac{R}{N} = \frac{588{,}6\,N}{2957\,N} = \underline{0{,}20}$

13.341+

⇑ y-retning



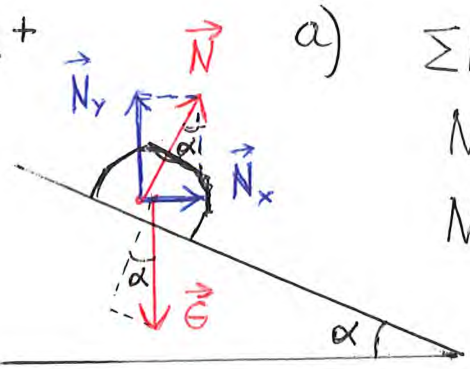
G : tyngdekraft
N : normalkraft
R : friksjonskraft

1) <u>Sann</u> pga. $\sum \vec{F} = m\vec{a}$ og $\vec{a}$ er mot sentrum.

2) <u>Usann</u>. Ved stor fart vil R virke ned skråplanet. Ved lav fart vil R virke opp skråplanet.

3) Sann. Ved en passe fart vil $R=0$ i tegningen og $N_y = G \Rightarrow N > G$

13.342+



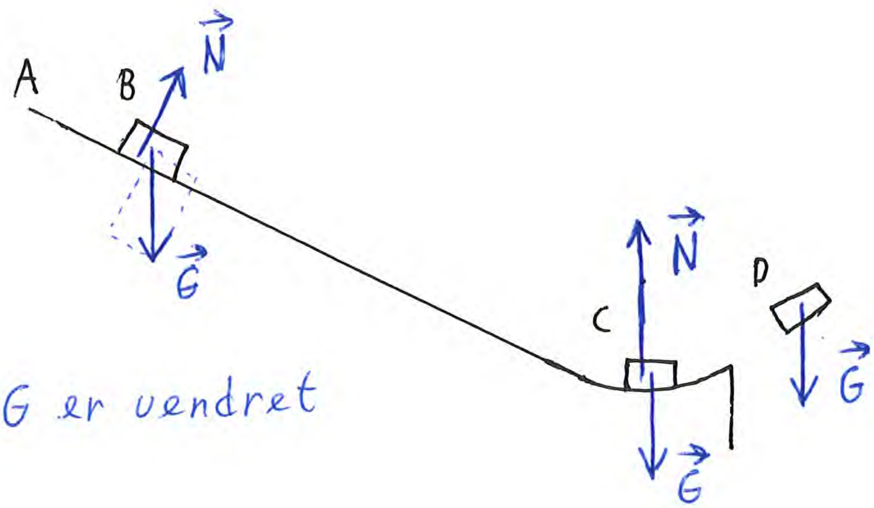
a)
$$\sum F = ma$$
$$N_x = m\frac{v^2}{r}$$
$$N \cdot \sin\alpha = m\frac{v^2}{r}$$
$$\frac{mg \cdot \sin\alpha}{\cos\alpha} = m\frac{v^2}{r}$$
$$g \cdot \tan\alpha = \frac{v^2}{r}$$
$$\tan\alpha = \frac{v^2}{gr}$$

$$\sum F_y = 0$$
$$N_y = G$$
$$N \cdot \cos\alpha = mg$$
$$N = \frac{mg}{\cos\alpha}$$

b) $r = 300\,m$ $\quad v = 60\,\frac{km}{h} = 60 \cdot \frac{1000\,m}{3600\,s} = 16{,}66\,\frac{m}{s}$

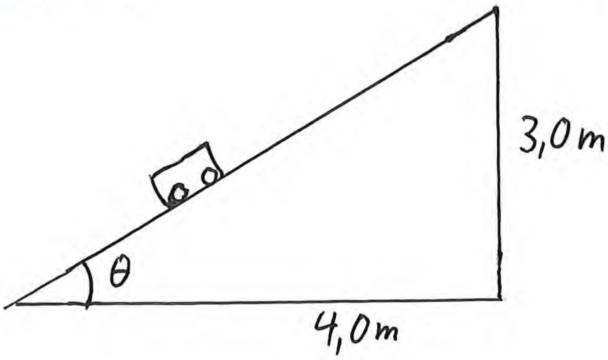
$$\tan\alpha = \frac{v^2}{gr}$$
$$\alpha = \tan^{-1}\left(\frac{v^2}{gr}\right)$$
$$\alpha = \tan^{-1}\left(\frac{(16{,}66\,\frac{m}{s})^2}{9{,}81\,\frac{m}{s^2} \cdot 300\,m}\right) = \underline{5{,}4°}$$

