Chapters 5 & 6 (Force and motion I and II)

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1- A 70-kg man stands on a spring scale in an elevator that has a downward acceleration of 2.8 m/s**2. The scale will read: (A: 490 N)

M = 70 kg

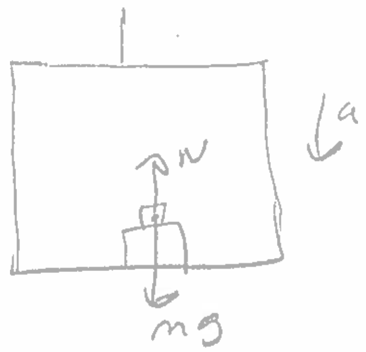
a = 2.8 m/s²

∴ mg − N = ma

(70)(9.8) − N = (70)(2.8)

∴ N = 686 − 196

= 490 N



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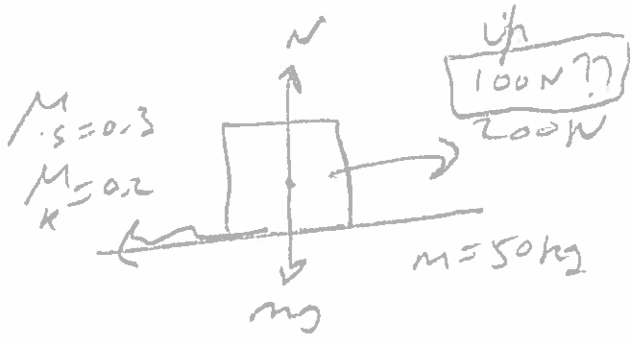
2- A person pulls a 50-kg box horizontally with a constant horizontal force of 200 N. If the coefficient of kinetic friction muk is 0.2 and the coefficient of static friction (mu_s) is 0.3. Find the acceleration of the box. (A: 2 m/s**2)

N = 50 × 9.8 = 490 N

$f_s = \mu_s N = 490(0.3)$

$f_s = 147 N$



$F_{net} = ma$

$200 - f_k = ma$

$200 - \mu_k N = 50a$

$200 - 98 = 50a$

∴ a = 2.04 N

3- A block of mass M = 10 kg is pushed up along a 30 degree inclined plane with a force F parallel to the inclined plane. If the velocity of the block is constant and the coefficient of kinetic friction μ_k is 0.2, find the magnitude of the force. (A: 66 N)

u is const $\Rightarrow a = 0$

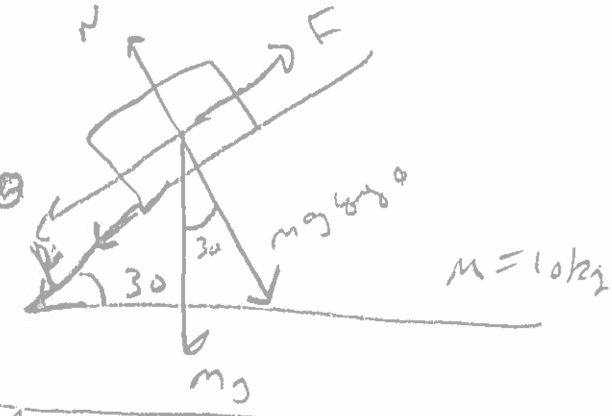
$\mu_k = 0.2$

$F = ?$

$F - mg\sin\theta - f_k = ma = 0$

$F = 20 + (10)(9.8)\sin 30$ (49)

$F = 69\ N$



$f_k = \mu_k N = \mu mg\cos\theta$

$= (0.2)(10)(9.8)\cos\theta$

$\approx 17\ N$

4- One end of a 1.0-m string is fixed; the other end is attached to a 2.0-kg stone. The stone swings in a vertical circle, and has a speed of 4.0 m/s at the top of the circle. The tension in the string at this point is approximately: (A: 12 N)

