[illegible] Principles of Physics (10th edition) 141

Discussion

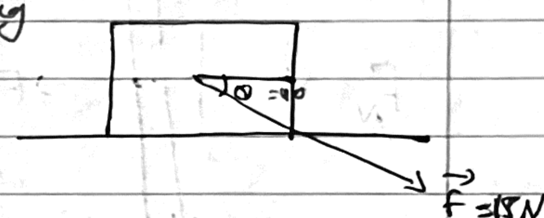
Chapter 6: Force and motion II

Problems: 9, 19, 21, 25, 39, 42, 53

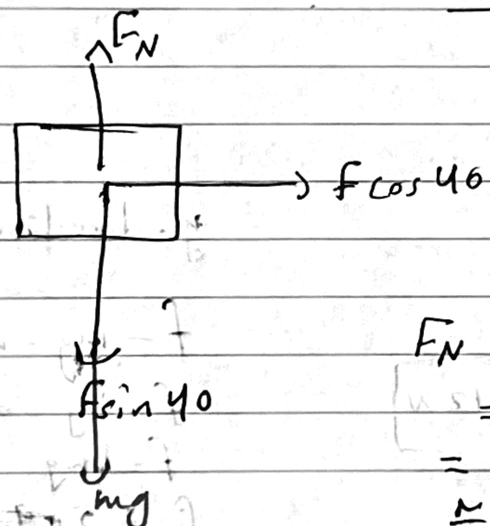
Problem 9: A 3.5 kg block is pushed along a horizontal floor by a force $\vec{F}$ of magnitude 15 N at an angle $\theta = 40°$ with the horizontal (Fig 6-17). The coefficient of kinetic friction between the block and the floor is 0.25. Calculate the magnitudes of a) the frictional force on the block from the floor and b) the block's acceleration.

sol: $F = 15\,N$, $\theta = 40°$, $m = 3.5\,kg$

$\mu_k = 0.25$



a)



$F_N = mg + F\sin 40$

$= (3.5 \times 9.8) + 15\sin 40$

$= 43.94$

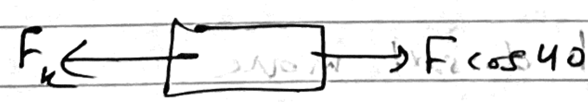
$\simeq 44\,N$

$f_k = \mu_k \vec{F_N}$

$= 0.25 \times 44$

$f_k = 11\,N$

b)



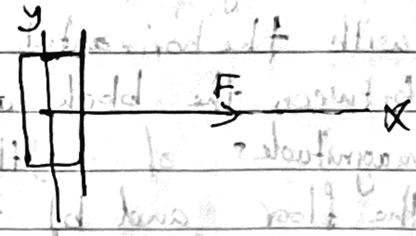
$\Sigma F = ma$

$F\cos 40 - f_k = ma$

$15\cos 40 - 11 = 3.5a$

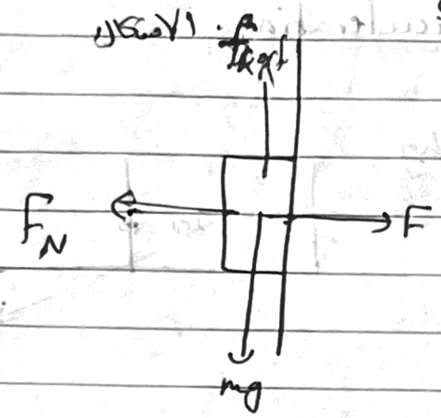
$0.5 = 3.5a \Rightarrow a = 0.143\,m/s^2$

Problem 19: A 12 N horizontal force $\vec{F}$ pushes a block weighing 5 N against a vertical wall (Fig 6-25). The coefficient of static friction between the wall and the block is 0.60, and the coefficient of kinetic friction is 0.4. Assume that the block is not moving initially a) will the block move?
b) In unit-vector notation, what is the force on the block from the wall?



sol: free body diagram

a)



