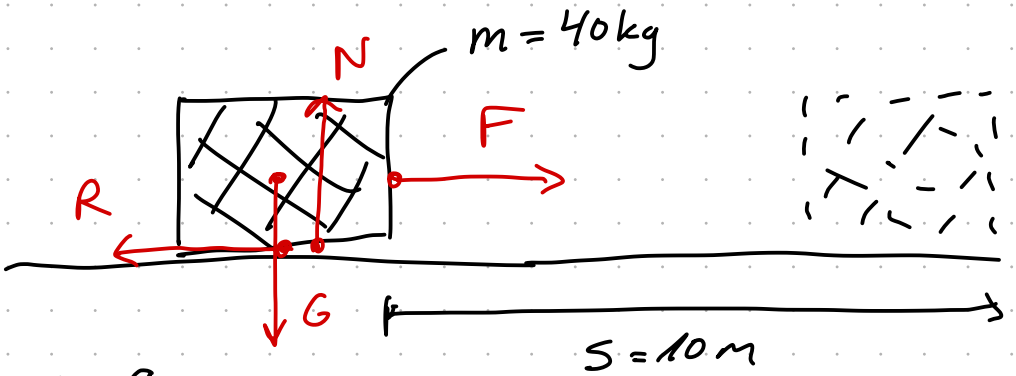
# Tentamen høst 2020

1.




$F = 90N$ , $\mu = 0{,}2$

a) $W_F = F \cdot s \cdot \underbrace{\cos\theta}_{=1 \text{ fordi } \theta = 0} = F \cdot s = 90N \cdot 10m = 900J$

b) $\Delta E_K = W_{\Sigma F}$ (arbeid-energi-setning)

$= W_F + W_R$ ← ?

Vi finner R: $R = \mu N = \mu G = \mu mg$

$= 0{,}2 \cdot 40kg \cdot 9{,}81\ m/s^2 = 78{,}48N$

$W_R = R \cdot s \cdot \underbrace{\cos\theta}_{=-1 \text{ fordi } \theta = 180°} = -78{,}48N \cdot 10m = -784{,}8J$

$\Delta E_K = W_{\Sigma F} = W_F + W_R = 900J - 784{,}8J = 115{,}2J$

$\Delta E_K = 115J$

2. Finner middelverdi:

$$\bar{\rho} = \frac{(7{,}875 + 7{,}866 + 7{,}870 + 7{,}873 + 7{,}869 + 7{,}871)}{6} 10^3 \frac{kg}{m^3}$$

$$= 7{,}8707 \cdot 10^3 \frac{kg}{m^3}$$

Største avvik fra middelverdi gir usikkerhet.

$$\delta\rho = (7{,}8707 - 7{,}866) \cdot 10^3 \frac{kg}{m^3} = 0{,}0047 \cdot 10^3 \frac{kg}{m^3}$$

$$= 0{,}005 \cdot 10^3 \frac{kg}{m^3}$$

Gjeldende sifre i $\bar{\rho}$:

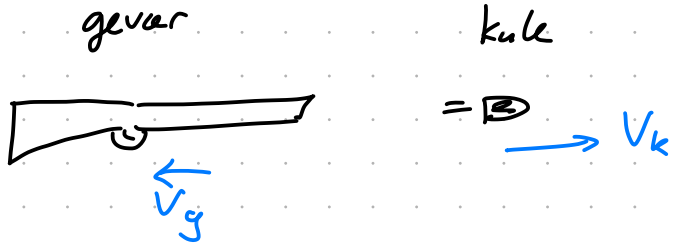
$$\bar{\rho} = 7{,}871 \cdot 10^3 \frac{kg}{m^3}$$

Relativ usikkerhet: $\frac{\delta\rho}{\bar{\rho}} = 5{,}9 \cdot 10^{-4} = 0{,}06\,\%$

$$\rho = 7{,}871 \cdot 10^3 \frac{kg}{m^3} \pm 0{,}06\,\%$$

3.

a)




Samlet bevegelsesmengde før og etter skuddd må være bevart.

