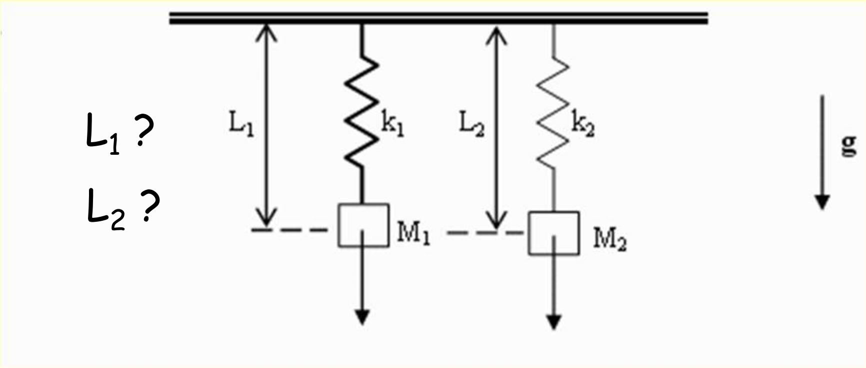
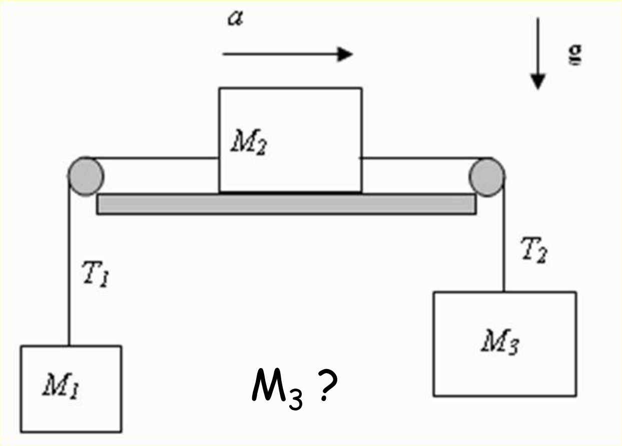
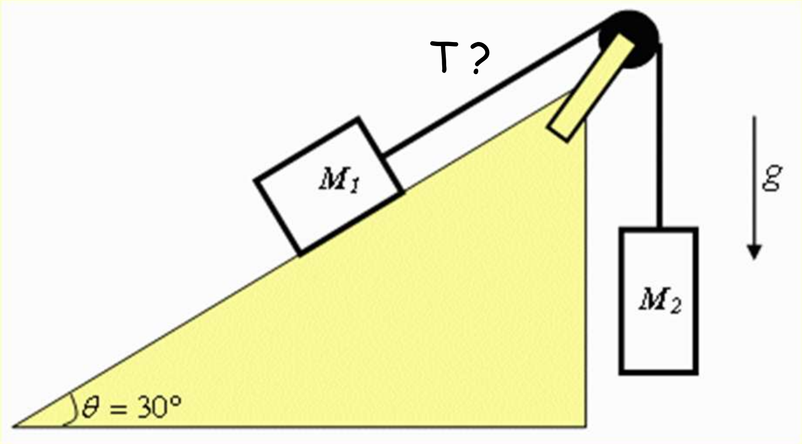
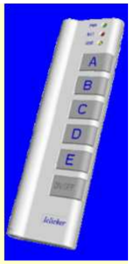
PHYS 100
Lecture 11







Music



BB

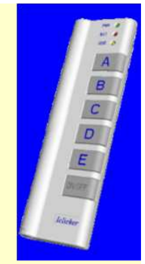
Who is the Artist?

A) Nnenna Freelon
B) Diana Krall
C) Carmen McRae
D) Diane Schurr
E) Darden Purcell

The BEST Local Female Vocalist I have ever heard here !!

She sings a week from today at SilverCreek
Happy Hour: 5:30pm – 7:30pm
With Donnie Heitler on the piano

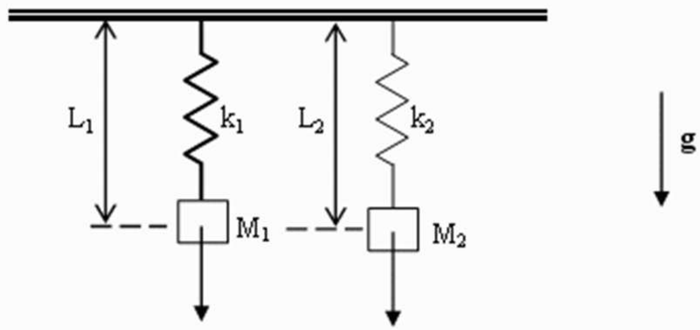
Preflight 1



The two massless springs have the same length L_0 when not compressed or stretched. The stiffness of each spring is k_1 and k_2, respectively. Mass M_1 hangs from spring 1 and it reaches equilibrium at position L_1. Mass M_2 hangs from spring 2 and it reaches equilibrium at position L_2.

