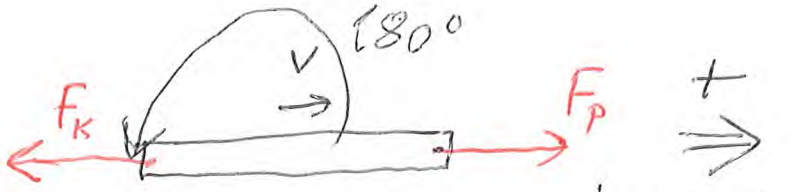
4.04



a)

$F_P = 640N$ $\quad v = konst$

Tao: $\Sigma F = 0$

$F_P = F_K = 640N$

b) $W_P = F \cdot s \cdot \cos\alpha = 640N \cdot 5{,}0m \cdot 1{,}00$

$\alpha = 0°$ $\quad = 3200J = \underline{3{,}2kJ}$

c) $\alpha = 180°$

$\cos 180° = -1 \Rightarrow W_K = \underline{-3{,}2kJ}$

d) $\Sigma W = W_P + W_K = 3{,}2kJ - 3{,}2kJ = \underline{0}$

4.05 a) $E_K = \frac{1}{2} m v^2 = \frac{1}{2} \cdot 2{,}0kg \cdot (12\frac{m}{s})^2 = 144kg\frac{m^2}{s^2}$

$= \underline{0{,}14kJ}$

b) $W = E_K = \underline{0{,}14kJ}$

4.06 a) $E_K = \frac{1}{2} m v^2$

$E_K = \frac{1}{2} \cdot 9{,}11 \cdot 10^{-31} kg \cdot (1{,}5 \cdot 10^7 \frac{m}{s})^2$

$= \underline{1{,}0 \cdot 10^{-16} J}$

$(fJ = 10^{-15} J)$

b) $E_K = \frac{1}{2} m v^2$

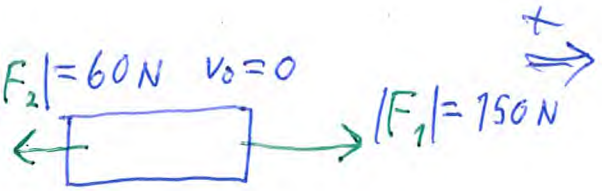
$2E_K = m v^2$

$\frac{2E_K}{m} = v^2$

$v = \sqrt{\frac{2E_K}{m}}$

$v = \sqrt{\frac{2 \cdot 1{,}01 \cdot 10^{-20} J}{5{,}31 \cdot 10^{-26} kg}} = \underline{617 \frac{m}{s}}$

4,07



$s = 27m$

$m = 15kg$

a) $W_1 = F_1 \cdot s = 150N \cdot 27m = 4050J = \underline{4{,}1kJ}$

$W_2 = F_2 \cdot s = -60N \cdot 27m = -1620J = \underline{-1{,}6kJ}$

b) $W_{\Sigma F} = W_1 + W_2 = 4050J - 1620J = 2430J$

$= \underline{2{,}4kJ}$

c) $\Sigma F = ma$

$F_1 - F_2 = ma$

$\frac{F_1 - F_2}{m} = a$

$a = \frac{150N - 60N}{15kg} = \underline{6{,}0 \frac{m}{s^2}}$

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

$2as = v^2$

$v = \sqrt{2as} = \sqrt{2 \cdot 6{,}0 \frac{m}{s^2} \cdot 27m}$

$= \underline{18 \frac{m}{s}}$

d) $E_K = \frac{1}{2} m v^2$

$= \frac{1}{2} \cdot 15kg \cdot \left(18 \frac{m}{s}\right)^2 = 2430J = \underline{2{,}4kJ}$

4.11 a) $v_n = 36\frac{km}{h} = 10\frac{m}{s}$ $\quad s = 10\,m$ $\quad v_0 = 0$

$m = 80\,kg$

$\Delta E_K = \frac{1}{2}mv^2 = \frac{1}{2}\cdot 80\,kg\cdot\left(10\frac{m}{s}\right)^2 = 40\cdot 100\,J$