13.358



G er uendret

13.359



$\tan\theta = \frac{3{,}0}{4{,}0}$

$\theta = \tan^{-1}\left(\frac{3{,}0}{4{,}0}\right) = 36{,}86°$

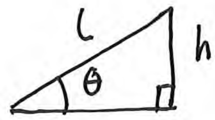
a) $V_0 = 6{,}0\,\frac{m}{s}$

$E_p = E_{K0}$

$mgh = \frac{1}{2} m V_0^2$

$gh = \frac{1}{2} V_0^2$

$h = \frac{V_0^2}{2g} = \frac{(6{,}0\frac{m}{s})^2}{2 \cdot 9{,}81\frac{m}{s^2}} = 1{,}834\,m$



$\sin\theta = \frac{h}{l}$

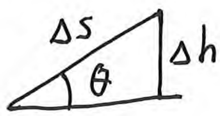
$l = \frac{h}{\sin\theta} = \frac{1{,}834\,m}{\sin 36{,}86°}$

$l = 3{,}057\,m = \underline{3{,}1\,m}$

b) $s = 2{,}6\,m$

$\Delta s = l - s$

$= 3{,}057\,m - 2{,}6\,m = 0{,}457\,m$



$\sin\theta = \frac{\Delta h}{\Delta s}$

$\Delta h = \Delta s \cdot \sin\theta$

$\Delta h = 0{,}457\,m \cdot \sin 36{,}86°$

$= 0{,}2741\,m$

$W_f = R \cdot s$

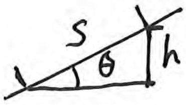
$mg\Delta h = R \cdot s$

$R = \frac{mg\Delta h}{s}$

$R = \frac{8{,}0\,kg \cdot 9{,}81\,\frac{N}{kg} \cdot 0{,}2741\,m}{2{,}6\,m}$

$R = 8{,}273\,N = \underline{8{,}3\,N}$

13.359 c) $s = 1{,}2\,m$



$h = s \cdot \sin\theta$

$= 1{,}2\,m \cdot \sin 36{,}86°$

$= 0{,}7198\,m$

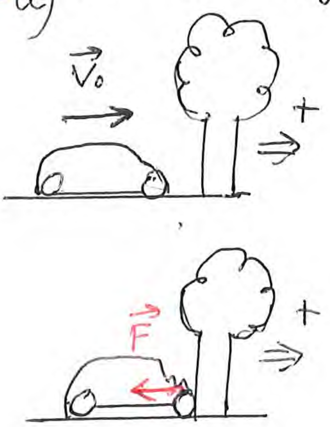
$W = E_p + E_k$

$F \cdot s = mgh + \frac{1}{2}mv^2$

$F = \frac{m(gh + \frac{1}{2}v^2)}{s} = \frac{8{,}0\,kg\left(9{,}81\,\frac{m}{s^2} \cdot 0{,}7198\,m + \frac{1}{2} \cdot \left(6{,}0\,\frac{m}{s}\right)^2\right)}{1{,}2\,m}$

$= 167\,N = \underline{0{,}17\,kN}$

13.362 a) $m = 1400\,kg$



$V_0 = 82\,\frac{km}{h} = 82 \cdot \frac{1000\,m}{3600\,s} = 22{,}77\,\frac{m}{s}$

$t = 0{,}40\,s$

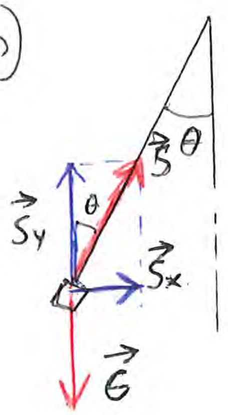
$\sum F = m\bar{a}$

$\bar{F} = m\frac{(v - v_0)}{t}$

$\bar{F} = 1400\,kg \cdot \frac{(0 - 22{,}77\,\frac{m}{s})}{0{,}40\,s} = -79695\,N$