If $k_2 = k_1$ and $M_2 = 3\,M_1$, which of the relationships below is correct?

- $L_2 = 3L_1$
- $L_1 = 3L_2$
- $L_2 = 2L_1 - 3L_0$
- $L_2 = 3L_1 - 2L_0$
- $L_1 = 3(L_2 - L_0)$



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Do we need to write down any equations to answer this question?

A) NO, it's just a proportion problem
B) YES, we should write down Newton's second law for both masses
C) Not Sure…

"If the mass is 3 times as large in case 2 than case 1, the length the spring stretches is 3 times as the spring in the other case."

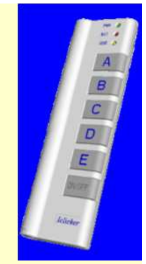
A) TRUE
B) FALSE

Therefore: $L_2 = 3L_1$

A) TRUE
B) FALSE

"Total Length" is NOT EQUAL to "Amount Stretched" !!

Preflight 1



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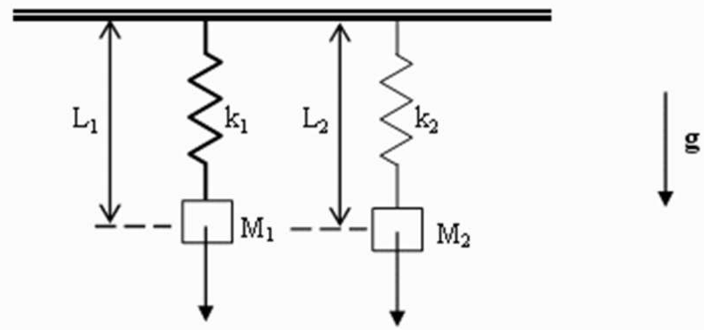

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What is the equation for M_1?

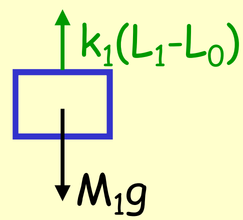
A) $M_1g + k_1(L_1-L_0) = 0$

B) $M_1g - k_1(L_1-L_0) = 0$

C) $M_1g - k_1(L_1+L_0) = 0$

D) $M_1g + k_1(L_1+L_0) = 0$

Draw FBD !!



Write Newton's Second Law (a=0)

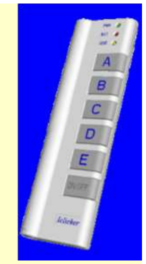
$\sum \vec{F} = 0 \Rightarrow$

$M_1g - k_1(L_1-L_0) = 0$

Exactly the same equation for M_2 !!

$M_2g - k_2(L_2-L_0) = 0$

Preflight 1



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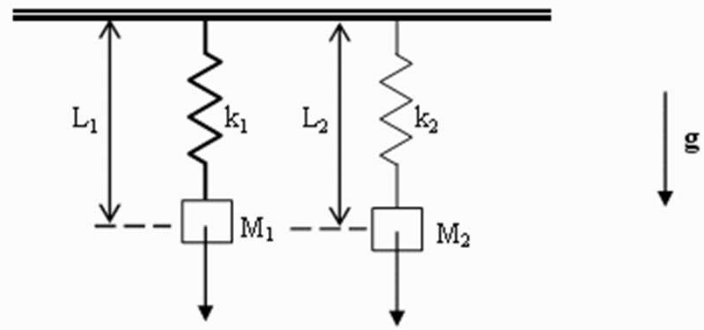

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$$M_1 g - k_1(L_1-L_0) = 0$$

$$M_2 g - k_2(L_2-L_0) = 0$$

SOLVE and VOTE !

i) $M_1 g - k(L_1-L_0) = 0$

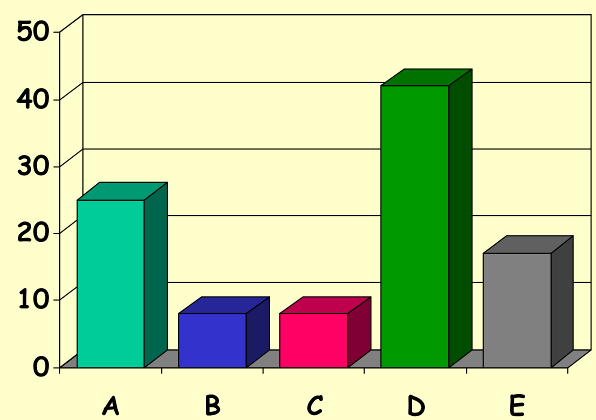
ii) $3M_1 g - k(L_2-L_0) = 0$

Multiply i) by 3 and subtract ii)

