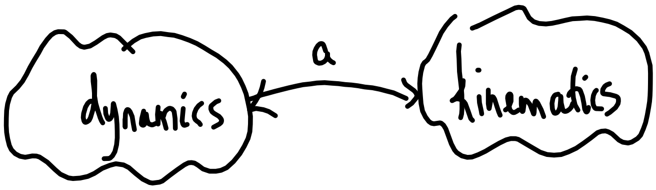
Newton's Second Law

$$\vec{F}_{net} = m\vec{a}$$

DRAW A FBD!



$F_{net} = ma$ $\qquad$ $a, v_1, v_2, \Delta t, \Delta d$

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4. $m = 15\,kg$

$\vec{F}_a = 5.5\,N\,[N]$

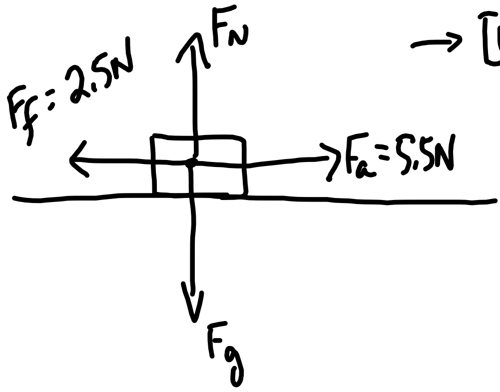
$\vec{F}_f = 2.5\,N\,[S]$

$v_1 = 0$

$\Delta t = 4.0\,s$

$\Delta d = ?$

+ → [N]



$$\vec{F}_{net} = m\vec{a}$$

$$F_a - F_f = ma$$

$$5.5\,N - 2.5\,N = (15\,kg)a$$

$$3.0\,N = (15\,kg)a$$

$$a = 0.20\,m/s^2$$

$$\Delta d = \cancel{v_1 t}^{\,0} + \frac{1}{2}at^2$$

$$\Delta d = \frac{1}{2}(0.20\,m/s^2)(4.0\,s)^2$$

$$\Delta d = 1.6\,m$$

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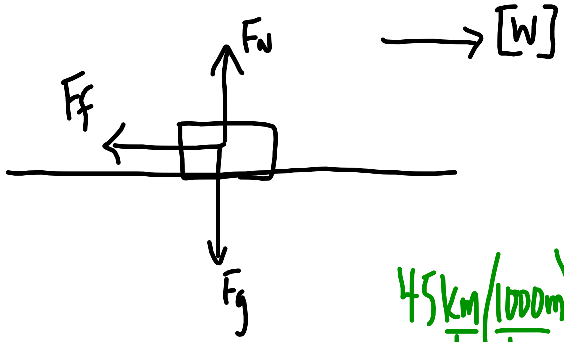
6. $m = 1.2 \times 10^3\,kg$

$\left.\begin{array}{l} v_1 = 45\,km/h \\ v_2 = 0 \\ \Delta d = 35\,m \end{array}\right\} \rightarrow a$

$\mu = ?$



$45\,\frac{km}{h}\left(\frac{1000\,m}{1\,km}\right)\left(\frac{1\,h}{3600\,s}\right)$

$12.5\,m/s$

① Find the acceleration:

$$\cancel{v_2^2}^{\,0} = v_1^2 + 2a\Delta d$$

$$2a\Delta d = -v_1^2$$

$$a = \frac{-v_1^2}{2\Delta d}$$

$$a = \frac{-(12.5\,m/s)^2}{2(35\,m)}$$

$$a = -2.2\,m/s^2$$

② Find F_f:

$$\vec{F}_{net} = m\vec{a}$$

$$-F_f = ma$$

$$-F_f = (1.2 \times 10^3\,kg)(-2.2\,m/s^2)$$

$$F_f = 2.7 \times 10^3\,N$$

③ Find μ:

$$F_f = \mu F_N$$

$$\mu = \frac{F_f}{F_N}$$

$$\mu = \frac{F_f}{F_g}$$

$$\mu = \frac{2.7 \times 10^3\,N}{(1.2 \times 10^3\,kg)(9.81\,m/s^2)}$$

$$\mu = 0.23$$

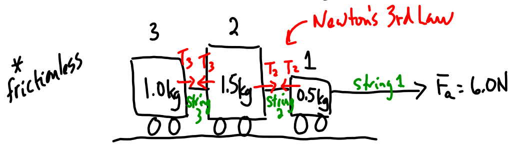
Newton's Third Law

For every action force on object B due to object A, there is a reaction force, equal in magnitude but opposite in direction due to object B acting back on object A.

$$\vec{F}_{A\,on\,B} = -\vec{F}_{B\,on\,A}$$

Example

Find the tension in each string of the pull toy:



① Find the acceleration:

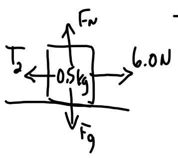
$\vec{F}_{net} = m\vec{a}$

$F_a = m\vec{a}$ ← total mass

$(6.0N) = (3.0kg)a$

$a = 2.0 m/s^2$

② Consider only Cart 1:



$\rightarrow$

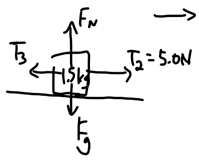
$\vec{F}_{net} = m\vec{a}$

$6.0N - T_2 = (0.5kg)(2.0m/s^2)$

$6.0N - T_2 = 1.0N$

$T_2 = 5.0N$

③ Consider Cart 2:



$\rightarrow$

$\vec{F}_{net} = m\vec{a}$

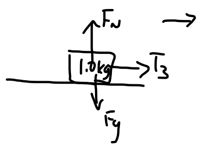
$T_2 - T_3 = ma$

$5.0N - T_3 = (1.5kg)(2.0m/s^2)$

$5.0N - T_3 = 3.0N$

$T_3 = 2.0N$

You can check using Cart 3:



$\rightarrow$

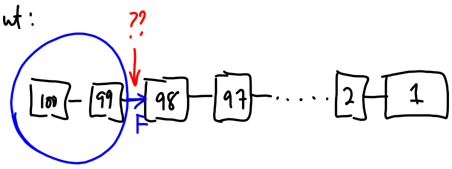
$\vec{F}_{net} = m\vec{a}$

$T_3 = (1.0kg)(2.0m/s^2)$

$T_3 = 2.0N$

SAME

A shortcut:



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