$= \underline{-80\,kN}$

b)



x: $\sum F = m \cdot a$

$S_x = ma$

$S \cdot \sin\theta = ma$

$\frac{mg \cdot \sin\theta}{\cos\theta} = ma$

$a = g \cdot \tan\theta$

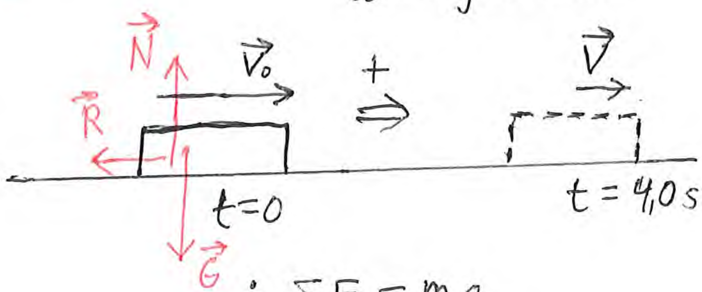
y: $\sum F = 0$

$S_y = G$

$S \cdot \cos\theta = mg$

$S = \frac{mg}{\cos\theta}$

c)



$\mu = ?$ $V_0 = 5{,}0\,\frac{m}{s}$

$\mu = \frac{R}{N}$ $V = 1{,}0\,\frac{m}{s}$

og $N = G$ fordi $\sum F = 0$ i y-retning.