$= \underline{4{,}0\cdot 10^3\,J}$

$W = \Delta E_K$

$\overline{F}\cdot s = \Delta E_K$

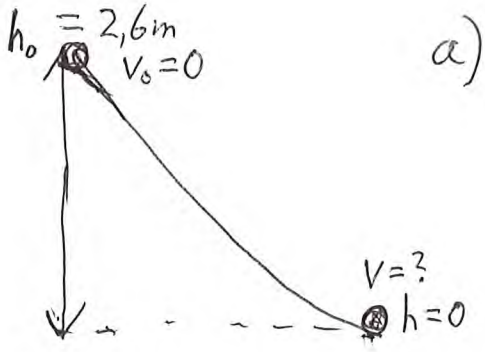
$\overline{F} = \frac{\Delta E_K}{s}$

$\overline{F} = \frac{4{,}000\cdot 10^3\,J}{10\,m} = 4{,}0\cdot 10^2\,N = \underline{0{,}40\,kN}$

b) $s = 7{,}0\,m$ $\quad W_R = \Delta E_K = \underline{-4{,}0\cdot 10^3\,J}$, dvs så mye tap

$\overline{F} = \frac{\Delta E_K}{s} = \frac{-4{,}0\cdot 10^3\,J}{7{,}0\,m} = -571\,N$

$= \underline{-0{,}57\,kN}$

4.13 

a) $E_K = E_{p0}$

$\frac{1}{2}mv^2 = mgh_0$

$v^2 = 2gh$

$v = \sqrt{2gh}$

$v = \sqrt{2\cdot 9{,}81\frac{m}{s^2}\cdot 2{,}6\,m} = 7{,}142\frac{m}{s}$

$= \underline{7{,}1\frac{m}{s}}$

b) $m = 20\,kg$ $\quad v_n = 2{,}6\frac{m}{s}$

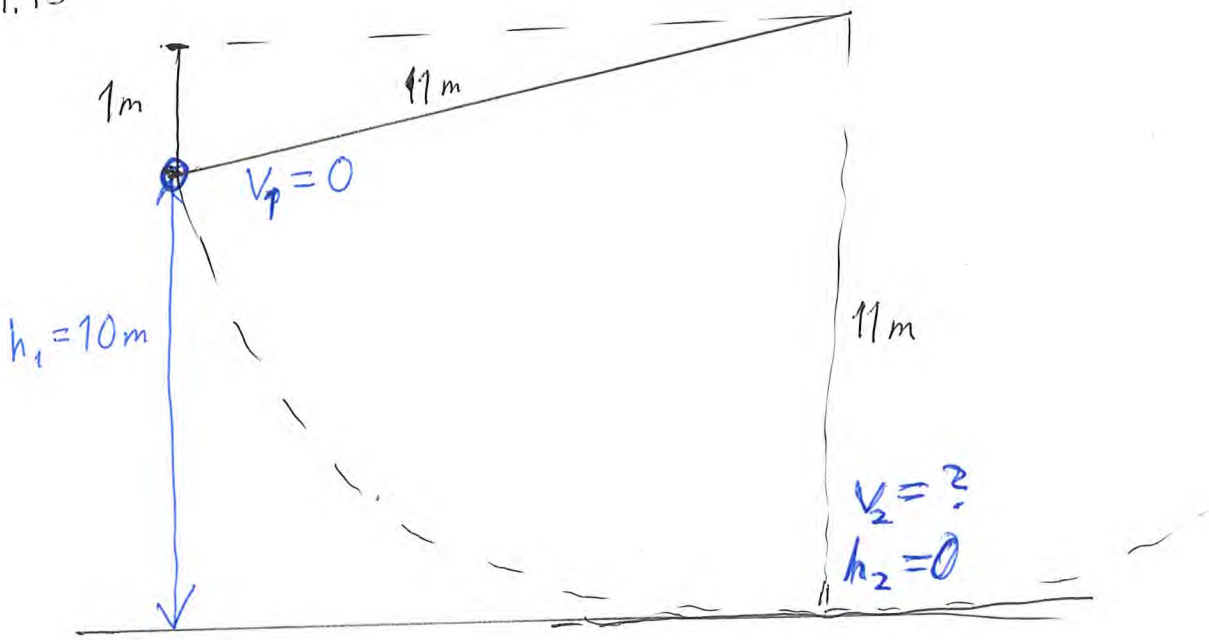
$\Delta E = E_{p0} - E_{kn}$

$= mgh_0 - \frac{1}{2}mv_n^2 = m\left(gh_0 - \frac{1}{2}v_n^2\right)$

$= 20\,kg\left(9{,}81\frac{m}{s^2}\cdot 2{,}6\,m - \frac{1}{2}\cdot\left(2{,}6\frac{m}{s}\right)^2\right)$

