Dynamics Study Guide – AP1

d. You push a friend sitting on a swing. She has a mass of 50 kg and accelerates at a rate of 4 m/s^2. Find the force you exerted. [200N]

e. How much force would it take to push another, larger friend who has a mass of 70 kg to accelerate at the same rate of 4 m/s^2? [280N]

f. A worker drops his hammer off the roof of a house. The hammer has a mass of 9 kg, and gravity accelerates it at the usual 9.8 m/s^2. How much force does the earth apply to the hammer? [88.2N]

g. A car whose mass is 1000 kg is traveling at a <u>constant</u> speed of 10 m/s. Neglecting any friction, how much force will the engine have to supply to keep going the same speed? [0N]

5. Solve the following:

a. A box of mass 10kg is pulled on a level surface by a rope parallel to the surface. The rope exerts 28N of force. The surface has coefficients of friction μ_k=0.14 & μ_s=0.21.

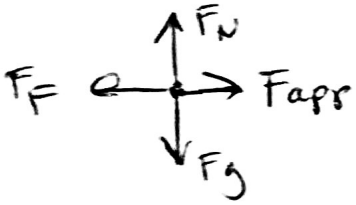
I. Create a free body diagram for the situation

II. Does the box move? If so, with what acceleration?

$F_N = 98$

$F_{FS} = 20.58$

$F_{FK} = 13.72$



$\Sigma F_x = m \cdot a =$

$10 \cdot a = 28 - 13.72$

$a = 1.43\ m/s^2$

b. A box of mass 40kg is pulled on a level surface by a guy parallel to the surface. The rope exerts 144N of force. The surface has coefficients of friction μ_k=0.31 & μ_s=0.48.

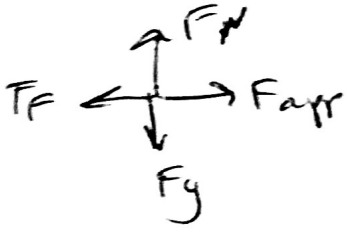
I. Create a free body diagram for the situation

II. Does the box move? If so, with what acceleration?

$F_N = 392$

$F_{FS} = 188.16$

Not moving

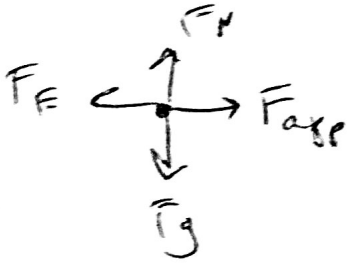


c. A box of mass 25kg is pulled on a level surface by a rope parallel to the surface. The rope exerts 95N of force and the box accelerates at 0.95m/s^5.

I. Create a free body diagram for the situation

II. What is the coefficient of friction for the surface?

$F_N = 245$



$\Sigma F_x = m \cdot a = (25kg)(0.95) = F_{appr} - F_f$

$(25)(0.95) = 95 - \mu(245)$

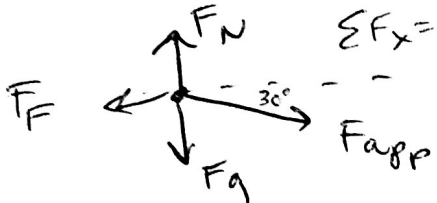
$-71.25 = -\mu(245)$

$\mu_K = 0.29$

Dynamics Study Guide – AP1

d. A box of mass 25kg is pulled on a level surface by a rope parallel to the surface. The rope exerts 95N of force and the box accelerates at $0.95 m/s^5$.
   I. Create a free body diagram for the situation
   II. What is the coefficient of friction for the surface?

e. A box of mass 10kg sits on a level surface, with coefficients of friction μ_s=0.22 & μ_k=0.13. It is pushed by a man at 50N an angle of 30° above the horizontal.
   I. Create a free body diagram for the situation.
   II. Does it move? If so, with what acceleration?