$\Downarrow$

$N = mg$

x: $\sum F = ma$

$R = ma$

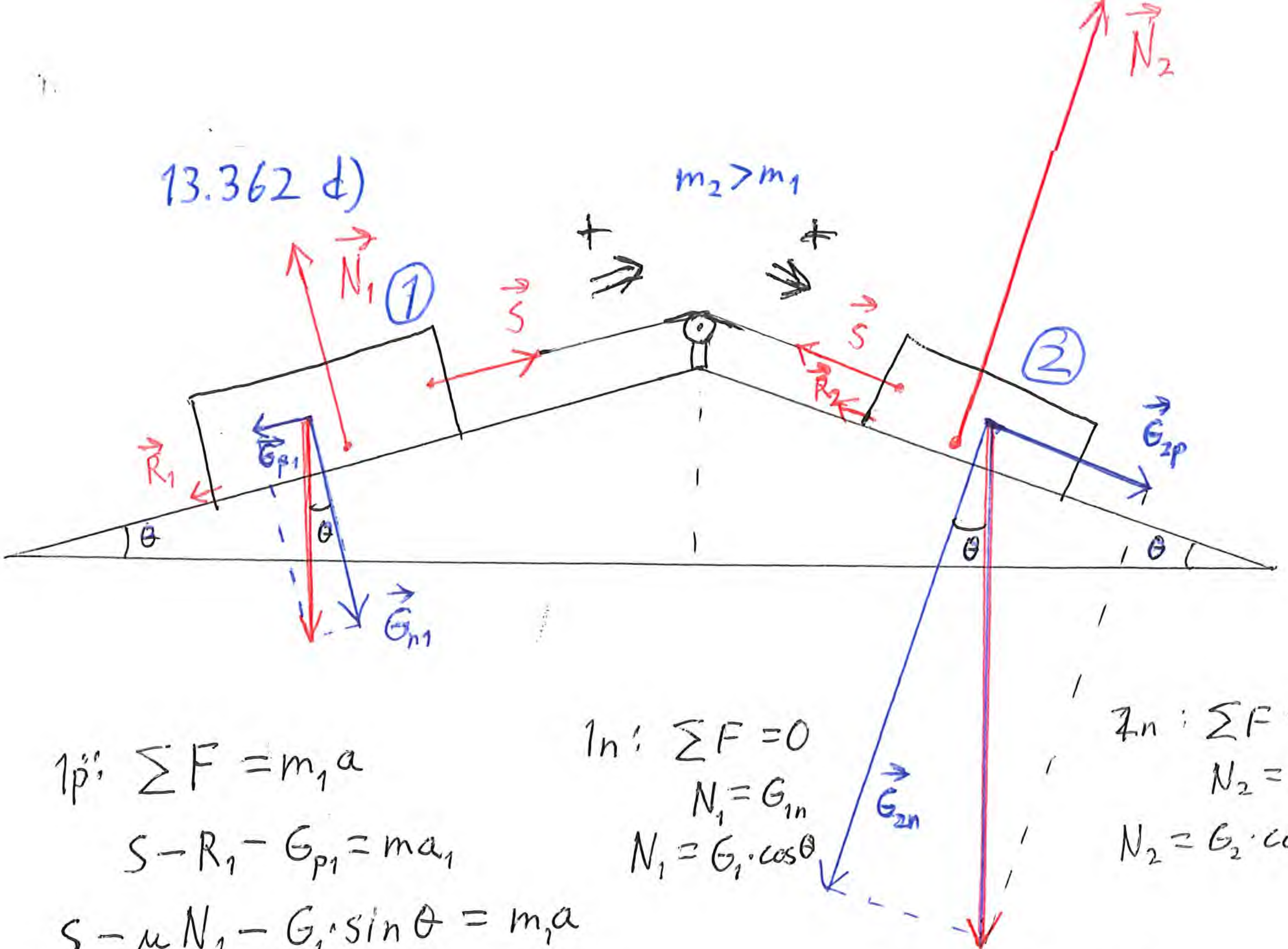
$R = m\frac{v - v_0}{t}$

$\mu = \frac{|R|}{N} = \frac{|\cancel{m} \cdot (\frac{v - v_0}{t})|}{\cancel{m}g} = \frac{|v - v_0|}{t \cdot g}$

$\mu = \frac{|1{,}0 - 5{,}0|\,\frac{m}{s}}{4{,}0\,s \cdot 9{,}81\,\frac{m}{s^2}} = \underline{0{,}10}$

13.362 d)

$m_2 > m_1$



1p: $\sum F = m_1 a$

$S - R_1 - G_{p1} = m a_1$

$S - \mu N_1 - G_1 \cdot \sin\theta = m_1 a$

$S - \mu G_1 \cdot \cos\theta - G_1 \cdot \sin\theta = m_1 a$

$S = m_1 a + G_1 \cdot (\sin\theta + \mu \cdot \cos\theta)$

$S = m_1 a + m_1 g \cdot (\sin\theta + \mu \cdot \cos\theta)$

1n: $\sum F = 0$

$N_1 = G_{1n}$

$N_1 = G_1 \cdot \cos\theta$

2n: $\sum F = 0$

$N_2 = G_{2n}$

$N_2 = G_2 \cdot \cos\theta$

2p: $\sum F = m_2 a$

$G_{p2} - S - R_2 = m_2 a$

$G_2 \cdot \sin\theta - S - \mu N_2 = m_2 a$

$G_2 \cdot \sin\theta - S - \mu G_2 \cdot \cos\theta = m_2 a$

$$m_2 g \cdot \sin\theta - [m_1 a + m_1 g \cdot (\sin\theta + \mu \cos\theta)] - \mu m_2 g \cdot \cos\theta = m_2 a$$

$$m_2 g \sin\theta - m_1 a - m_1 g \cdot \sin\theta - m_1 g \cdot \mu \cdot \cos\theta - \mu m_2 g \cdot \cos\theta = m_2 a$$

$$\sin\theta \cdot [m_2 g - m_1 g] - \cos\theta \cdot [m_1 g \mu + m_2 g \mu] = [m_2 + m_1] \cdot a$$

$$g \cdot \sin\theta \cdot (m_2 - m_1) - \mu \cdot g \cdot \cos\theta \cdot (m_2 + m_1) = (m_2 + m_1) \cdot a$$

$$\left(\frac{m_2 - m_1}{m_2 + m_1}\right) \cdot g \cdot \sin\theta - \mu g \cdot \cos\theta = a$$

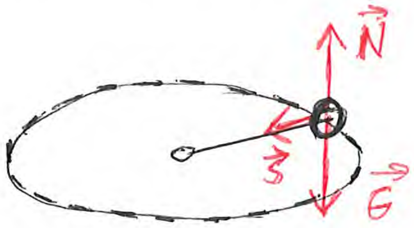
$$m_1 = 0 \Rightarrow a = \left(\frac{m_2 - 0}{m_2 + 0}\right) \cdot g \cdot \sin\theta - \mu g \cdot \cos\theta$$

$$a = g \cdot \sin\theta - \mu g \cdot \cos\theta$$

$$a = g \cdot (\sin\theta - \mu \cdot \cos\theta)$$

13.364 $m = 0{,}060\,kg$ $S_{max} = 10N$ $r = 0{,}84\,m$ T

a)



b) $T = 2\pi\sqrt{\frac{mr}{S}}$

$$T = 2\pi\sqrt{\frac{0{,}060 \cdot 0{,}84m}{10N}} = 0{,}4460s$$
$$= \underline{0{,}45s}$$