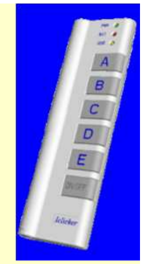
$$3M_1 g - 3k(L_1-L_0) - 3M_1 g + k(L_2 - L_o) = 0$$

$$-3(L_1-L_0) + (L_2 - L_o) = 0$$

$$L_2 = 3L_1 - 2L_o$$



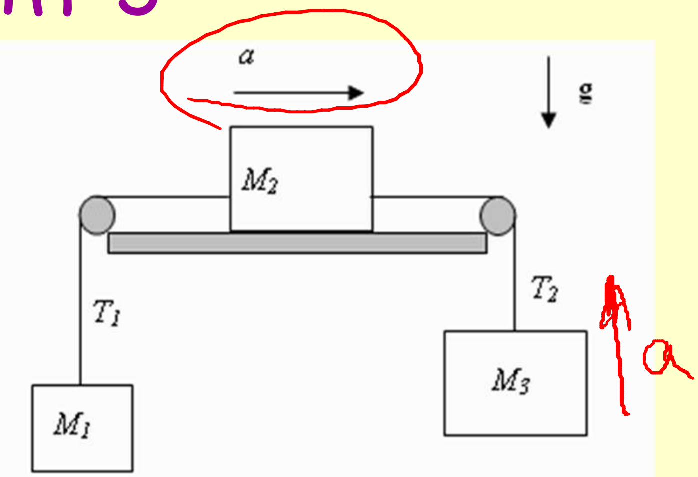
Preflight 3



BB

Three boxes are arranged as shown. The middle box has mass M_2 and accelerates to the right with acceleration a on a horizontal frictionless table. The boxes to the left and right hang freely, suspended by strings over massless, frictionless pulleys. The box to the left has mass M_1 and the box on the right has mass M_3. The tension in the left string is T_1.

What is M_3 in terms of M_2, T_1, a, and g ?



The general strategy I was looking for: "I used FBD's for each block and then used Newton's second law to determine M_3"

THREE ANSWERS:

I) I simply looked at the equations and figured out the one that makes the most sense based on Newton's Laws. **Bad Idea: Always solve the problem and then look at answers**

II) since the boxes are accelerating to the right M3g>T2. The total force on M2 is M2a+ T1 which equals T2. You then set M3g equal to the total force that is on M2. and you get M3=(T1+M2a)/g

III) The total force on M is equal to m*a=T2-m3g. T2 is equal to T1+m2a and then I solved for M3.

A) True B) False

$M_3 a = T_2 - M_3 g$ $T_2 - T_1 = M_2 a$ (a not the same)

(A) II is correct (B) III is correct (C) Neither is correct

Preflight 3

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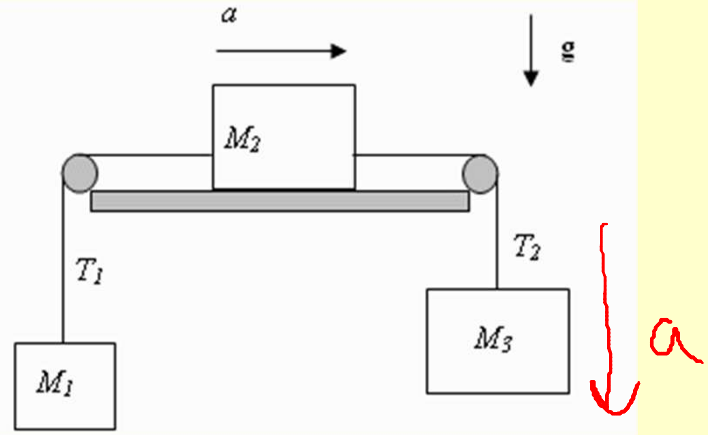
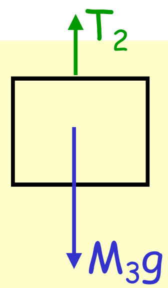


FBD for M_3

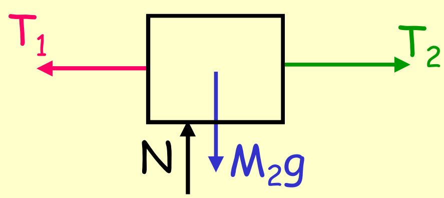


Newton's Second Law for M_3: $M_3 g - T_2 = M_3 a$

One Equation
Two Unknowns
M_3 and T_2

How do we find T_2?