x – direction

$F - F_N = \cancel{ma_x}$

$F = F_N \Rightarrow \boxed{F_N = 12\,N}$

y - direction

$f - mg = \cancel{ma_y}$

$f - mg = 0$

$f = mg$

$f = 5\,N$

but $f_s = \mu_s F_N = 0.6 \times 12 = 7.2\,N$

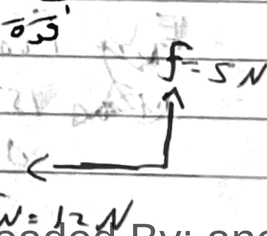
قوة الاحتكاك السكوني   الوزن   ساكن

$\Rightarrow 7.2 > 5\,N \Rightarrow$ block is static

$\Rightarrow$ The block doesn't move

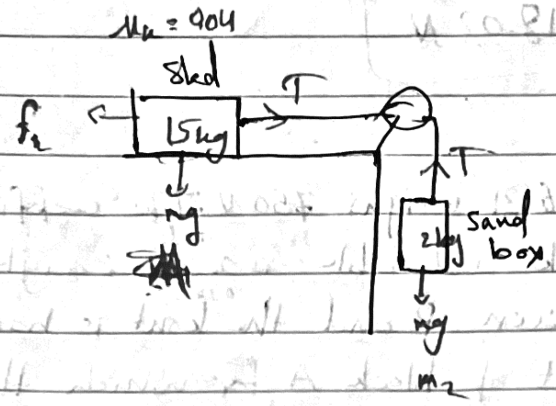
b) لا يوجد احتكاك حركي لأن القوة اكبر من قوة الاحتكاك

$F = -12\,N\,\hat{i} + 5\,N\,\hat{j}$



حل

Problem 21:- In Fig 6-27, a 15 kg sled is attached to a 2 kg sand box by a string of negligible mass, wrapped over a ~~pulley~~ pulley of negligible mass and friction. The coefficient of kinetic friction between the sled and table top is 0.04. Find (a) the acceleration of the sled and (b) the tension of the string

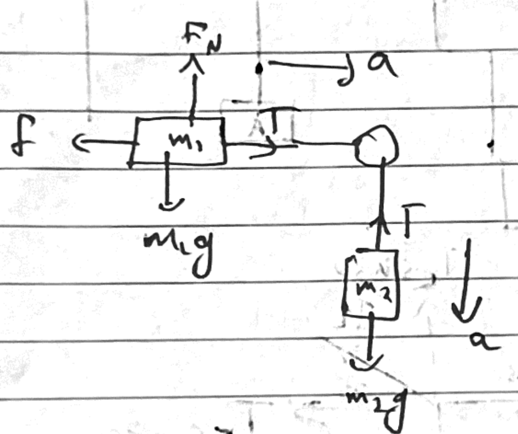


$m_1 = 15\ kg$

$m_2 = 2\ kg$

$\mu_k = 0.04$

free body diagram



for sled

$\Sigma F = m_1 a$

$T - f = m_1 a$

الاحتكاك

$f_k = \mu_k F_N$ لكن

$= 0.04\ (9.8 \times 15)$

$f_k = 5.88\ N$

$T - 5.88 = 15 a$ — (1)

~~for sand box~~

for sand box $\quad \Sigma F = m_2 a$

نعتبر اتجاه a الموجب

$m_2 g - T = m_2 a$

$2 \times 9.8 - T = 2 a$

$19.6 - T = 2a$ — (2)

$T - m_2 g = -m_2 a$

$\Rightarrow m_2 g - T = m_2 a$ ✓

نجمع (1) و (2)

$T - 5.88 + 19.6 - T = 15 a + 2a$

$13.72 = 17 a \quad \Rightarrow a = \frac{13.72}{17} = 0.81\ m/s^2$

b) سابقا

عوضنا a في احدى المعادلتين لنحل (1)