$$p_{før} = m_g v_g + m_k v_k = m_g \cdot 0\,m/s + m_k \cdot 0\,m/s = 0\ kg\frac{m}{s}$$

$$p_{etter} = 0\ kg\frac{m}{s}$$

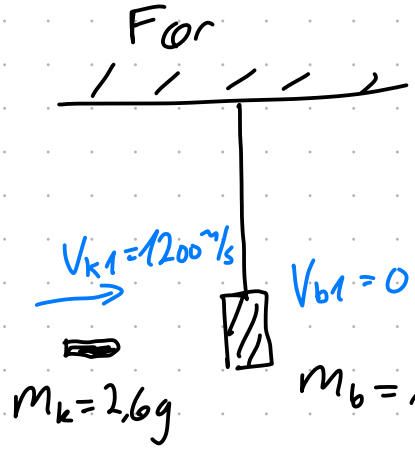
$$p_{etter} = m_g v_g + m_k v_k$$

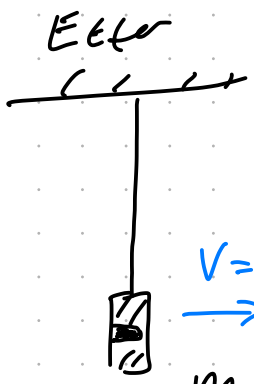
$$m_g v_g = -m_k v_k$$

$$v_g = -\frac{m_k v_k}{m_g} = -\frac{0{,}0026kg \cdot 1200\frac{m}{s}}{3{,}0kg} = -1{,}04\frac{m}{s}$$

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

b)




$$p_{før} = m_k v_{k1} + m_b v_{b1} \quad (v_{b1} = 0)$$

$$p_{etter} = m \cdot v$$

$$p_{før} = p_{etter}$$

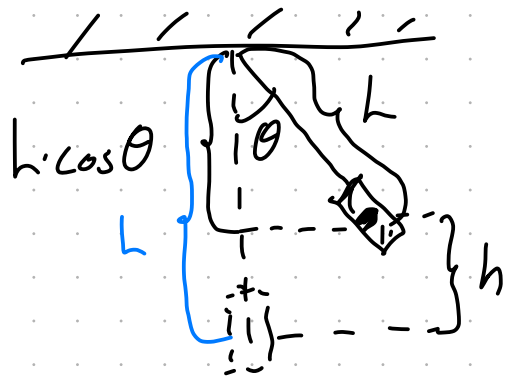
$$m_k v_{k1} = mv = (m_k + m_b) v$$

$$v = \frac{m_k v_{k1}}{m_k + m_b} = 3{,}112\ \frac{m}{s}$$

Bruker bevaring av mekanisk energi for å finne høyden.

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

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




Vi skal finne vinkelen $\theta$.

$$h = L - L \cdot \cos\theta = L(1 - \cos\theta)$$

$$L(1 - \cos\theta) = \frac{v^2}{2g}$$

$$\theta = \cos^{-1}\left(1 - \frac{v^2}{2gL}\right)$$

$$1 - \cos\theta = \frac{v^2}{2gL} \Rightarrow \cos\theta = 1 - \frac{v^2}{2gL} \Rightarrow$$

$$\theta = 59{,}6^\circ = 60^\circ$$

4.

a) Bevaring av mekanisk energi

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

$$v^2 = \frac{kx^2}{m} \Rightarrow v = \sqrt{\frac{kx^2}{m}} = \sqrt{\frac{k}{m}}\sqrt{x^2} = x\sqrt{\frac{k}{m}}$$

$$v_1 = x\sqrt{\frac{k}{m_1}} = 0{,}1\,m\sqrt{\frac{230\,N/m}{0{,}015\,kg}} = \underline{12{,}4\,\frac{m}{s}}$$

$$v_2 = -x\sqrt{\frac{k}{m_2}} = \underline{-8{,}8\,\frac{m}{s}}$$

b) Sentralt elastisk støt:

Fart før: $v$

Fart etter: $u$

1) $m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$ Bevaring av bevegelsesmengde