$\Sigma F_x = 10a = 43.3 - 16$

$a = 2.73$

$F_{appy} = 25\ N$

$F_{appx} = 43.3\ N$

$F_N = F_g + F_{appy}$

$F_N = 123\ N$

$F_{FS} = 27.06$

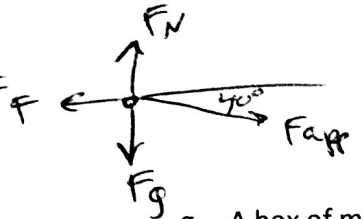
Moving

$F_{FK} = 16$

f. A box of mass 15kg sits on a level surface. It is pushed by a man at 35N an angle of 40° above the horizontal and moves at a constant speed.
   I. Create a free body diagram for the situation.
   II. What is the coefficient of friction of the surface?

$F_{appy} = 22.5$

$F_{appx} = 26.81$



$F_N = F_{appy} + F_g = 22.5 + 147$

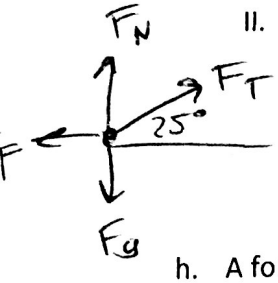
$F_N = 169.5$

$F_{FS} = F_{appx}$

$\mu(169.5) = 26.81$

$\mu_K = 0.158$

g. A box of mass 10kg sits on a level surface, with coefficients of friction μ_s=0.41 & μ_k=0.29. It is *pulled* by a rope at a constant speed an angle of 25° above the horizontal.
   I. Create a free body diagram for the situation.
   II. What is the force of tension in the rope?



$F_N = 98 - T\sin 25°$

$F_F = \mu(F_N) = T\cos 25$ *balanced, $a = 0$

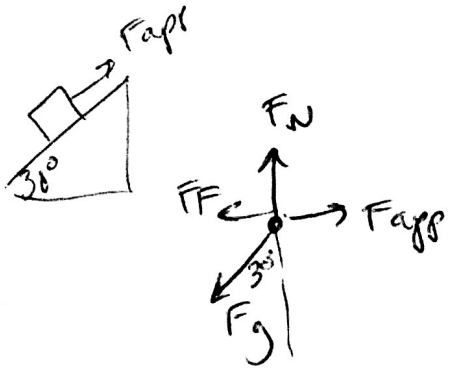
$0.29(98 - T\sin 25) = T\cos$

$28.42 - 0.122T = T(0$

$28.42 = 1.03$

$T = 27.59$

h. A force of 500 N is exerted to slide a 25kg mass *up* a ramp with an incline of 30° at a constant speed. What is the coefficient of kinetic friction of the surface?



$F_N = F_{gy} = 245\cos 30$

$F_N = 212.18 N$

$a \neq 0$ → const. speed

$F_F + F_{gx} = F_{app}$

$\mu(212.18) + 122.5 = 500$

$\mu(212.18) = 377.5$

$\mu = 1.78$

Dynamics Study Guide – AP1

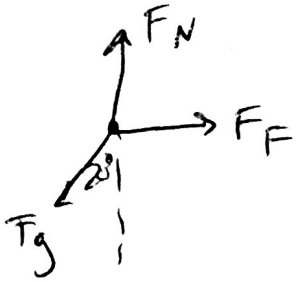
i. A 10kg mass sits on an incline of 35°. It is held in place by static friction. What is the force of static friction acting on the mass?

$F_{FS} = F_{gx}$

$F_{FS} = 98 \sin 35$

$= 56.21 N$

j. A 5kg mass sits on a 20° incline. The coefficients of friction for the incline are μ_s=.24 and μ_k=.16. Does the mass move? If so, with what acceleration?