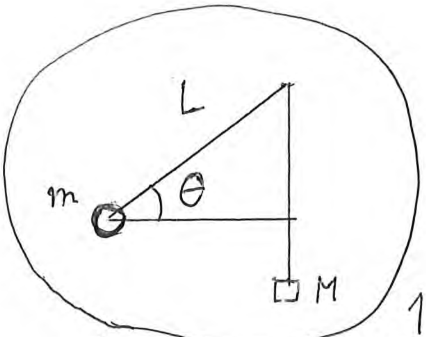
$$v = \frac{s}{t} = \frac{2\pi r}{T} = \frac{2\pi \cdot 0{,}84m}{0{,}4460s} = 11{,}83\frac{m}{s}$$
$$= \underline{12\,\frac{m}{s}}$$

c) $v = \frac{s}{t}$ gir $v_b = \frac{2\pi r}{T}$ for banefarten.

$$\Downarrow$$
$$T = \frac{2\pi r}{v_b}$$

og $\sum F_x = m a_x$ gir

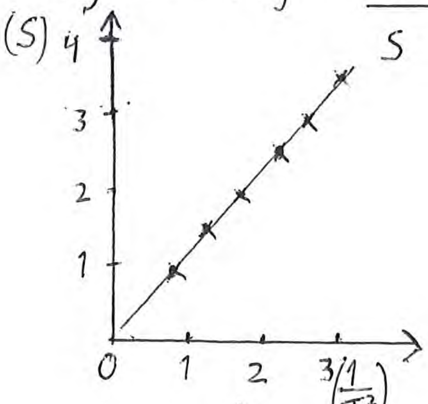
$$S = m\frac{v_b^2}{r}$$
$$\frac{S \cdot r}{m} = v_b^2$$
$$v_b = \sqrt{\frac{S \cdot r}{m}}$$



$$T = 2\pi \cdot \frac{r}{\sqrt{\frac{S \cdot r}{m}}} = 2\pi r \cdot \sqrt{\frac{m}{S \cdot r}}$$
$$T = 2\pi \cdot \sqrt{r^2} \cdot \sqrt{\frac{m}{S \cdot r}} = 2\pi \cdot \sqrt{\frac{m \cdot r^2}{S \cdot r}}$$
$$\underline{T = 2\pi\sqrt{\frac{mr}{S}}}$$

d) $S = Mg$

$\frac{1}{T^2}$	$0{,}8416\,s^{-2}$	$1{,}234\,s^{-2}$	$1{,}686\,s^{-2}$	$2{,}100\,s^{-2}$	$2{,}519\,s^{-2}$	$2{,}972\,s^{-2}$
S	$0{,}981\,N$	$1{,}471\,N$	$1{,}962\,N$	$2{,}452\,N$	$2{,}943\,N$	$3{,}433\,N$



e) $\sum F = m\frac{v^2}{r}$

$$S_x = m \cdot \frac{\left(\frac{2\pi r}{T}\right)^2}{r}$$

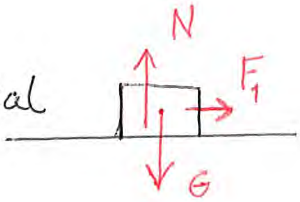
$$S \cdot \cos\theta = 4\pi^2 \cdot m \cdot \frac{r}{T^2}$$
$$S \cdot \cancel{\cos\theta} = 4\pi^2 \cdot m \cdot \frac{L \cdot \cancel{\cos\theta}}{T^2}$$

$\uparrow$

$\frac{S}{\left(\frac{1}{T^2}\right)} = \text{konst}$ $\Longleftrightarrow$ $\frac{S}{\left(\frac{1}{T^2}\right)} = \text{konst.}$ <u>stemmer</u>