$= 442{,}5\,J = \underline{0{,}44\,kJ}$

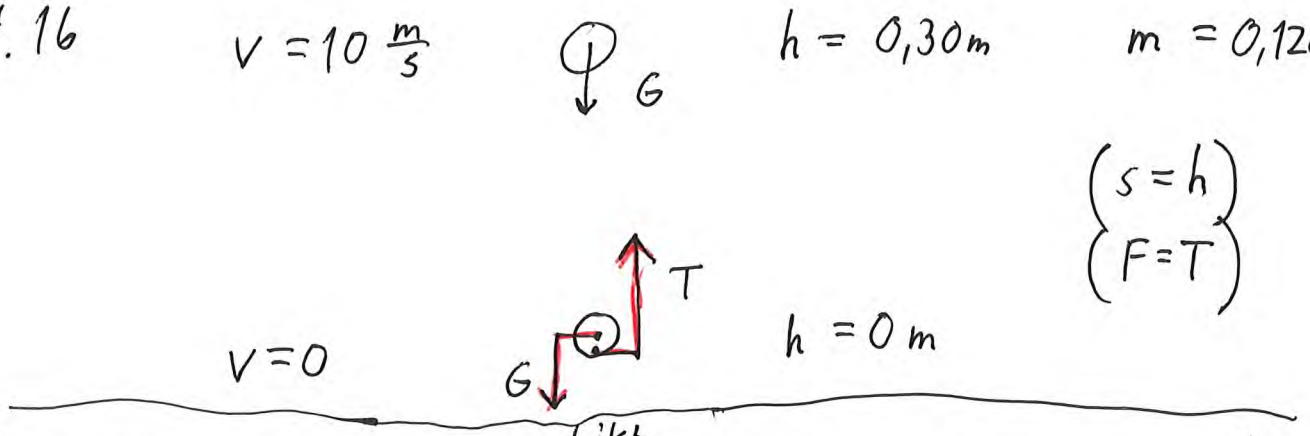
4.15



a)
$$E_{K2} + E_{P2} = E_{K1} + E_{P1}$$
$$\frac{1}{2} m v_2^2 = m g h_1$$
$$v_2^2 = 2 g h_1$$
$$v_2 = \sqrt{2 g h_1}$$
$$v_2 = \sqrt{2 \cdot 9{,}81 \cdot 10}\ \frac{m}{s} = \underline{14\ \frac{m}{s}}$$

b) Samme høydeforskjell og startfart $\Rightarrow$ samme svar.

4.16 $v = 10\,\frac{m}{s}$ $h = 0{,}30\,m$ $m = 0{,}120\,kg$



Likt $\longleftrightarrow$

a) $W_T = T \cdot h$ $\longleftrightarrow$ $W_F = F \cdot s$

$W_T = \Delta E_p + \Delta E_k$ $\longleftrightarrow$ $W_F = \Delta E_p + \Delta E_k$

$T \cdot h = mgh + \frac{1}{2} m v^2$ $\longleftrightarrow$ $F \cdot s = mgs + \frac{1}{2} m v^2$

$T = mg + \frac{m v^2}{2h}$ $\longleftrightarrow$ $(F - mg)s = \frac{1}{2} m v^2$

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

$= 0{,}120\,kg \cdot \left(9{,}81\,\frac{m}{s^2} + \frac{\left(10\,\frac{m}{s}\right)^2}{2 \cdot 0{,}30\,m}\right) = 21{,}17\,N$

$= \underline{21\,N}$

Energibetraktning gir $g = 9{,}81\,\frac{m}{s^2}$

E_p er positiv fordi energien øker oppover.

(I bevegelseslikning tar man hensyn til retningen på a og s)

$W_{\Sigma F} = \Delta E_k$

$W_T - W_G = \Delta E_k$ $\quad \left(F \cdot s - m \cdot g \cdot s = \frac{1}{2} m v^2\right)$

$W_T = W_G + \Delta E_k$

4.16

b) $\Delta E_p = \Delta E_K$

$mg\Delta h = \frac{1}{2} m v^2$

$\Delta h = \frac{v^2}{2g} = \frac{(10\,\frac{m}{s})^2}{2 \cdot 9{,}81\,\frac{m}{s^2}} = \underline{5{,}1\,m} \quad (5{,}096\,m)$

