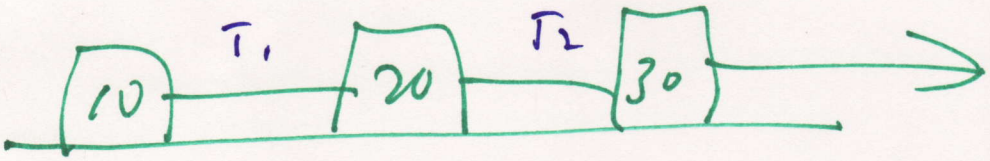
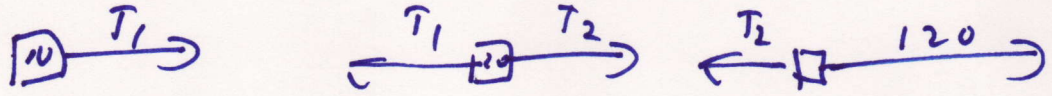


Problem 1: Three boxes of mass 10 kg, 20 kg and 30 kg are connected as shown above. They are pulled to the right by a force of 120N.

(a)(10) If there is no friction, what is the acceleration of the system and the tension in each of the two ropes?
(b)(5) If the system starts at rest, how far has it gone after 5 seconds?
(c)(10) Now, suppose there is friction between the boxes and the ground. What is the minimum coefficient of static friction so that the 120N force is unable to move the boxes? (You may assume that the friction coefficients are the same for each box.)

a)



$T_1 = 10a$ $\quad T_2 - T_1 = 20a$ $\quad 120 - T_2 = 30a$

$T_2 = 30a$ $\quad \rightarrow \quad 120 = 60a$

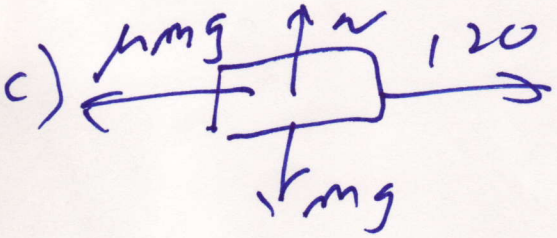
$\boxed{a = 2\ m/sec^2}$

$T_1 = 20$ N

$T_2 = 60$ N

b) $\Delta x = \frac{1}{2}(2)(5)^2 = \boxed{25\ m}$

c)



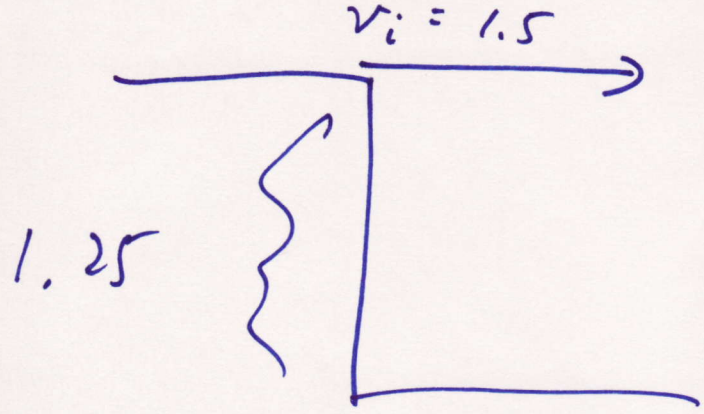
$120 = \mu mg$

$\mu = 120/mg = 120/(60)(10)$

$= \boxed{.2}$

Problem 2 . A kitchen table is 1.25 meters high. Thor jumps up on the table, skids, and goes flying off horizontally at 1.5 m/sec.

(a)(10) How long is he in the air? Where does he hit the ground?
(b)(10) Suppose instead that there is a wall located 50 centimeters from the table. How high above the ground does Thor hit the wall?
(c)(5) What is his velocity on impact?



$v_{xf} = 1.5$ $v_{yf} = (-10)t$

$\Delta x = 1.5t$ $\Delta y = -\frac{1}{2}(10)t^2$

what is t when $\Delta y = -1.25$m

$-1.25 = -5t^2$

$t = .5$ sec

$\Delta x = (1.5)(.5) =$ .75 m

b) what is Δy when $x = .5$?

$.5 = 1.5t$ $\Delta y = -\frac{1}{2}(10)\left(\frac{1}{3}\right)^2$

$t = 1/3$ $= -.54$ m below tabletop

$\Rightarrow$ .71 m above ground

c) $v_{xf} = 1.5$ m/sec, $v_{yf} = -\frac{10}{3}$ m/sec

Problem 4:

(a)(10) Thor, for no apparent reason, accelerates from rest, running in a straight line, with $a = 3$ m/sec^2 for 4 seconds, then decelerates with $a = -2$ m/sec^2 for 3 seconds. How far does he go during the seven seconds?

(b)(10) Thor is now walking due east at a constant speed of 10 cm/sec. A flea on his back moves at a speed of 4 cm/sec at an angle of 20 degrees south of west relative to Thor. What is the speed of the flea relative to the ground?

(c)(5) An unrelated multiple-choice question: A rock is dropped from the roof at the same time that a ball is thrown from the roof horizontally. Ignore air resistance. Which is true: (A) the ball hits the ground first, (B) the rock hits the ground first, or (C) they hit at the same time? Put your answer here: C

1ST interval

$v_i = 0$, $a = 3$, $t = 4$

$v_f = at = 12$ m/sec

$\Delta x = \frac{1}{2}at^2 = 24$ m

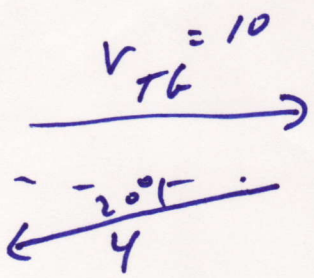
2nd interval

$v_i = 12$, $a = -2$, $t = 3$

$\Delta x = (12)(3) + \frac{1}{2}(-2)(3)^2 = 27$ m

$(\Delta x)_{TOTAL} = 51$ m

b)



$\vec{v}_{FG} = \vec{v}_{FT} + \vec{v}_{TG}$

x: $(v_{FG})_x = -4\cos 20 + 10 = 6.24$

y: $(v_{FG})_y = -4\sin 20 = -1.37$

$(v_{FG}) = \sqrt{v_{FG_x}^2 + v_{FG_y}^2} = 6.4$ cm/sec