13.366 a) $m = 10\,kg$

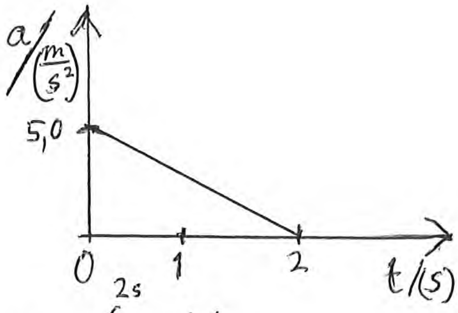
Antar F_1 horisontal



$F_1(t)$

$F_1(0) = 50\,N$

$F_1(2{,}0\,s) = 0$



$a(t=0) = \frac{50\,N}{10\,Kg} = 5{,}0\,\frac{m}{s^2}$

$\sum F = ma$

$F_1 = ma$

$a = \frac{F_1}{m}$

$$v = \int_0^{2s} a\,dt = \text{Areal av trekant} = \frac{(a + a_0)}{2} \cdot t$$

$$= \frac{(0 + 5{,}0\,\frac{m}{s^2})}{2} \cdot 2{,}0\,s = \underline{5{,}0\,\frac{m}{s}}$$

b) $m = 0{,}20\,kg$

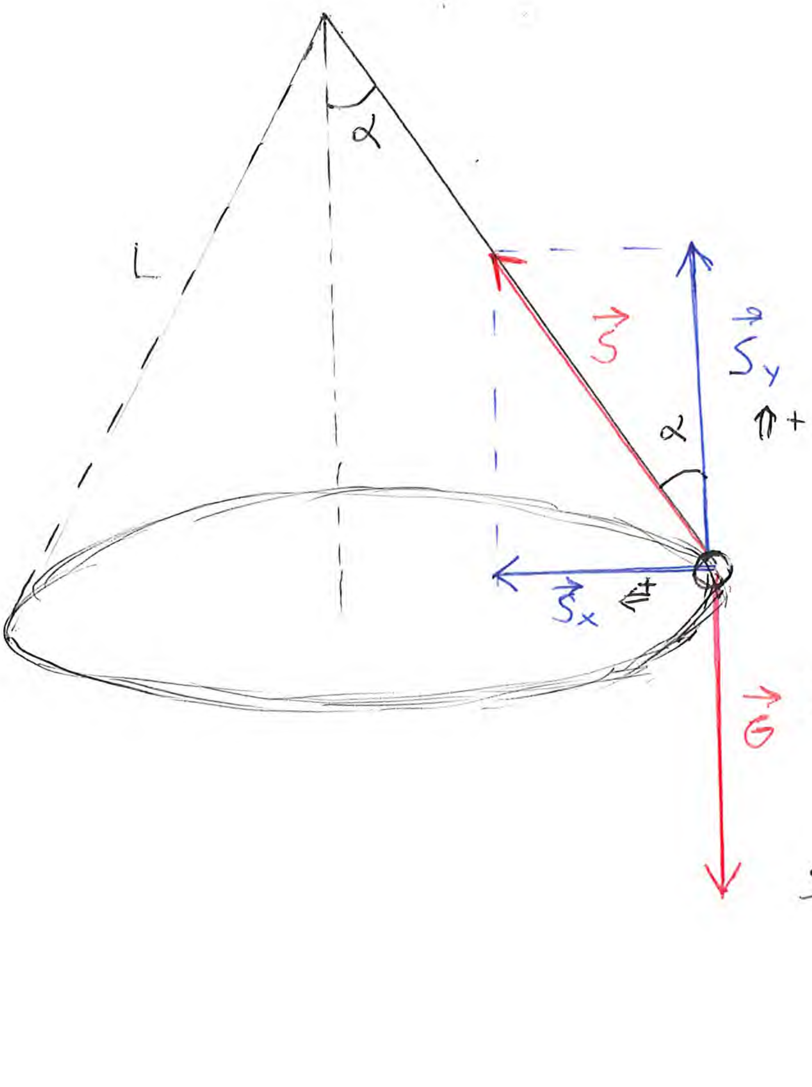
$L = 1{,}20\,m$

$\alpha = 30^\circ$

x: $\sum F = ma$

$S_x = m\frac{v^2}{r}$

$S \cdot \sin\alpha = \sum F$



y: $\sum F = 0$

$S_y - G = 0$

$S_y = G$

$S \cdot \cos\alpha = mg$

$S = \frac{mg}{\cos\alpha}$

$S \cdot \sin\alpha = \frac{mg}{\cos\alpha} \cdot \sin\alpha$

$\sum F = mg \cdot \tan\alpha$

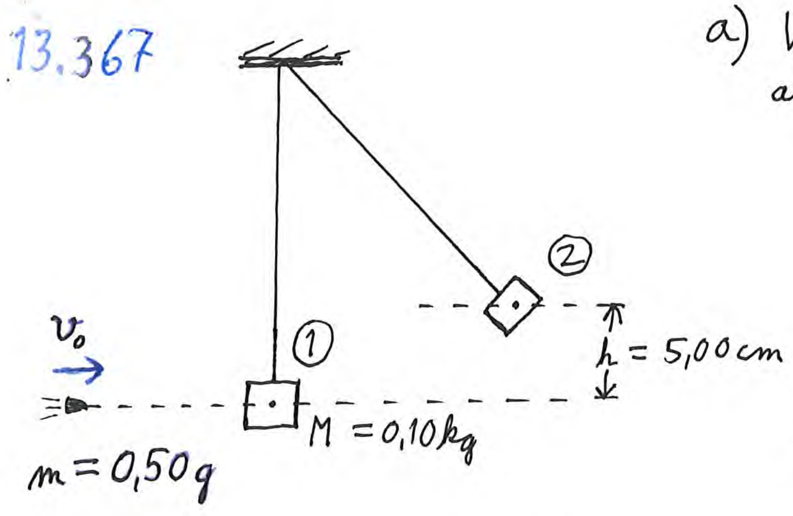
$\sum F = 0{,}20\,kg \cdot 9{,}81\,\frac{N}{kg} \cdot \tan 30^\circ$

$= \underline{1{,}1\,N} \quad (1{,}132\,N)$

$S = \frac{mg}{\cos\alpha} = \frac{0{,}20 \cdot 9{,}81\,N}{\cos 30^\circ}$

$= 2{,}265\,N = \underline{2{,}3\,N}$

13.367



a) Vis at $v = 1{,}0\,\frac{m}{s}$ rett etter at kula har festet seg.

$$E_{p2} = E_{k1}$$

$$(m+M)gh = (m+M)v^2$$

$$2gh = v^2$$

$$v = \sqrt{2gh}$$