c) $E_{K0} = E_K + E_p$

$\frac{1}{2} m v_0^2 = \frac{1}{2} m v^2 + mgh$

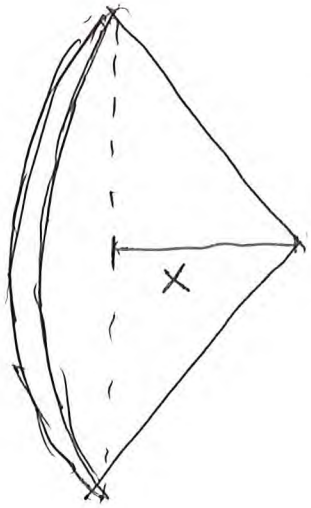
$v_0^2 = v^2 + 2gh$

$v^2 = v_0^2 - 2gh$

$v = \sqrt{v_0^2 - 2gh}$

$v = \sqrt{(10\,\frac{m}{s})^2 - 2 \cdot 9{,}81\,\frac{m}{s^2} \cdot 2{,}5\,m} = \underline{7{,}1\,\frac{m}{s}}$

4.18



$F = kx$

$k = \frac{F}{x}$

$k = \frac{100\,N}{0{,}20\,m}$

$= 500\,\frac{N}{m}$

$= \underline{0{,}50\,\frac{kN}{m}}$

b) $E_p = \frac{1}{2} k x^2 = \frac{1}{2} \cdot 500\,\frac{N}{m} \cdot (0{,}26\,m)^2$

$= \underline{17\,J} \quad (16{,}9\,J)$

c) $E_K = E_{p0}$

$\frac{1}{2} m v^2 = \frac{1}{2} k x^2$

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

$v = \sqrt{\frac{k}{m}} \cdot x$

$v = \sqrt{\frac{500\,N/m}{0{,}020\,kg}} \cdot 0{,}26\,m = \underline{41\,\frac{m}{s}}$

4.19 a) $E_{k0} = \frac{1}{2} m v_0^2 = \frac{1}{2} \cdot 0{,}140\,kg \cdot \left(8{,}0\,\frac{m}{s}\right)^2 = \underline{13\,J}\ (12{,}8\,J)$

b) $x = 0{,}10\,m$

$E_{k0} = E_k + E_p$

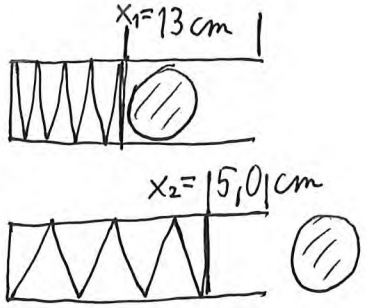
$\frac{1}{2} m v_0^2 = \frac{1}{2} m v^2 + \frac{1}{2} k x^2$

$E_{k0} - E_p = E_k$

$E_k = E_{k0} - \frac{1}{2} \cdot 400\,\frac{N}{m} \cdot (0{,}10\,m)^2$

$E_k = \underline{11\,J}\ (10{,}8\,J)$

4.20



$m = 0{,}025\,kg$

$k = 100\,\frac{N}{m}$

a) $W_f = \Delta E_p = \frac{1}{2} k x_1^2 - \frac{1}{2} k x_2^2 = \frac{1}{2} k \left(x_1^2 - x_2^2\right)$

$= \frac{1}{2} \cdot 100\,\frac{N}{m} \cdot \left(0{,}13^2 - 0{,}050^2\right) m^2 = \underline{0{,}72\,J}$

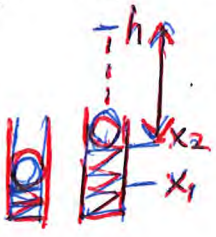
b) $\Delta E_k = W_f$

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

$v^2 = \frac{2 W_f}{m}$

$v = \sqrt{\frac{2 W_f}{m}} = \sqrt{\frac{2 \cdot 0{,}72\,J}{0{,}025\,kg}} = \underline{7{,}6\,\frac{m}{s}}$