$F_N = F_{gy} = 46.04N$ $F_{gx} = 16.75$

$F_{FS} = 11.05N$ $F_{gx} > F_{FS}$, moving

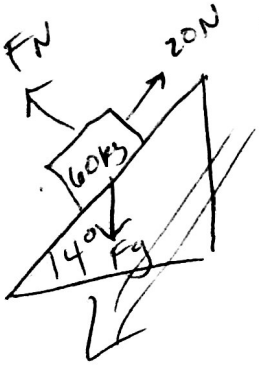
$F_{FK} = 7.37N$

$\Sigma F_x = 5 \cdot a = 16.75 - 7.37$

$5a = 9.38$

$a = 1.88$

k. A 60kg box sits on an incline of 14°. A rope pulls *up* the ramp with a force of 20N parallel to the ramp. The ramp has coefficients of friction μ_s=0.14 and μ_k=0.08. Which way does the mass move? With what acceleration?



$F_{gx} = 142.25$ $\Sigma F_y = 0 = F_N - F_{gy}$

$F_N = 570.53N$

$F_{FS} = 79.87$ $F_{FK} = 45.64$

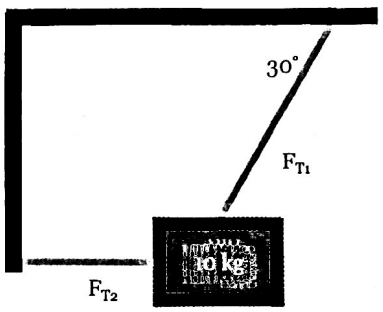
$\Sigma F_x = ma = F_{gx} - F_{app} - F_F$

$60a = 142.25 - 20 - 45.64$

$a = 1.28 \, m/s^2$ down

6. Find the tension in the ropes below.

a.

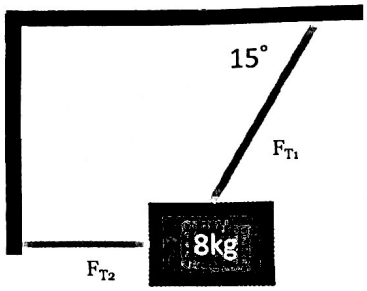


$F_{T1} = 196N$

$F_{T2} = 169.74N$

Dynamics Study Guide – AP1

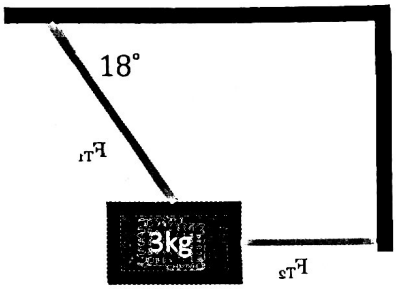
b.



$T_1 = 302.9N$

$T_2 = 292.59N$

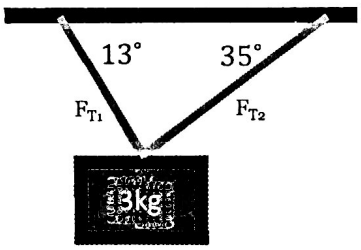
c.



$T_1 = 95.14N$

$T_2 = 90.48N$

d.



$T_2 \sin 35 + T_1 \sin 13 = 29.4$

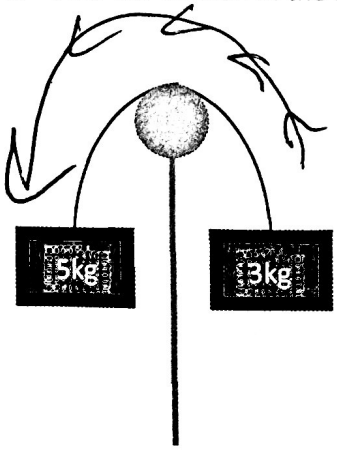
$T_2 \cos 35 = T_1 \cos 13$

$.7767T_1 = 29.4$

$T_1 = 37.85N$

$T_2 = 45N$

e. Find the tension in the rope and the acceleration of the system.



