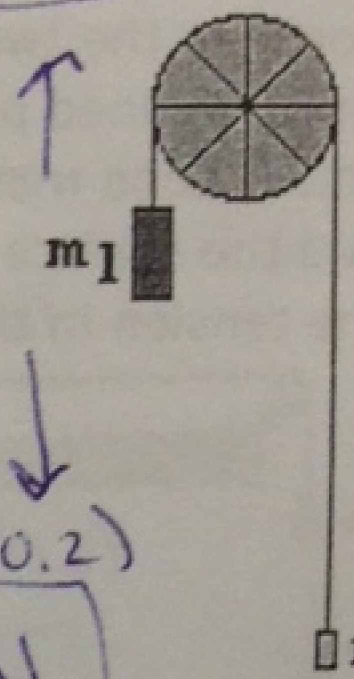
FORCES : ATWOODS MACHINE etc.

Solutions

Problem 1

A 200.0-gram mass (m_1) and 50.0-gram mass (m_2) are connected by a string. The string is stretched over a pulley. Determine the acceleration of the masses and the tension in the string.



$F_c = 0.49N$

$F_g = (9.8)(0.2)$

$F_g = 1.96N$

$F_g = (9.8)(0$

$F_g = 0.49N$

$F_{net} = 1.96 - 0.49$

$F_{net} = 1.47N$ (Down)

$$a = \frac{F_{net}}{M_1 + M_2}$$

$$a = \frac{1.47N}{0.25kg}$$

$a = 5.88 m/s^2$

$$T = \frac{2gM_1M_2}{M_1 + M_2}$$

$$T = \frac{2(9.8)(0.2)(0.05)}{0.25}$$

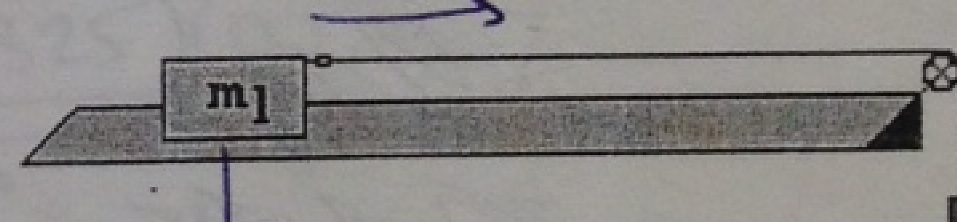
$T = 0.784N$

Problem 2

Consider the two-body situation at the right. A 20.0-gram hanging mass (m_2) is attached to a 250.0-gram air track glider (m_1). Determine the acceleration of the system and the tension in the string.

