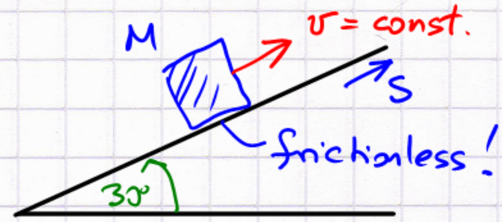
Week 6 6.5

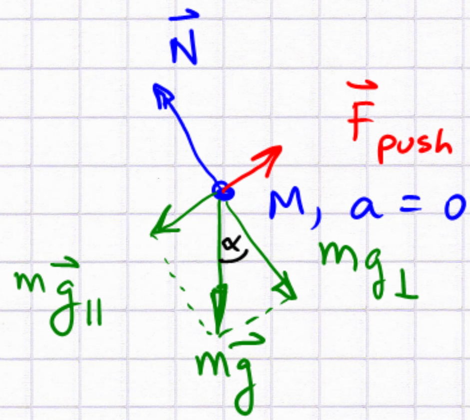


$M = 24$ kg , $\Delta s = 20$ m

$W = ?$

Solution.

v = const. implies the crate is force-free.



We need: $W = \int_0^{\Delta s} F_{push}\, ds$

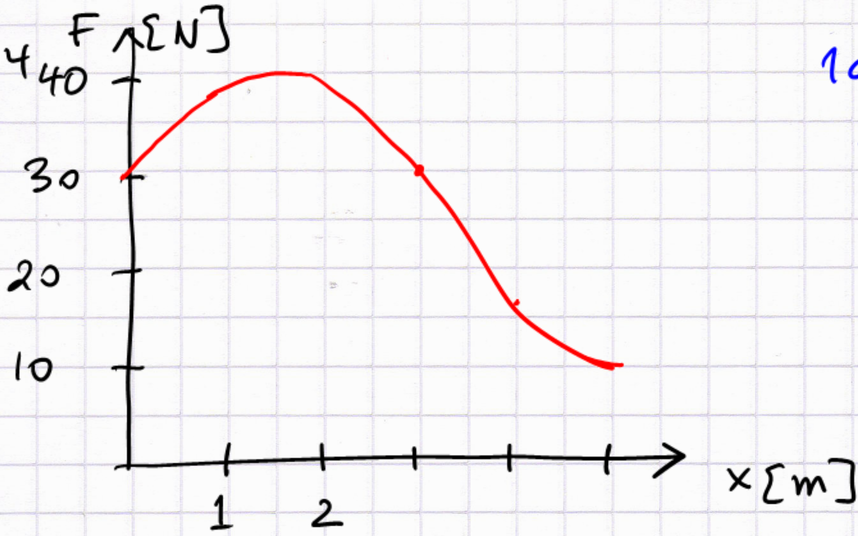
$|\vec{F}_{push}| = m|\vec{g}_{\parallel}|$ $\qquad g_{\parallel} = g \sin\alpha$

$$W = m\, g \sin(30^\circ) \int_0^{\Delta s} ds = m\, g \sin 30^\circ\, \Delta s$$

$$= m \frac{g}{2} \Delta s = 24 \cdot \frac{9.8}{2} \times 20 \text{ Nm}$$

$$W = 2352 \text{ J} = 2.4 \times 10^3 \text{ J} = 2.4 \text{ kJ}$$

6.14



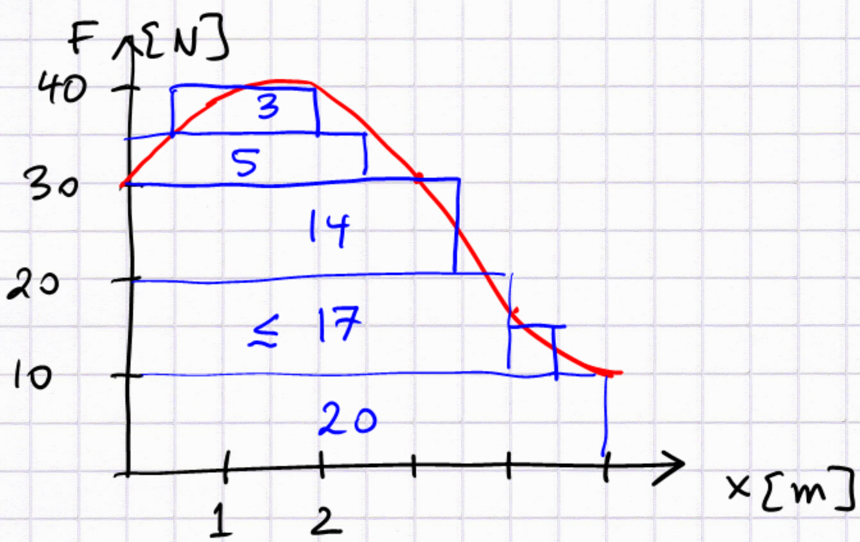
1d motion:

$x_i = 0$

$x_f = 5\,m$

$W = ?$

Solution



count boxes.

each box =

$0.5\,m \times 5\,N =$

$2.5\,J$

$20 + 17 + 14 + 8 = 59$

$W \approx 59 \times 2.5\,J$

$= 147.5\,J$

$= 150\,J$

measurement good to two digits?

book says: 143 J ?!

58 boxes =

I say: $\underline{145}$ J

6.17

$m = 1500\ kg \qquad v_i = 10\ m/s \qquad \Delta x = 200\ m$

$v_f = 25\ m/s$

$\Delta(KE) = ?$

Solution.

More data are given than necessary:

$KE_i = \frac{1}{2} m v_i^2 \quad ; \quad KE_f = \frac{1}{2} m v_f^2$

$\Delta(KE) = KE_f - KE_i = \frac{1}{2} m (v_f^2 - v_i^2)$

$= 0.5 \times 1.5 \times 10^3 (25^2 - 10^2) \quad J$

$= 394 \quad kJ \qquad = 3.9 \times 10^5 \quad J$

(Nm)

energy = power · time → (Ws)

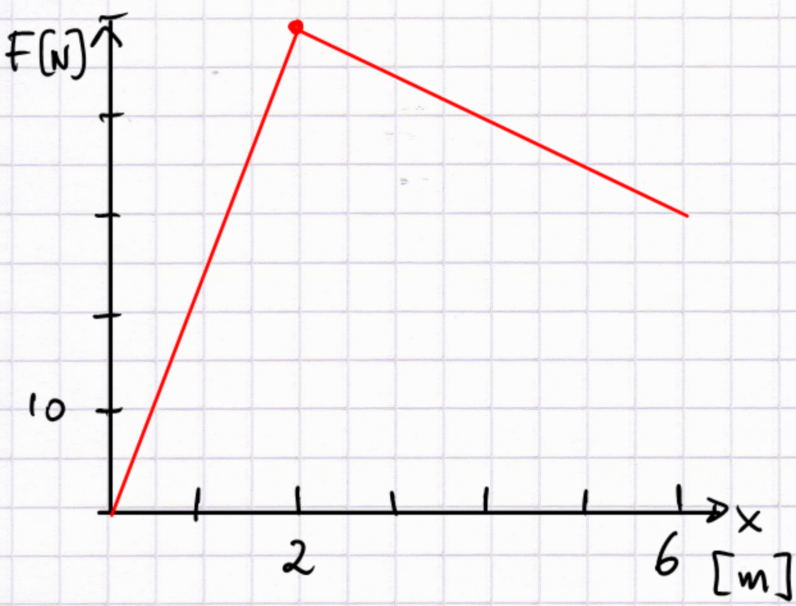
The additional data allow us to estimate:

→ assume a constant acc. force

$v_f^2 - v_i^2 = 2 a \Delta x \qquad a = \frac{0.5 \times 525}{200} \frac{m}{s^2} = 1.3 \frac{m}{s^2}$

$F_{acc} = 1.95 \times 10^3\ N \qquad W = F_{acc} \cdot \Delta x \rightarrow 394\ kJ$ ✓