$5a = F_g - T = 49 - T$

$3a = T - F_g = T - 29.4$

$5a = 49 - 3a - 29.4$

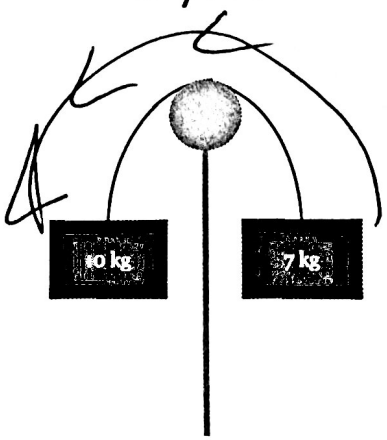
$8a = 19.6$

$a = 2.45 m/s^2$

$T = 36.75$

Dynamics Study Guide – AP1

f.



$10a = F_g - T = 98 - T$

$7a = T - F_g = T - 68.6$

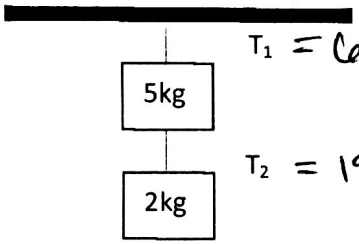
$10a = 98 - 7a - 68.6$

$17a = 29.4$

$a = 1.73\ m/s^2$

$T = 80.71\ N$

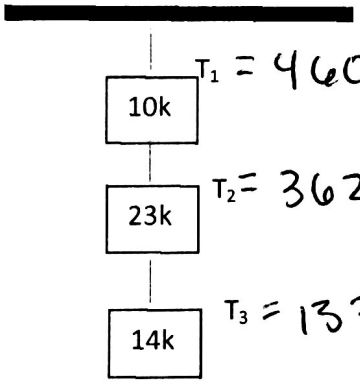
g. find the tension in each rope



$T_1 = 68.6\ N$

$T_2 = 19.6\ N$

h.

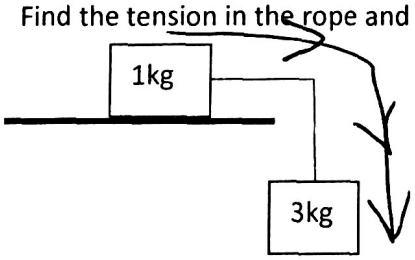


$T_1 = 460.6\ N$

$T_2 = 362.6\ N$

$T_3 = 137.2\ N$

i. Find the tension in the rope and the acceleration of the system (neglect friction)