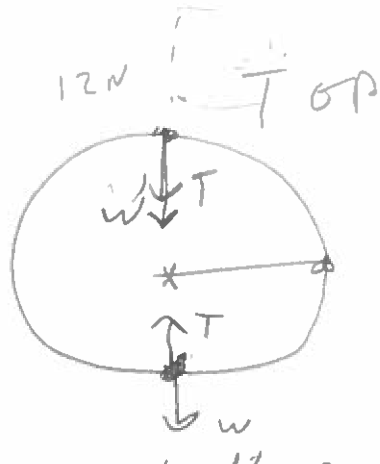
$m = 2\ kg$

$u = 4\ m/s$

$T = ?$

$a = \frac{u^2}{R} = \frac{4^2}{1}$

$a = 16\ m/s^2$



$T = 51.6\ N$

$F_{net} = ma$

$T + W = ma$

$T = ma - W$

$= (2)(16) - (2)(9.8)$

$T \approx 12\ N$

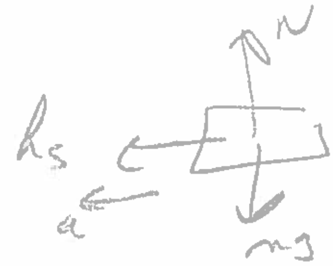
5- A 3.5-kg block is pulled at constant velocity along a horizontal floor by a force F = 15 N that makes an angle of 40 degrees with the horizontal. Find the magnitude of the force of friction between the block and the floor. (A: 11 N)

6- Find the minimum coefficient of static friction between the tyres of a car and a level road if the car is to make a circular turn of radius 90 m at a speed of 60 km/h. (A: 0.315)

$R = 90\,m$

$u = 60\,km/h$

$u = 16.7\,m/s$



$F_{net} = m a$

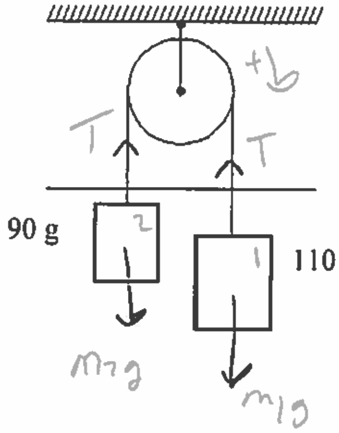
$f_s = m a = m \frac{u^2}{R}$

$\mu_s m g = m \frac{u^2}{R}$

$\mu_s = \frac{u^2}{g R} =$

$\mu_s = 0.319$

7- Two blocks are connected by a string and pulley as shown. Assuming that the string and pulley are massless, the magnitude of the acceleration of each block is: (A: 0.98 m/s^2)



$F_{net} = ma$

$m_1: \; m_1 g - T = m_1 a$

$(110)(9.8) - T = 110a$ ①

$m_2: \; T - m_2 g = m_2 a$

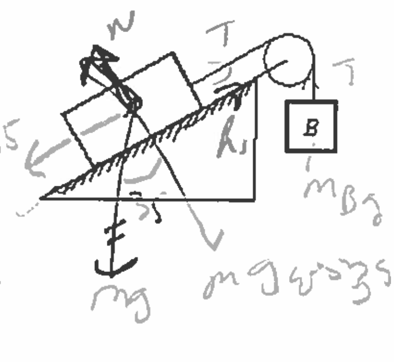
$T - (90)(9.8) = 90a$ ②

① + ② ⇒ $(110)g - (90)g = 200a$

$\therefore a = \frac{(20)(g)}{200}$

$a = 0.98 \; m/s^2$

8- Block A, with a mass of 10 kg, rests on a 35° incline. The coefficient of static friction is 0.40. An attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. What is the smallest mass m_B, attached to the dangling end, for which A remains at rest? (A: 2.5 kg)



$T = m_B g$ ①

$f_s = \mu_s (mg \cos 35)$ ②

$f_s = 32$

$f_s + mg \sin 35 = T ; f_s = m_B g - f_s$

$(32 + 56.2) = m_B g$

$m_A = 10$

$\mu_s = 0.4$

$\theta = 35$