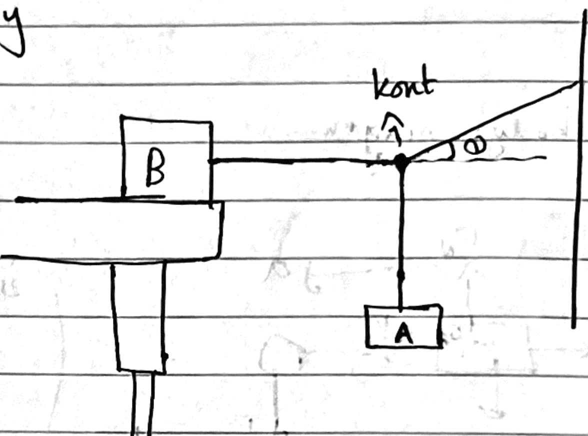
$T - 5.88 = 15a$

$T = 15a + 5.88$

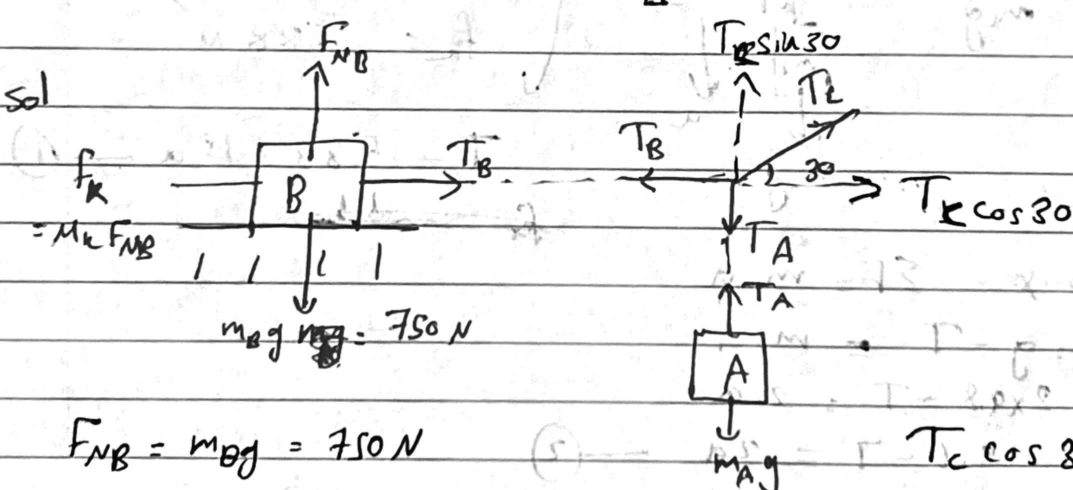
$= 15 \times 0.81 + 5.88$

$\boxed{T = 18.03\,N}$

Problem 25:- Block B in Fig 6-31 weighs 750 N. The coefficient of static friction between block and table is 0.25 ; angle θ is 30° assume that the cord (السلك) between B and the kont (العقدة) is horizontal. Find the maximum weight of block A for which the system will be stationary (ثابت أو متزن)



sol



$F_{NB} = m_B g = 750\,N$

stationary $\Sigma F = 0$

$\Rightarrow T_B - f_k = 0$

$T_B = f_k$

$= \mu_k F_{NB} = 0.25 \times 750$

$= 187.5\,N$

$T_c \cos 30 - T_B = 0$

$T_c \cos 30 = T_B$

$\Rightarrow T_c = \dfrac{T_B}{\cos 30}$

$= \dfrac{187.5}{0.866}$

$T_c = 216.5\,N$

سارو جا

$T_c \sin 30 - T_A = 0$

$T_c \sin 30 = T_A$

$216.5 \times 0.5 = T_A$

$108.25\ N = T_A$

$1.1 \times 10^2\ N =$

واشباع قاعدة الغث

For m_A $\quad T_A - mg = 0$

$T_A = mg = 108.25$

$= 1.1 \times 10^2\ N$

Problem 39: calculate the ratio of the drag force on a jet flying at 1200 km/h at an altitude (ارتفاع) of 15 km to the drag force on a porp-driven (مركبة تعمل بمروحيات) transport flying at half that speed and altitude. The density of air is 0.38 km/m3 at 10 km and 0.67 kg/m3 at 5.0 km Assume that the air planes have the same effective cross-sectional area and drag coefficent C.

sol: Hight of jet : 15 km

velocity of jet at 15 km = 1200 km/h

Hight of prop-driven $= \frac{15}{2} = 7.5$ km

velocity of prop-driven at 7.5 = 600 km/h

ρ_{air} at 10 km = 0.38 kg/m3

ρ_{air} at 5 km = 0.67 kg/m3

Drag ثابت ← $C_{jet} = C_{prop}$

$A_{jet} = A_{prop}$

$\frac{D_{jet}}{D_{prop}}$ المطلوب

$\frac{D_j}{D_{prop}} = \frac{\cancel{\frac{1}{2}} \cancel{C} \rho_1 \cancel{A_j} V_j^2}{\cancel{\frac{1}{2}} \cancel{C} \rho_2 \cancel{A_{prop}} V_{prop}^2}$

V_j : termenal velocity for the jet

(6)

معامل جار

$$\frac{D_j}{D_p} = \frac{\rho_j \, V_j^2}{\rho_2 \, V_p^2} = \frac{0.38\,(1200)^2}{0.67\,(600)^2} = 2.3$$

Problem 42: suppose the coefficient of static friction between the rod and the tires on a car is 0.60 and the car has no negative lift. What speed will put the car on the verge of ~~sliding~~ sliding as it rounds a level curve of 32.0 m radius