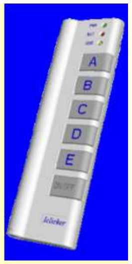
FBD for M_2



Newton's Second Law for M_2: $T_2 - T_1 = M_2 a$

Two Equations
Two Unknowns
M_3 and T_2

Preflight 3



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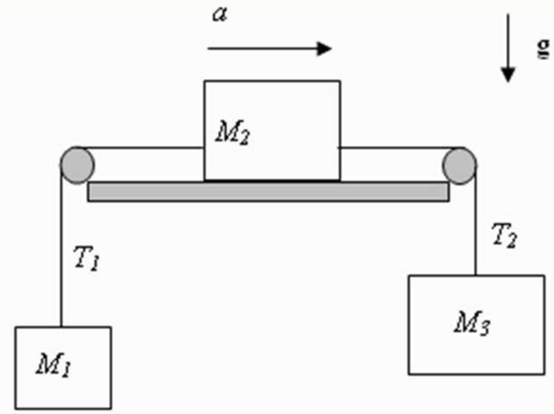


What is M_3 in terms of M_2, T_1, a, and g ?

- $M_3 = M_2 a/g$
- $M_3 = (T_1 + M_2 a)/(g+a)$
- $M_3 = (T_1 + M_2 a)/(g-a)$
- $M_3 = (T_1 + M_2 g)/a$
- $M_3 = (T_1 + M_2 a)/g$

$$M_3 g - T_2 = M_3 a$$

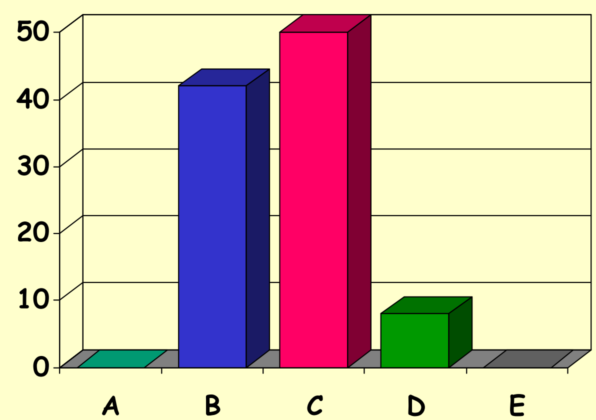
$$T_2 - T_1 = M_2 a$$

Add the two equations:

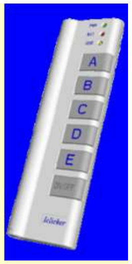
$$M_3 g - T_2 + T_2 - T_1 = M_3 a + M_2 a$$

$$M_3 g - T_1 = M_3 a + M_2 a$$

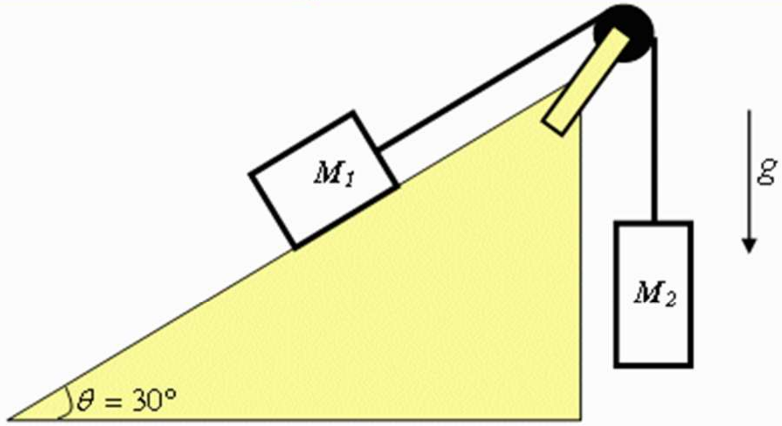
$$M_3 = (T_1 + M_2 a)/(g-a)$$



Preflight 6



A 30 kg block (M_1) is placed on a frictionless plane that inclines at a 30° angle with respect to the surface of Earth. This block is connected to another 20 kg block (M_2) via a weightless rope over a frictionless, ideal pulley. The second block is hanging vertically, as shown in the figure. What is the tension of the rope?