Assume no Friction

$F_{app} = 0.196N$



$F_g = (9.8)(0.25)$

$F_g = 2.45N$

$F_g = (9.8)(0.02)$

$F_g = 0.196N$

$F_{net} = 0.196N$

$$a = \frac{F_{net}}{M_1 + M_2}$$

$$a = \frac{0.196N}{0.27kg}$$

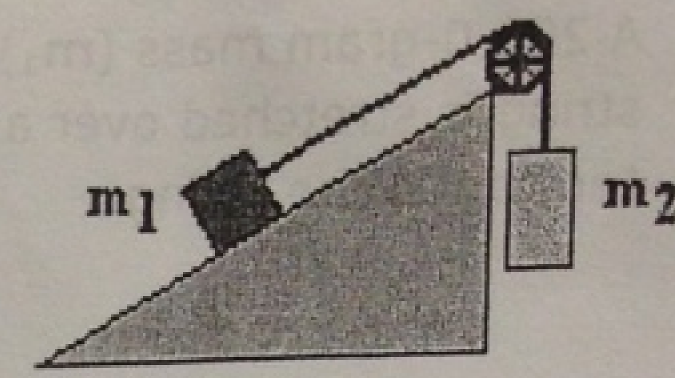
$a = 0.726 m/s^2$

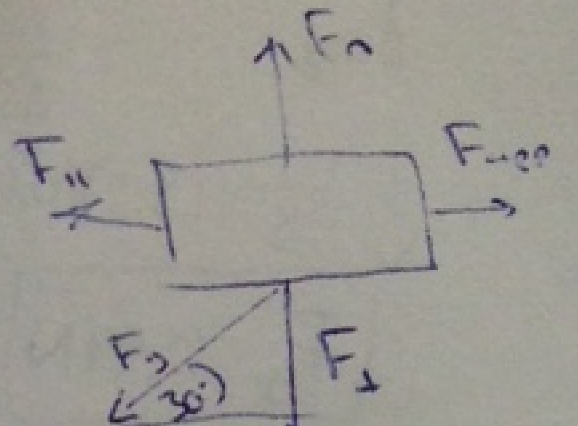
$$T = \frac{2(9.8)(0.02)(0.25)}{0.27}$$

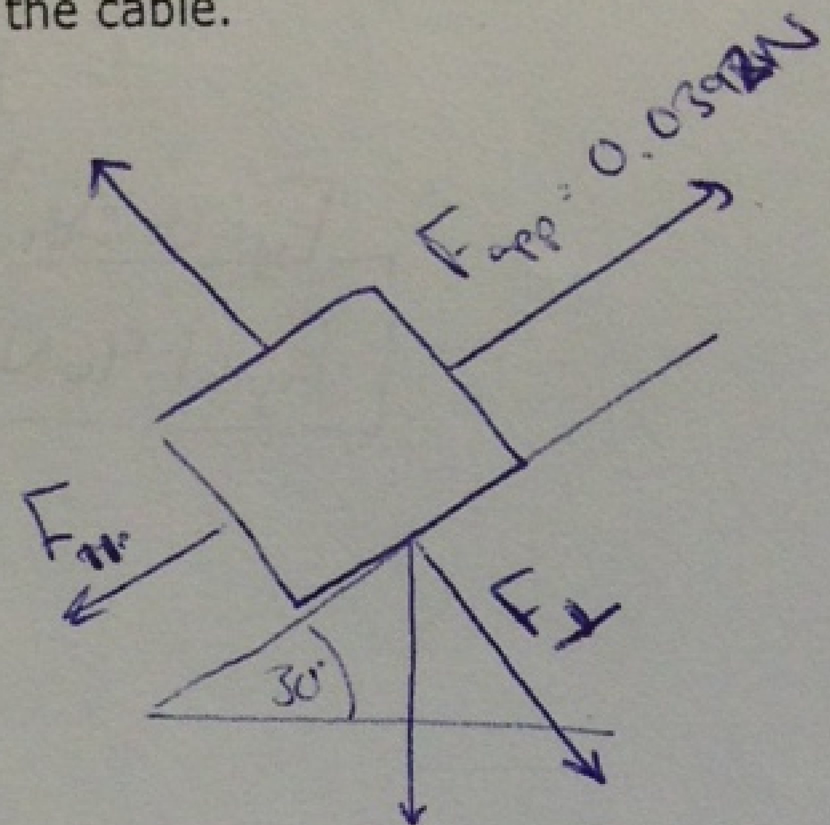
$T = 0.363N$

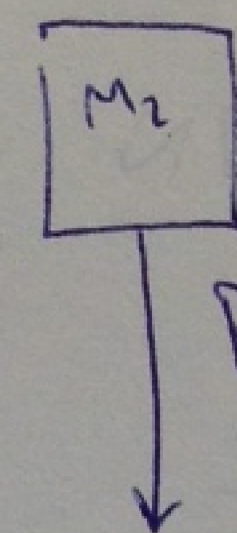
Problem 3

Consider the two-body situation at the right. A 2.50x103-kg crate (m_1) rests on an inclined plane and is connected by a cable to a 4.00x103-kg mass (m_2). This second mass (m_2) is suspended over a pulley. The incline angle is 30.0° and the surface is frictionless. Determine the acceleration of the system and the tension in the cable.