الاطارات السيارات — موقع سلبي — على وشك الانزلاق — دورانها — منحنى مستوى

sol: $\mu_s = 0.60$

$R = 32.0\,m$

* The magnitude of the car as he rounds the curve is given by $\frac{v^2}{R}$

V: The speed of the car

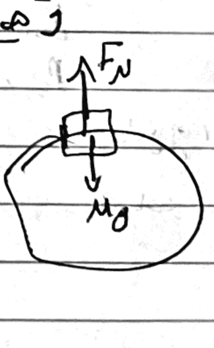
R: The raduis of the curve

بما أن الطريق horizantal (افقي) بالتالي فقط قوة الاحتكاك الي تصنع $\vec{a}$ (لا يوجد drag force)

$$\Rightarrow F_x = \frac{mv^2}{R}$$

حسب قانون نيوتن يعني القوة المركزية وهي افقي

قوة التلامس العمودية للطريق على السيارة $F_N = mg$, m: كتلة السيارة



$$\Rightarrow F_y = F_N = mg$$

المركبة الافقية للقوة = القوة المركزية

المركبة العمودية للقوة = قوة التلامس العمودية و mg

7

The maximum value of static friction

$f_{s\,max} = \mu_s F_N$

$f_{s\,max} = \mu_s mg$

horizontal

If the car doesn't slip $\Rightarrow$ $F \leq \mu_s mg$

$$\frac{\cancel{m} v^2}{R} \leq \mu_s \cancel{m} g$$

$$v^2 \leq \mu_s g R$$

$$v \leq \sqrt{\mu_s g R}$$

$\Rightarrow$ The maximum speed with which the car can round the curve without slipping or sliding is

$$V_{max} = \sqrt{\mu_s g R}$$

$$= \sqrt{0.60 \times 9.8 \times 32.0}$$

$$= \sqrt{188.6}$$

$$= 13.7 \text{ m/s}$$

~~= 14 m/s~~

~~= 13.7 × 10⁻³~~

$$= 13.7 \frac{\cancel{m}}{\cancel{s}} \times \frac{10^{-3} \text{ km}}{\cancel{m}} \times \frac{60 \cancel{s}}{\cancel{min}} \times \frac{60 \cancel{min}}{h}$$

$$= 49.32 \text{ km/h}$$

$$\simeq 49 \text{ km/h}$$

سارودكار — مسطحة — زاوية

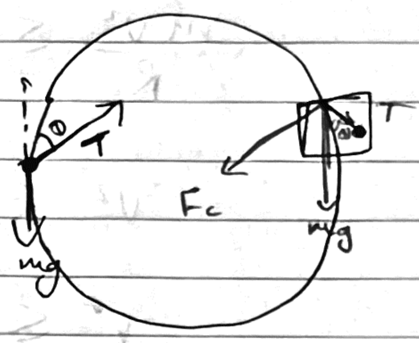
Problem 53: An old street car round a flat ~~a flat~~ corner of radius 10.5 m at 16 km/h. What angle with the vertical will be made by the loosely hanging hand straps?

ارزمة اليد المفضفاضة

sol: Free body diagram (for the hand straps of mass m)

. الجسم الحر body diagram

على اعتبار ان السيارة تلف باتجاه اليمين



$\Rightarrow |\vec{a}| = \frac{v^2}{R}$

سيارة بداخلها جسم معلق ستؤثر عليه قوة طرد مركزية تجعله يتحرك للخارج

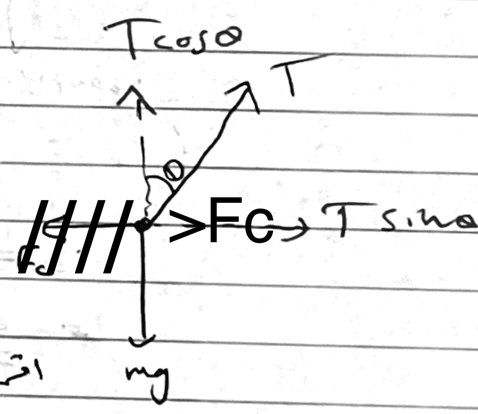
$v = 16 \text{ km/h}$

$= 16 \times \frac{1000}{3600} \text{ m/s}$

$= 16 \times \frac{5}{18}$

$v = 4.4 \text{ m/s}$

(+x is right word)
(+y is upword)



$T\sin\theta = F_c = \frac{mv^2}{R}$

$T\sin\theta = \frac{mv^2}{R}$ ——— (1)

$T\cos\theta = mg$ ——— (2)

$\frac{\sin\theta}{\cos\theta} = \frac{mv^2}{R} \div mg$

$\tan\theta = \frac{\cancel{m}v^2}{R} \times \frac{1}{\cancel{m}g}$

b)
$$\tan\theta = \frac{v^2}{Rg}$$

$$\Rightarrow \theta = \tan^{-1}\left(\frac{v^2}{Rg}\right)$$

$$= \tan^{-1}\left(\frac{(4.4)^2}{10.5 \times 9.8}\right)$$

$$\cancel{= \tan^{-1}(1.0427)}$$

$$= \tan^{-1}(0.188)$$

$$= 10.6^\circ$$

$$\theta \simeq 11^\circ$$