T = ??

HOW TO START?

A) The acceleration a = 0

B) The acceleration a is not 0 and we need to find the direction of a before we can sove for the tension

C) The acceleration a may or not be equal to 0, but we do not need to know it in order to solve for the tension

Preflight 6

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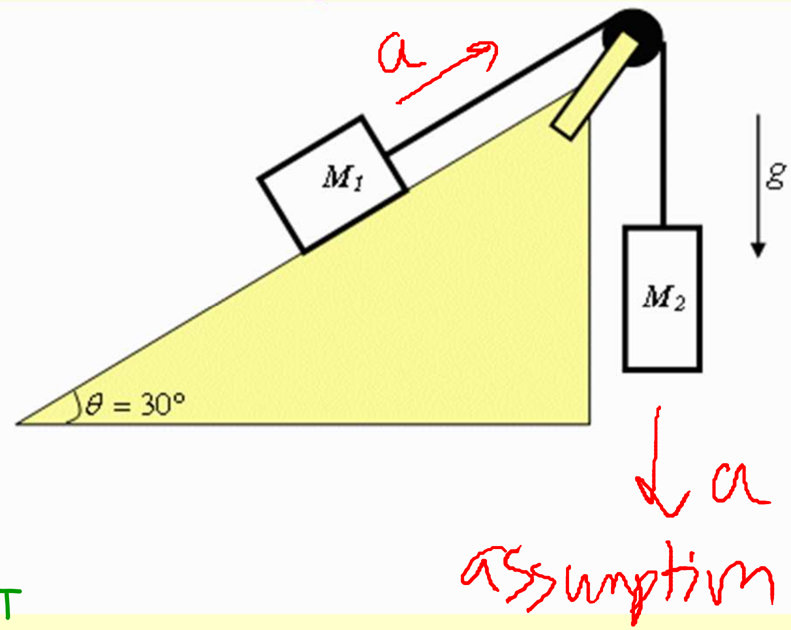
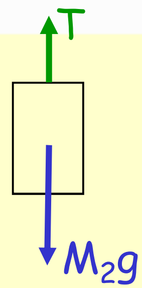
- ○ 55.0 N
- ○ 92.4 N
- ○ 147.4 N
- ○ 176.6 N
- ○ 294.6 N

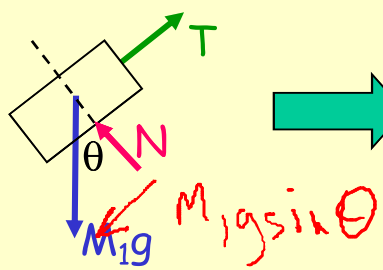


FBD for M_2



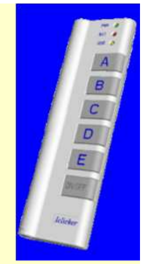
$$M_2g - T = M_2a$$

FBD for M_1



$$T - M_1g\sin\theta = M_1a$$

Preflight 6



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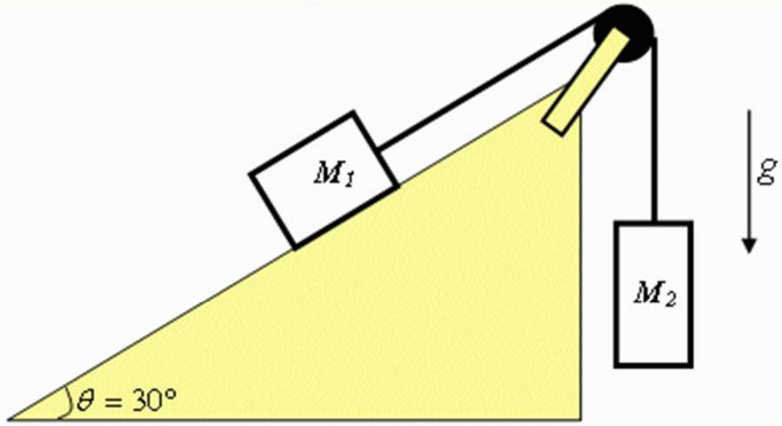

$$M_2g - T = M_2a$$

$$T - M_1g\sin\theta = M_1a$$

Solve for T: → eliminate a → $a = g - T/M_2$

substitute for a → $T - M_1g\sin\theta = M_1(g - T/M_2)$

$$T(1 + M_1/M_2) = M_1g(1 + \sin\theta)$$

$$T = g(1 + \sin\theta)\, M_1M_2/(M_1+M_2)$$ → $$T = 18g = 176.6\text{N}$$