6.29

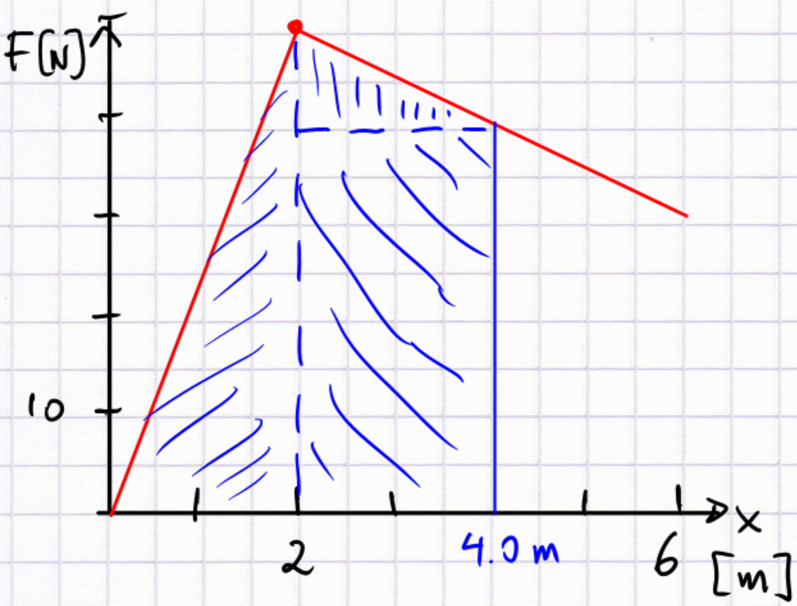


$v(x=4.0\,m) = 5.0\ \frac{m}{s}$

$v(x=0\,m) = 0\ \frac{m}{s}$

$m = ?$

Solution.



$KE\,(x=0) = 0$

$KE\,(x=4.0) = \left(5.0\ \frac{m}{s}\right)^2 \frac{m}{2}$

$\Delta(KE) = W_{0\to x=4.0}$

$\frac{1}{2} m \left(v_f^2 - v_i^2\right) = W_{0\to x=4.0}$

$\frac{1}{2} m \left(25 - 0\right) = W_{0\to x=4.0}$

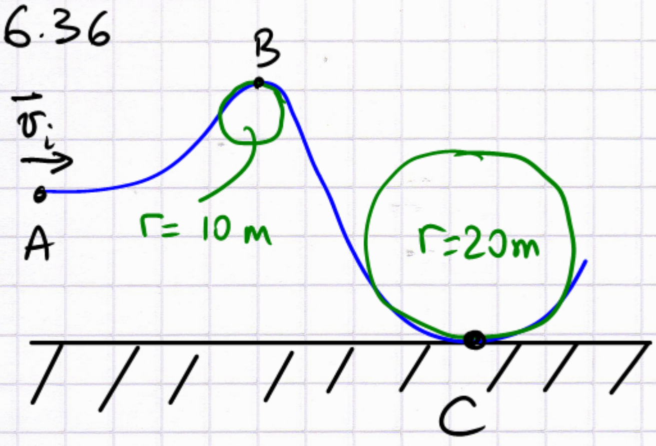
$W_{0\to 4.0m}$ = area (2 triangles + rectangle)

$T_1 = \frac{1}{2}(2.0) \times 50\,Nm = 50\ Nm = 50\ J$

$T_2 = 2.0 \times 40\ Nm = 80\,J$ $\quad \therefore W_{0\to 4.0} = 140\,J$

$T_3 = \frac{1}{2}\ (2.0) \times 10\ Nm = 10\ J$ $\quad m = \frac{280\ Nm}{25\ N} = 11(.2)\ kg$

6.36



$v_i = 15 \ m/s$

$m_G = 30 \ kg$

$h_A = 25 \ m \qquad h_B = 35 \ m$

apparent weight $w_B = ? \qquad w_C = ?$

Solution.

$KE_A = \frac{1}{2} m_G v_i^2 = 3375 \ J$

$KE_B = \frac{1}{2} m_G v_B^2 = KE_A - mg\Delta y = (3375 - 30 \cdot 9.8 \cdot 10) \ J$

$= 435 \ J \qquad \therefore \quad v_B^2 = \frac{435 \cdot 2}{30} = 29.0 \ \frac{m^2}{s^2}$

To move in the circle we observe:

$m a_{cp} = m \frac{v^2}{r} = mg - N \qquad \therefore \quad N = mg - m\frac{v^2}{r}$

$N_B = (\underbrace{30 \cdot 9.8}_{294 N} - 30 \cdot \frac{29.0}{10}) \ N = 207 \ N \rightarrow 210 N$

(reduced by "almost 1/3")

At C : $KE_C = KE_A + mgh_A$ (since $h_C = 0$)

$= (3375 + 30 \cdot 9.8 \cdot 25) \ J = 10,725 \ J$

$v_C^2 = \frac{10,725 \cdot 2}{30} = 715 \ \frac{m^2}{s^2}$ At C: $ma_{cp} = N - mg$

$N_C = mg + m\frac{v_C^2}{r_C} = (30 \cdot 9.8 + \frac{30 \cdot 715}{20}) \ N = 1370 N$

(= 1400 N)

4.6 times normal weight!