Chapter 5

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. Newton's second law
2. normal component of a contact force (i.e. normal force)
3. frictional component of a contact force (i.e. friction)
4. kinetic friction
5. static friction
6. maximum static friction
7. coefficient of kinetic friction
8. coefficient of static friction
9. x-component of weight and y-component of weight for an object on a hill, with the coordinate system oriented with the x-axis parallel to the hill and the y-axis perpendicular to the hill.
10. equilibrium
11. torque
12. moment arm

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- Newton's second law for an object labeled A:

$$\Sigma \vec{F}_{on\ A} = m_A \vec{a}_A \tag{1}$$

- Newton's second law written in component form:

$$\Sigma F_x = ma_x \qquad \Sigma F_y = ma_y \tag{2}$$

- kinetic friction:

$$f_k = \mu_k F_N \tag{3}$$

- maximum static friction:

$$f_{s,max} = \mu_s F_N \tag{4}$$

- static friction:

$$0 \leq f_s \leq f_{s,max} \qquad \text{depending on other forces} \tag{5}$$

- torque:

$$\tau = \pm F_\perp d \qquad \text{where d is the moment arm} \tag{6}$$

Skills

1. sketch a free-body diagram for an object in a given situation.
2. Apply Newton's second law in two dimensions and solve for an unknown force or an unknown acceleration by drawing a picture, identifying the object to analyze, drawing a free-body diagram, substituting into Newton's second law, and solving for the unknown.
3. Apply Newton's second law to an object on a hill and resolve the weight vector into a component parallel to the hill (w_x) and perpendicular to the hill (w_y).
4. Apply Newton's second law to an object on which there is a frictional force.
5. Apply both conditions of equilibrium ($\Sigma\vec{F} = 0$ and $\Sigma\tau = 0$) to an object that is in equilibrium.

Lab Skills

1. measure the acceleration of an object if given its position x as a function of time, in the form $x = At^2 + Bt + C$.
2. measure the acceleration of an object if given its velocity v_x as a function of time, in the form $v_x = mt + b$.
3. calculate the impact force on an object, given its acceleration and other forces, such as for a gymnast that is landing on a mat during a dismount.