$F_g = (9.8)(4\times10^{-3})$

$F_g = 0.0392\text{ N}$

$F_\perp = F_g \cos 30$

$F_\perp = 0.021\text{N}$

$F_g = (9.8)(2.5\times10^{-3})$

$F_g = 0.0245\text{N}$

$F_{net} = F_{app} - F_\parallel$

$= 0.0392 - 0.0123$

$F_{net} = 0.0269\text{N}$

$F_\parallel = F_g \sin 30$

$F_\parallel = 0.0123\text{N}$

$= 0.049\text{ N}$

$a = \frac{F_{net}}{m_1 + m_2}$

$a = \frac{0.0269\text{N}}{6.5\times10^{-3}}$

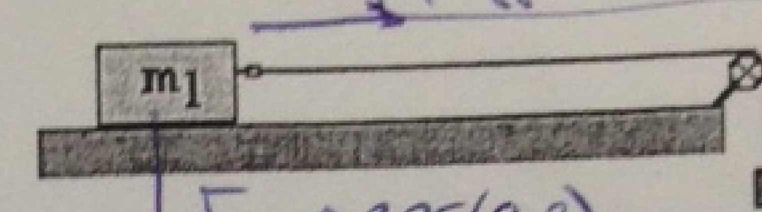
$a = 4.14\text{ m/s}^2$

$T = \frac{2(9.8)(0.0025)(0.004)}{0.0065}$

$T = 0.0301\text{N}$

Check Your Understanding

1. Consider the two-body situation at the right. A 100.0-gram hanging mass (m2) is attached to a 325.0-gram mass (m1) at rest on the table. The coefficient of friction between the 325.0-gram mass and the table is 0.215. Determine the acceleration ~~of the system and~~ the tension in the string.



