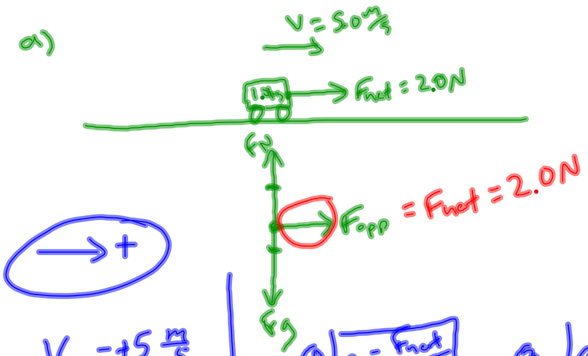
Solving Newton's 2nd Law Word Problems

THE PERFECT SOLUTION (FOR FORCE PROBLEMS):

1a. Sketch a quick diagram of the entire situation
1b. Draw a FBD for the relevant object(s) and then choose your positive coordinate system
2. Write out all variables with signs and units
3. Covert units to m, s, or kg
4. Pick the appropriate equation – box it
5. Rearrange for the variable you need
6. Sub in numbers in brackets
7. Type into calculator in one step
8. Answer with units and direction – circle it

1. A 1.0 kg toy car is moving across a smooth (frictionless) floor with a velocity of 5.0 m/s. An unbalanced force (net force) of 2.0 N acts on the car for 4.0 s. Determine the velocity of the car at the end of the interval (V_2) each situation below.
(a) if the force acts in the direction of motion of the car
(b) if the force acts in the opposite direction to the motion of the car

a)



$V_1 = +5\ m/s$
$V_2 = ?$
$a = +2.\ m/s^2$
$\Delta d =$
$\Delta t = 4.0\ s$
$m = 1.0\ kg$
$F_{net} = +2.0\ N$
$a = ?$

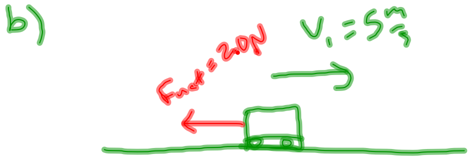
① $a = \frac{F_{net}}{m} = \frac{+2.0N}{1.0kg} = +2\ m/s^2$

② $a = \frac{V_2 - V_1}{\Delta t}$

$V_2 = V_1 + a\Delta t = +5 + (+2)(4) = +13\ m/s$

$\therefore \vec{V_2} = 13\ m/s\ [\rightarrow]$

b)



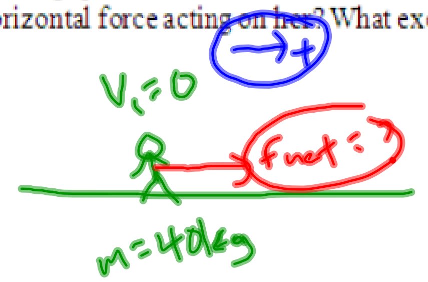
$V_1 = +5$
$V_2 = ?$
$a = -2$
$\Delta d =$
$\Delta t = 4.0\ s$
$F_{net} = -2.0N$
$m = 1.0\ kg$
$a = ?$

① $a = \frac{F_{net}}{m} = \frac{-2.0N}{1\ kg} = -2\ m/s^2$

② $V_2 = V_1 + a\Delta t = +5 + (-2)(4) = -3\ m/s$

$\therefore V_2 = 3\ m/s\ [\leftarrow]$

2. A 40 kg sprinter starts from rest and 2.0 s later is running at a speed of 8.0 m/s. What is the average net horizontal force acting on her? What exerts this force?



$v_1 = 0$

$v_2 = +8\ \frac{m}{s}$

$a = ?$

$\Delta d =$

$\Delta t = 2.0\ s$

$F_{net} = ?$

$m = 40\ kg$

$a =$

① $a = \dfrac{v_2 - v_1}{\Delta t}$

$= \dfrac{(+8) - (0)}{2.0}$

$= +4.0\ \frac{m}{s^2}$

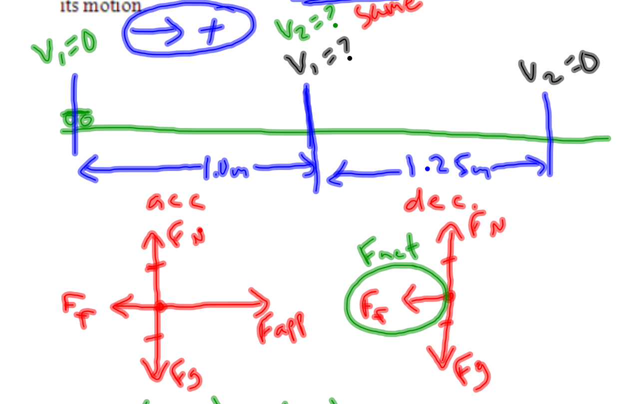
② $F_{net} = ma$

$= (40)(+4)$

$= +160\ N$

$\therefore F_{net} = 160\ N\ [\rightarrow]$

3. A 0.50 kg skateboard is at rest on a rough, level floor on which two lines have been drawn 1.0 m apart. A constant horizontal force is applied to the skateboard at the beginning of the interval, and is removed at the end. The skateboard takes 8.5 s to travel the 1.0 m distance, and it then coasts for another 1.25 m before coming to rest. Calculate the force applied to the skateboard, and also the constant frictional force opposing its motion.



$F_{net} = (+F_{app}) + (-F_f)$

① $F_{net} = F_{app} - F_f$

② $\Delta d = \left(\frac{v_1 + v_2}{2}\right)\Delta t$

$v_2 = \frac{2\Delta d}{\Delta t} - v_1$

same $= 0.235\ \frac{m}{s}$

$v_1 = 0$	$v_1 = +0.235\ \frac{m}{s}$
$v_2 = +0.235\ \frac{m}{s}$	$v_2 = 0$
$a =$	$a =$
$\Delta d = +1.0\ m$	$\Delta d = 1.25\ m$
$\Delta t = 8.5\ s$	$\Delta t =$
$F_{net} =$	$F_{net} = F_f = ?$
$m = 0.5\ kg$	$m = 0.5\ kg$
$a =$	$a =$

① $\Delta d = v_1 \Delta t + \frac{1}{2} a \Delta t^2$

$a = \frac{2\Delta d}{\Delta t^2} = +0.027\ \frac{m}{s^2}$

② $F_{net} = ma$

$= +0.0135\ N$

④ $v_2^2 = v_1^2 + 2a\Delta d$

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

$= -0.022\ \frac{m}{s^2}$

⑤ $F_{net} = ma$

$= -0.011\ N$

⑥ ∴ $\vec{F}_f = 0.011\ N\ [\leftarrow]$

⑦ $F_{net} = F_{app} - F_f$

$F_{app} = F_{net} + F_f$

$= 0.0135 + 0.011$

$= 0.0245\ N$

∴ $\vec{F}_{app} = 0.0245\ N\ [\rightarrow]$