This end fixed to overhead beam

Combination Machine Problem

Overhead beam



Lever 2

Pulley 3

Pulley 2

Pulley system 1

Lever 1

Pull here

Fixed

Moveable



Block

Axle

Wheel

Inclined plane



10 questions (100 points):

1. In order to lift the block 5 ft off the ground using the ramp,

(show calculations)

* 1. How far in ft. does the cable at #1 need to travel? (4, 5, 10, 15)
  2. How far in ft. does the cable at #2 need to travel? (4, 5, 10, 15)
  3. How far in ft. does cable #3 need to travel? (1, 2, 2.5, 5)

1. Continue with question #1:
   1. How far in ft. does cable #4 need to travel? (2, 4, 5, 7.5)
   2. How far in ft. does cable #5 need to travel? (4, 5, 7.5, 10)
   3. How far in ft. does cable #6 need to travel? (10, 20, 25, 50)
   4. How far in ft. does cable #7 need to travel? (20, 50, 100, 125)
2. What is the ideal mechanical advantage (IMA) of each of the following? Ch. 3 has the formulas if you forgot.

(show calculations)

* 1. The inclined plane (1:1, 2:1, 1:2, 2:3)
  2. Lever 2 (1:5, 1:4, 4:1, 5:4)
  3. Pulley 2 (1:1, 1:2, 2:1, 3:4)

1. Continue with question #3:
   1. Lever 1 (1:1, 1:2, 2:1, 3:1)
   2. Wheel and axle system (2:1, 4:1, 5:1, 1:5)
   3. Pulley system 1 (1:1, 1:2, 2:1, 3:1)
2. What is the overall IMA of the entire sequence? Show calculation for credit. (10:1, 20:1, 40:1, 100:1)
3. If the block weighs 100 lbs, with how much force in lbs. must you pull on cable #7 to get it to move up the ramp? Assume no friction. (hint: You don’t need to use trig to solve this. Just compute the IMA for the inclined plane using Ch. 3, and then use IMA = L/Ei. The answer is not 100 lbs!) (5, 10, 20, 50)
4. If the block weighs 100 lbs, how much actual “work” in lb-ft. is done raising the block 5 ft. off the ground by using this contraption? Review “work” in Ch. 3. Hint: you don’t need to use any trig to solve this. (100, 200, 500, 1000)
5. If the amount of work in #5 is done in 10 seconds, how much power in Watts is required? Review power and Watts in Ch. 3. (21, 33, 68, 95)
6. Design question: What change(s) could you make to the overall system to cut the IMA in half? In other words, what machine could you change to accomplish this, and how would you change it? There are many possible answers, so be specific! (note: the answer is not, “reduce friction”)
7. Design question:
   1. Up until now, we haven’t considered “efficiency”. What do you think would be the “least efficient” machine in the entire sequence? Think about how that particular machine would operate, and how much friction is probably generated, and how.
   2. How could you make it more efficient? Don’t just say, “lubricate it more”. I’m looking for creative solutions!