$\Sigma F_y = 3 \cdot a = F_g - T$

$3a = (9.8)(3) - T$

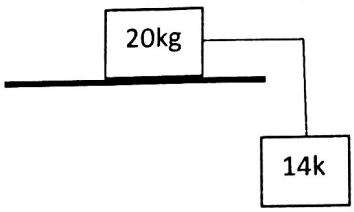
$3a = 29.4 - T$

$\Sigma F_x = 1a = T$

$4a = 29.4$

$a = 7.35\ m/s^2$ $\quad T = 7.35\ N$

Dynamics Study Guide – AP1



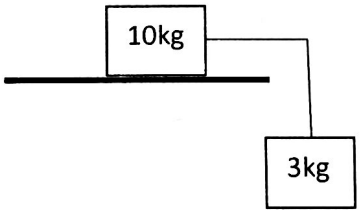
$\Sigma F_y = 14a = (14)(9.8) - T$

$14a = 137.2 - T$

$\Sigma F_x = 20a = T$

$34a = 137.2$

$a = 4.035\ m/s^2 \quad T = 80.7N$

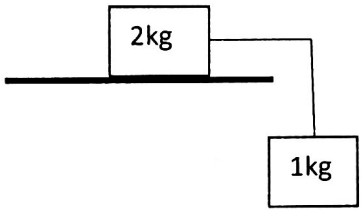


$\Sigma F_y = 3a = 29.4 - T$

$\Sigma F_x = 10a = T$

$13a = 29.4$

$a = 2.26\ m/s^2 \quad T = 22.6N$



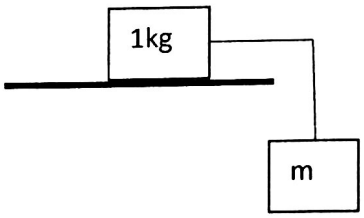
$\Sigma F_y = 1a = 9.8 - T$

$\Sigma F_x = 2a = T$

$3a = 9.8$

$a = 3.267\ m/s^2 \quad T = 6.53N$

Find m so $a_{sys}=3m/s^2$



$\Sigma F_y = 3 \cdot m = 9.8m - T$

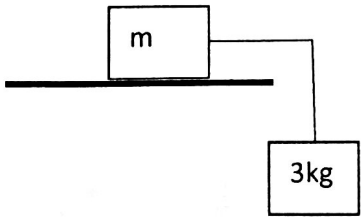
$T = 6.8m$

$\Sigma F_x = 1 \cdot 3 = T$

$T = 3N$

$3 = 6.8m$

$m = 0.44kg$



$\Sigma F_y (3kg \cdot 3\ m/s^2) = 29.4 - T$

$9 = 29.4 - T$

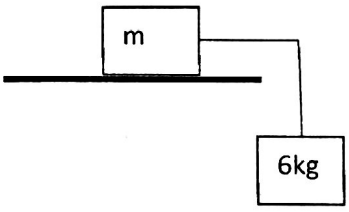
$T = 20.4$

$3m = 20.4$

$m = 6.8kg$

$\Sigma F_x = 3 \cdot m = T$

Dynamics Study Guide – AP1



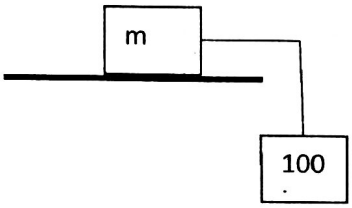
$\Sigma F_y = 6 \cdot 3 = 58.8 - T$

$T = 40.8\,N$

$\Sigma F_x = 3m = T$

$3m = 40.8$

$M = 13.6\,kg$



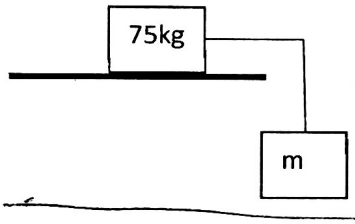
$\Sigma F_y = 100 \cdot 3 = 980 - T$

$680 = T$

$\Sigma F_x = 3m = 680$

$M = 226.67\,kg$

Assume u_k=0.21 for all surface. Find m so a = 6m/s^2



$\Sigma F_y = 6 \cdot m = F_g - T$

$6m = 9.8m - T$ —

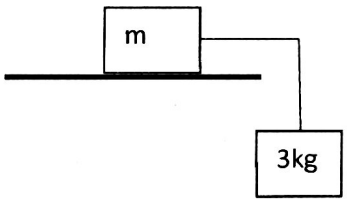
$\Sigma F_x = 75 \cdot 6 = T - F_F$

$450 = T - 0.21(735)$

$T = 154.35$

$6m = 9.8m - 154.35$

$M = 40.62\,kg$



$\Sigma F_y = 3 \cdot 6 = F_g - T$

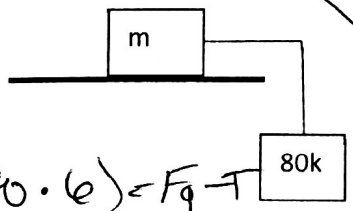
$T = 11.4\,N$

$\Sigma F_x = M \cdot 6 = T - F_F$ (F_N)

$6m = 11.4 - (0.21)(9.8)(m)$

$8.058m = 11.4$

$M = 1.41\,kg$



$\Sigma F_y = (80 \cdot 6) = F_g - T$

$480 = 784 - T$

$T = 304\,N$

$\Sigma F_x = 6m = T - F_F$ (F_N)

$6m = 304 - (0.21)(9.8)(m)$

$8.058m = 304$

$m = 37.72\,kg$