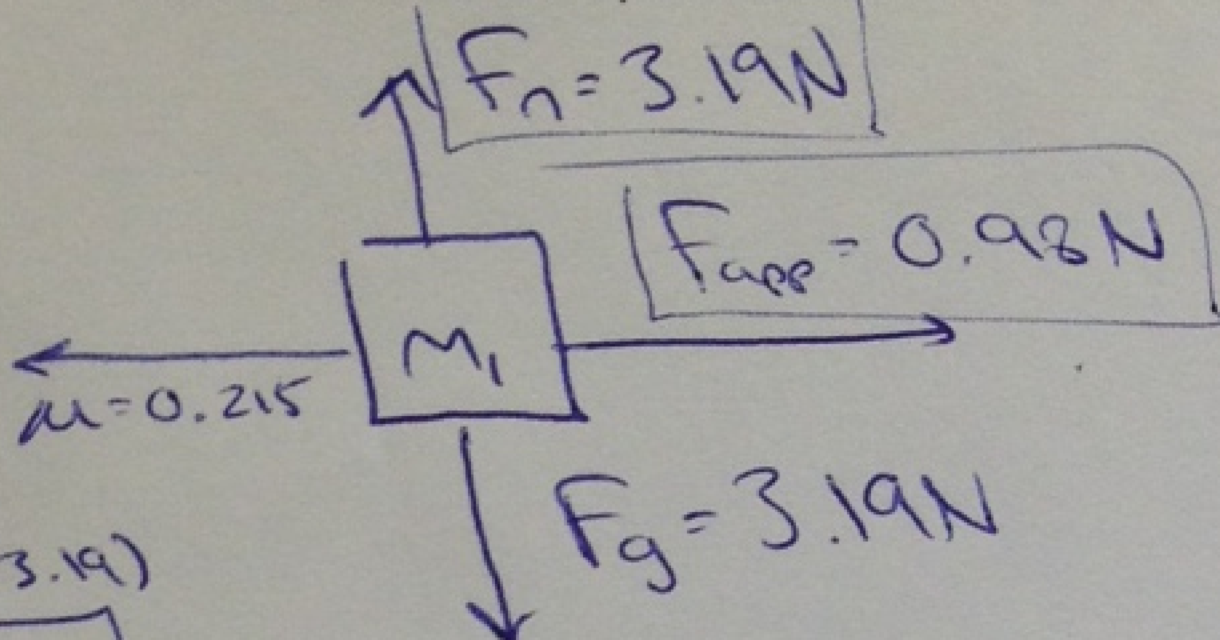
$F_{app} = 0.98N$

$F_g = 0.325(9.8)$

$F_g = 3.19N$

$F_g = 9.8(0.1)$

$F_g = 0.98N$



$F_{fr} = \mu \cdot F_n$

$= (0.215)(3.19)$

$F_{fr} = 0.69N$

$F_{net} = 0.98 - 0.69$

$F_{net} = 0.29N$

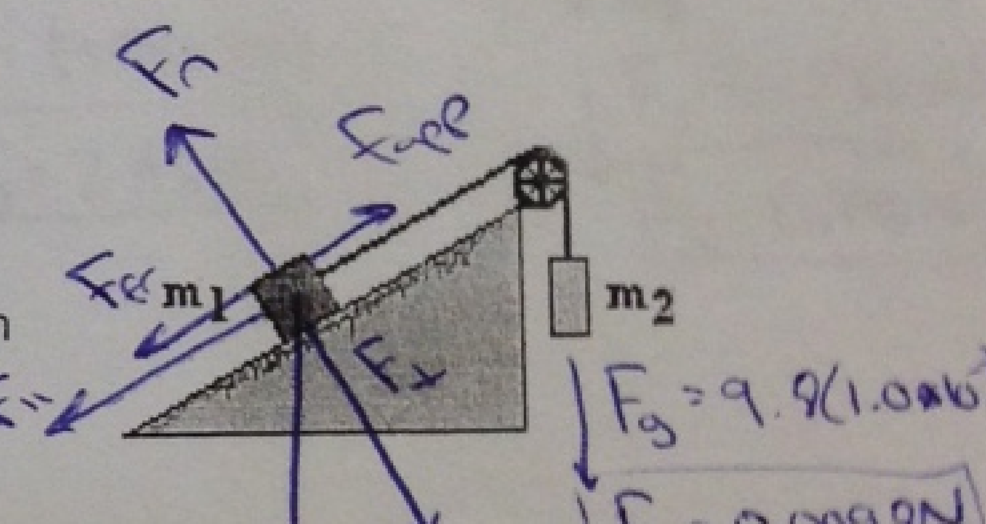
$a = \frac{F_{net}}{M_1 + M_2} = \frac{0.29N}{0.425kg}$

$a = 0.68 \, m/s^2$

$T = \frac{2gM_1 \cdot M_2}{M_1 + M_2} = \frac{2(9.8)(0.325)(0.1)}{0.425}$

$T = 1.5N$

2. Consider the two-body situation at the right. A 3.50x10^{-3}-kg crate (m1) rests on an inclined plane and is connected by a cable to a 1.00x10^{-3}-kg mass (m2). This second mass (m2) is suspended over a pulley. The incline angle is 30.0° and the surface has a coefficient of friction of 0.210. Determine the acceleration of the system and the tension in the cable.

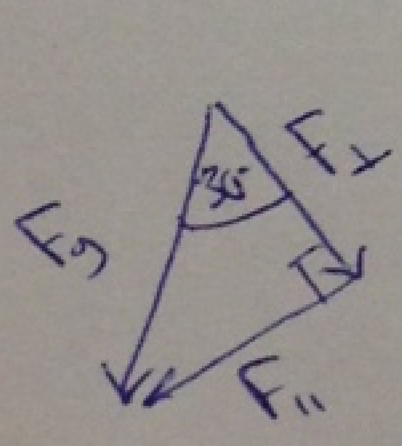


$F_g = 9.8(1.0\times10^{-3})$

$F_g = 0.0098N$

$F_g = 9.8(3.5\times10^{-3})$

$F_g = 0.0343N$



$F_{fr} = \mu \cdot F_n$

$= (0.210)(0.0297N)$

$F_{fr} = 6.24\times10^{-3}N$

$F_\perp = 0.0343\cos 30$

$F_\perp = 0.0297N = F_n$

$F_{\parallel} = 0.0343\sin 30$

$F_{\parallel} = 0.0172N$

$F_{net} = F_{app} - F_{\parallel} - F_{fr}$

$= 0.0098 - 0.0172 - 6.24\times10^{-3}$

$F_{net} = 0.0136N$ (down ramp)

$a = \frac{F_{net}}{M_1 + M_2} = \frac{0.0136N}{4.5\times10^{-3}kg}$

$a = 3.02 \, m/s^2$

$T = \frac{2(9.8)(3.5\times10^{-3})(1\times10^{-3})}{0.0045}$

$T = 0.0152N$