c) $W_f - W_G = m g h$

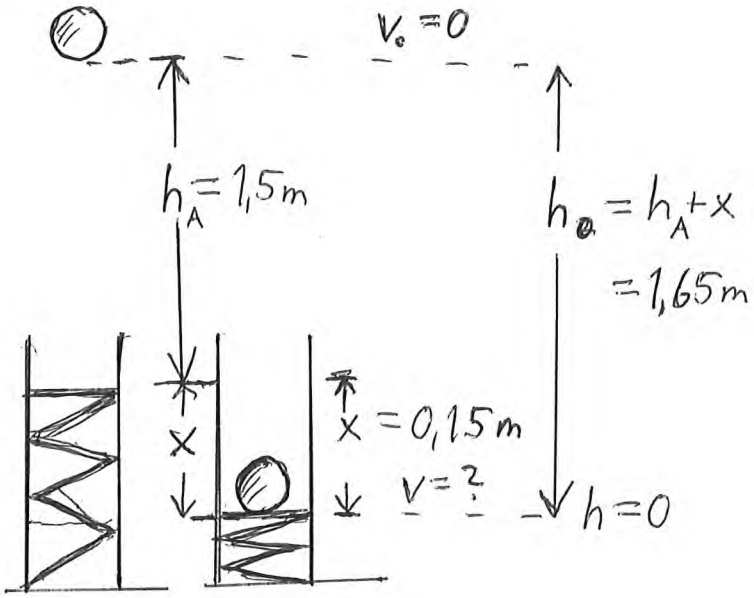


$h = \frac{W_f - W_G}{mg} = \frac{W_f - mg(x_1 - x_2)}{mg}$

$= \frac{0{,}72\,J - 0{,}025\,kg \cdot 9{,}81\,\frac{m}{s^2}(0{,}13 - 0{,}050)\,m}{0{,}025\,kg \cdot 9{,}81\,\frac{m}{s^2}} = \underline{2{,}9\,m}$

4.21 $k = 2{,}4\ \frac{kN}{m}$

$m = 7{,}3\,kg$



$$E_{pfjær} = \frac{1}{2}kx^2 = \frac{1}{2}\cdot 2{,}4\cdot 10^3\,\frac{N}{m}\cdot(0{,}15\,m)^2 = 27\,J$$

$$E_{pkule} = mgh_0 = 7{,}3\,kg\cdot 9{,}81\,\frac{N}{kg}\cdot 1{,}65\,m = 118\,J$$

$$E_{pkule} = E_{pfjær} + E_{kkule}$$

$$E_{pkule} - E_{pfjær} = \frac{1}{2}mv^2$$

$$\sqrt{\frac{2\cdot(E_{pkule} - E_{pfjær})}{m}} = v$$

$$v = \sqrt{\frac{2\cdot(118\,J - 27\,J)}{7{,}3\,kg}} = \underline{5{,}0\ \frac{m}{s}}$$

4.26 $V = 1150 \cdot 10^6\ m^3$ $\quad h = 316\ m$

a) $E_p = mgh = \rho \cdot V \cdot g \cdot h = 0{,}998 \cdot 10^3 \frac{kg}{m^3} \cdot 1{,}150 \cdot 10^9\ m^3 \cdot 9{,}81 \frac{m}{s^2} \cdot 316\ m$

$= 3{,}5578 \cdot 10^{15}\ J = \underline{3{,}56 \cdot 10^{15}\ J\ (= 3{,}56\ PJ)}$

$P = 220 \cdot 10^6\ W$

b) $E_d = P \cdot t = 220 \cdot 10^6\ W \cdot 24\ h = 5{,}280 \cdot 10^9\ Wh\ (= 5{,}28 \cdot 10^6\ kWh)$

$= \underline{5{,}28\ GWh}$

c) $A = 14\ km^2$

$E_d = E_{pd}$ produsert el. energi per døgn = tap i potensiell energi per døgn

$E_d = mgh$

$E_d = \rho \cdot V_d \cdot g \cdot h$

$E_d = \rho \cdot A \cdot \Delta h \cdot g \cdot h$

$\Delta h = \dfrac{E_d}{\rho \cdot A \cdot g \cdot h}$

$\Delta h = \dfrac{5{,}28 \cdot 10^9 \cdot 3600\ J}{998 \frac{kg}{m^3} \cdot 14 \cdot (10^3\ m)^2 \cdot 9{,}81 \frac{m}{s^2} \cdot 316\ m} = \dfrac{1{,}9008 \cdot 10^{13}\ J}{4{,}331 \cdot 10^{13}\ N}$

(3600 s: sekunder i en time)

$= 0{,}4388\ m = \underline{0{,}44\ m}$

4.28 $F = 0{,}45\ kN$ $\quad E$ per mil $= \dfrac{33 \cdot 10^6\ J \cdot 0{,}70}{mil} = 23{,}1 \cdot 10^6\ J/mil$

$W = F \cdot s = 0{,}45 \cdot 10^3\ N \cdot 10^4\ m = 4{,}5 \cdot 10^6\ J$ nyttbart arbeid per mil

$\eta = \dfrac{\text{nyttbart arbeid}}{\text{tilført energi}} = \dfrac{4{,}5 \cdot 10^6\ J}{23{,}1 \cdot 10^6\ J} = 0{,}19 = \underline{19\%}$