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Exercises and Complements for the Introduction to Physics I for Students of Biology, Pharmacy and Geoscience

Sheet 4 / September 30, 2019 **Solutions**

Exercise 16.
The force can be calculated by using the cosine theorem:

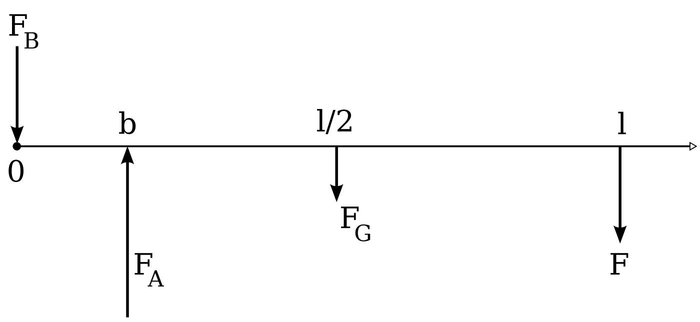
$$F_R = \sqrt{(4000\ \text{N})^2 + (7000\ \text{N})^2 + 2 \cdot 4000\ \text{N}\ \cdot 7000\ \text{N} \cdot \cos 120^\circ} = 6083\ \text{N}$$

Exercise 17.

1) No equilibrium ($M_{tot} \neq 0$); 2) equilibrium ($M_{tot} = 0$); 3) no equilibrium ($F_{tot} \neq 0$); 4) no equilibrium ($M_{tot} \neq 0$).

Exercise 18.

a)



b) The condition for a force equilibrium is :

$$F_A - F_B - Mg - mg = 0$$

The condition for a torque equilibrium acting on position B is:

$$F_A b - \frac{l}{2} Mg - mgl = 0$$

and from this F_A and F_B it can be calculated:

$$F_A = \frac{l}{b}\left(mg + \frac{1}{2}Mg\right) = 415.9 \text{ N}$$
$$F_B = F_A - (mg + Mg) = 286.4 \text{ N}$$

Exercise 19.

On the object with the weight mg acting in the direction of the motion, the down-hill slope force $F_H = mg\sin\alpha$ and in the opposite direction the friction force $F_R = \mu F_N$ with the normal force $F_N = mg\cos\alpha$. If F_H is greater than F_R , then the object will slide downwards. The accelerating force is then:

$$F_H - F_R = mg(\sin\alpha - \mu\cos\alpha) = ma$$

resulting in the coefficient of sliding friction:

$$\mu = \frac{\sin\alpha - (a/g)}{\cos\alpha} = 0.20$$

In the limiting case where $F_H = F_R$ (stiction), at $\alpha = \beta_0$ (friction angle), is $\mu_0 = \tan\beta_0 = 0.36$.

Exercise 20.

a) The kinetic friction on a horizontal plane is:

$$F = ma \qquad \text{and} \qquad F_R = \mu_g F_N = \mu_g mg$$

In the case where the system is in motion, the mass M which needs to be moved is composed of the two individual masses m_1 and m_2:

$$M = m_1 + m_2$$

The effective acceleration is:

$$a = \frac{F - F_R}{M} = \frac{F}{M} - \mu_g g$$

b) F_1: only mass m_1

$$F_1 = m_1 a + \mu_g m_1 g$$

$$F_1 = m_1(\frac{F}{M} - \mu_g g) + \mu_g m_1 g$$

$$F_1 = \frac{m_1 F}{M}$$