Mechanics
Center of Mass

Lana Sheridan

De Anza College

Nov 5, 2018

Last time

- isolated and nonisolated systems
- mechanical energy
- conservation of mechanical energy
- general conservation of energy
- how to solve energy problems

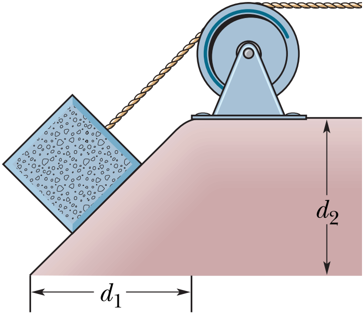
Overview

- go over quiz 4
- another energy example
- center of mass

Another Energy Example

Ch 8, #80

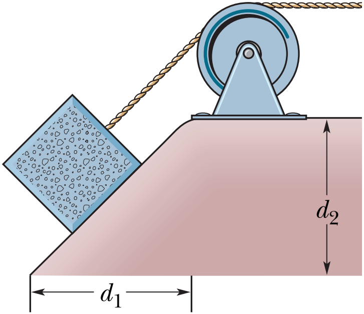
A 1400 kg block of granite is pulled up an incline at a constant speed of 1.34 m/s by a cable and winch. The indicated distances are $d_1 = 40$ m and $d_2 = 30$ m. The coefficient of kinetic friction between the block and the incline is 0.40. What is the power due to the force applied to the block by the cable?



Another Energy Example

Ch 8, #80

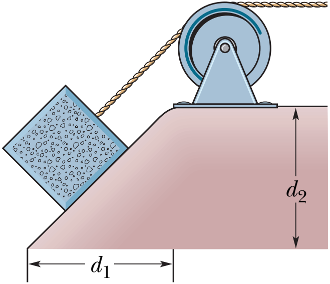
A 1400 kg block of granite is pulled up an incline at a constant speed of 1.34 m/s by a cable and winch. The indicated distances are $d_1 = 40$ m and $d_2 = 30$ m. The coefficient of kinetic friction between the block and the incline is 0.40. What is the power due to the force applied to the block by the cable?



Possible strategies:

1. Newton's 2nd law
2. Work-KE theorem, system is block only
3. Energy conservation with potential energy, system is block, earth, internal degrees of freedom in surfaces

Another Energy Example



Ans:

$$P = 1.7 \times 10^4 \text{ W}$$

Center of Mass

For a solid, rigid object:

center of mass

the point on an object where we can model all the mass as being, in order to find the object's trajectory; a freely moving object rotates about this point

also, the point at which if all the forces the object are modeled to act, the motion of that point is correctly predicted

Center of Mass

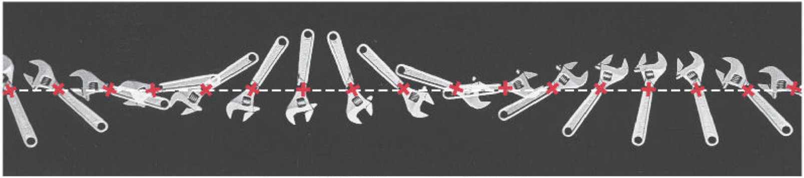
For a solid, rigid object:

center of mass

the point on an object where we can model all the mass as being, in order to find the object's trajectory; a freely moving object rotates about this point

also, the point at which if all the forces the object are modeled to act, the motion of that point is correctly predicted

The center of mass of the wrench follows a straight line as the wrench rotates about that point.



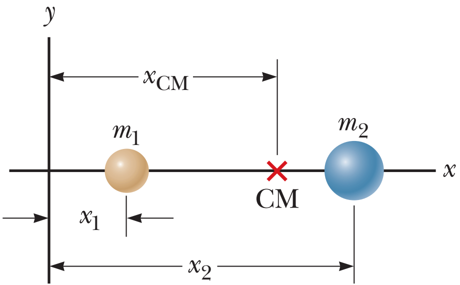
Center of Mass

[1]Figure from
http://www4.uwsp.edu/physastr/kmenning/Phys203/Lect18.html

Center of Mass

For a system of two particles, 1 dimension:

$$x_{CM} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$



Center of Mass

For a system of two particles, 1 dimension:

$$x_{\mathrm{CM}} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

For more particles in 1 dimension:

$$x_{\mathrm{CM}} = \frac{\sum_i m_i x_i}{\sum_i m_i}$$

or

$$x_{\mathrm{CM}} = \frac{1}{M} \sum_i m_i x_i$$

where M is the total mass of all the particles in the system.

Center of Mass

This expression also gives us the x coordinate of the center of mass when we have more dimensions.

$$x_{\text{CM}} = \frac{1}{M} \sum_i m_i x_i$$

Likewise for y:

$$y_{\text{CM}} = \frac{1}{M} \sum_i m_i y_i$$

and z:

$$z_{\text{CM}} = \frac{1}{M} \sum_i m_i z_i$$

where M is the total mass of all the particles in the system.

Center of Mass

Therefore, we can condense all three expressions into a single vector expression.

$$\mathbf{r}_{\mathrm{CM}} = \frac{1}{M} \sum_i m_i \mathbf{r}_i$$

where $\mathbf{r}_i = x_i \mathbf{i} + y_i \mathbf{j} + z_i \mathbf{k}$ is the displacement of particle i from the origin.

Summary

- went over quiz 4
- another energy example
- center of mass

Test 2 either Wed Nov 14 or Thurs, Nov 15 - give feedback asap.

Homework

- finish energy HW questions
- (Ch 9 Ques: 1; Probs: 1, 3, 5 - can wait to do)