2) $v_1 + u_1 = v_2 + u_2$ Bevaring av kinetisk energi

$$u_2 - u_1 = v_1 - v_2 = 12{,}4\,\frac{m}{s} - (-8{,}8\,\frac{m}{s}) = 21{,}2\,\frac{m}{s}$$

$$u_2 = 21{,}2\,\frac{m}{s} + u_1$$

1) $0{,}015\,kg \cdot v_1 + 0{,}030\,kg\,v_2 =$

$0{,}015\,kg \cdot 12{,}4\,\frac{m}{s} - 0{,}030\,kg \cdot 8{,}8\,\frac{m}{s} = -0{,}078\,kg\,\frac{m}{s}$

$$0{,}015\,kg \cdot u_1 + 0{,}030\,kg\left(21{,}2\,\frac{m}{s} + u_1\right) = -0{,}078\,kg\,\frac{m}{s}$$

$$0{,}045\,kg\,u_1 = -0{,}078\,\frac{kg\,m}{s} - 0{,}030\,kg \cdot 21{,}2\,\frac{m}{s}$$

$$u_1 = -\frac{0{,}714\,kg\,\frac{m}{s}}{0{,}045\,kg} = -15{,}9\,\frac{m}{s}$$

$$u_1 = -15{,}9\,\frac{m}{s}$$

$$u_2 = 5{,}3\,\frac{m}{s}$$

5.

a) $n = \frac{c_0}{c}$

$\begin{cases} n: \text{brytningsindeks flintglass} = 1{,}613 \\ c: \text{lyshastighet i flintglass} \\ c_0: 3 \cdot 10^8 \frac{m}{s} \end{cases}$

$$c = \frac{c_0}{n} = \frac{3 \cdot 10^8 \frac{m}{s}}{1{,}613} = 1{,}86 \cdot 10^8 \frac{m}{s}$$

b) Refleksjonslov gir

$$\alpha_r = \alpha_1 = 60°$$

Snells lov gir brytningsvinkel

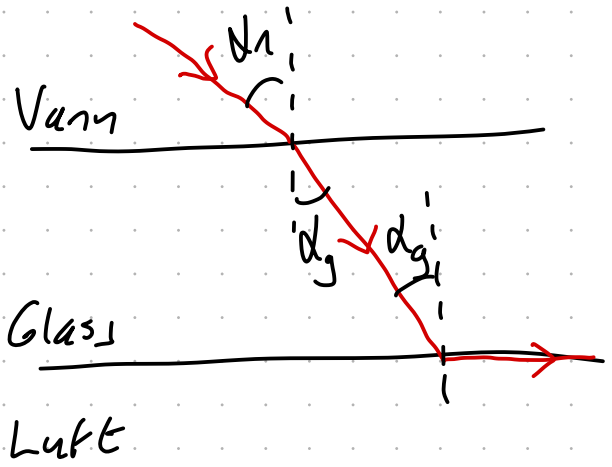
$$n_v \sin(\alpha_1) = n_g \sin(\alpha_b)$$

$$\sin(\alpha_b) = \frac{n_v}{n_g} \sin(\alpha_1)$$

$$\alpha_b = \sin^{-1}\left(\frac{n_v}{n_g} \sin(\alpha_1)\right) = \sin^{-1}\left(\frac{1{,}33}{1{,}52} \sin(60°)\right)$$

$$\underline{\alpha_b = 49{,}3° = 49°}$$

c)




Grensevinkel for totalrefleksjon glass → luft

$$n_g \sin(\alpha_g) = \underbrace{n_l \sin(90°)}_{1}$$

$$\sin(\alpha_g) = \frac{1}{n_g}$$

Finner vinkel $\alpha_1$ for totalreflekssjon

$$n_v \cdot \sin(\alpha_1) = n_g \cdot \sin(\alpha_g) = n_g \cdot \frac{1}{n_g} = 1$$

$$\alpha_1 = \sin^{-1} \frac{1}{n_v} = \sin^{-1}\left(\frac{1}{1{,}33}\right) = \underline{48{,}8°}$$