$$v = \sqrt{2 \cdot 9{,}81 \cdot 0{,}0500}\,\frac{m}{s} = 0{,}9904\,\frac{m}{s}$$

$$= \underline{1{,}0\,\frac{m}{s}}$$

b) $$\left(\sum mv\right)_{før} = \left(\sum mv\right)_{etter}$$

$$mv + \cancel{0} = (m+M)U \qquad U \text{ er } v \text{ fra a)}$$

$$\text{"} = \left(\frac{m+M}{m}\right)U = \left(\frac{0{,}00050 + 0{,}10}{0{,}00050}\right) \cdot 1{,}0\,\frac{m}{s} = 201\,\frac{m}{s} = \underline{0{,}20\,\frac{km}{s}}$$

c) Man kan filme kula med et høyhastighetskamera.

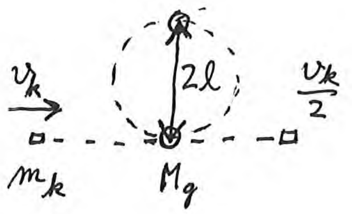
Fordel: Pålitelig resultat hele veien.

Ulempe: Trenger dyrt utstyr.

Man kan bruke lasersensorer og la kula passere to stykker og måle tida mellom passeringene når man kjenner avstanden.

Fordel: Pålitelig gjennomsnittsmåling av farten.

Ulempe: Mye utstyr.



d) $$\left(\sum mv\right)_{før} = \left(\sum mv\right)_{etter}$$

$$m_k v_k + 0 = \tfrac{1}{2} m_k v_k + M_g V_g$$

$$\tfrac{1}{2} m_k v_k = M_g V_g$$

$$\tfrac{1}{2} m_k v_k = M_g \cdot 2\sqrt{gl}$$

$$m_k v_k = M_g \cdot 4\sqrt{gl}$$

$$\underline{v_k = \frac{4M_g}{m_k}\sqrt{gl}}$$

topp ↘ ↙ bunn

$$E_p = E_k$$

$$M_g gh = \tfrac{1}{2} M_g V_g^2$$

$$g \cdot 2l = \tfrac{1}{2} V_g^2$$

$$4gl = V_g^2$$

$$V_g = \sqrt{4gl}$$

$$V_g = 2\sqrt{gl}$$

13.368 20 omdr./min.

$A = \pi r^2$

$r = 33\,m$

$V > V_{min}$

$P_{el} = 1{,}65 \cdot 10^6\,W$

$E_{tot} = 4{,}8 \cdot 10^9\,Wh$

$P_1 = \frac{1}{2} A \rho v^3$

$P_{el_1} = 0{,}40 \cdot P_1$

$V < V_{min}$

$P_{el} = 0$

$\rho = 1{,}29\,\frac{kg}{m^3}$

a) $v = ?$ hvis $P_{el1} = P_{el}$

$$0{,}40 \cdot \frac{1}{2} A \rho v^3 = P_{el}$$

$$0{,}40 \cdot \frac{1}{2} \cdot \pi r^2 \rho v^3 = P_{el}$$

$$v^3 = \frac{2 P_{el}}{0{,}40 \pi r^2 \cdot \rho}$$

$$v = \sqrt[3]{\frac{2 P_{el}}{0{,}40 \pi r^2 \rho}}$$

$$v = \sqrt[3]{\frac{2 \cdot 1{,}65 \cdot 10^6\,\frac{J}{s}}{0{,}40 \cdot \pi \cdot (33\,m)^2 \cdot 1{,}29\,\frac{kg}{m^3}}} = 12{,}31\,\frac{m}{s} = \underline{12\,\frac{m}{s}}$$

$$P_{el1} \cdot t = E_{tot}$$

$$t = \frac{E_{tot}}{P_{el1}} = \frac{4{,}8 \cdot 10^9\,\cancel{W} \cdot h}{1{,}65 \cdot 10^6\,\cancel{W}} = 2909\,h = 121\,\text{døgn}$$

$$= 0{,}33\,\text{år} = \underline{33\%\ \text{av året}}$$

b) Antall omdreininger gir

$h = 67\,m + 33\,m = 100\,m$ fallhøyde

$$s = v_0 t + \frac{1}{2} a t^2$$

$$h = \frac{1}{2} g t^2 \quad (v_{0y} = 0)$$

$$\frac{2h}{g} = t^2$$

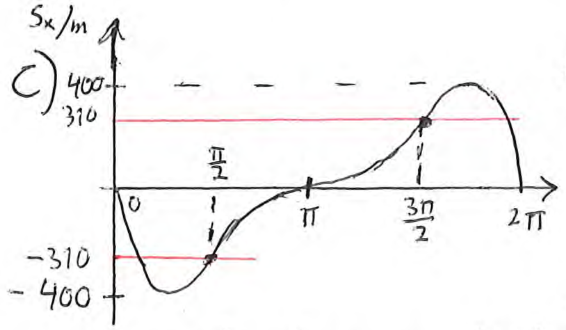
$$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \cdot 100\,m}{9{,}81\,\frac{m}{s^2}}} = 4{,}515\,s$$

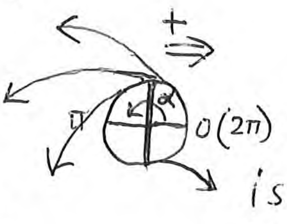
$$v = \frac{20 \cdot 2\pi r}{60\,s} = \frac{40\pi \cdot 33\,m}{60\,s} = 69{,}11\,\frac{m}{s}$$

$$s_x = v_x \cdot t = 69{,}11\,\frac{m}{s} \cdot 4{,}515\,s$$

$$= 312\,m = \underline{0{,}31\,km}$$

c)





Avstand $s_x = 0$ for $\alpha = 0, \pi, 2\pi$ fordi møllebladet da kaster isklumpen rett opp eller rett ned.

s_x blir som for et horisontalt kast for $\alpha = \frac{\pi}{2}$ og $\frac{3\pi}{2}$, men kastet blir enda lenger litt før toppen og litt etter bunnen pga. lenger tid i lufta kombinert med stor $|v_x|$.