1 A particle starts from rest at time t = 0.00 s and moves in the +x direction with constant acceleration. If the particle travels 6.0 m during the time t = 1.00 s to t = 2.00 s, find its acceleration (in m/s^2).

+4.00 -5.00 -10.00 +6.00 +2.00

2 A particle moving in the +x direction with constant acceleration travels from x = 10 m to x = 50 m in 2 s. If the velocity of the particle at the end of this motion is 10 m/s, find its acceleration (in m/s^2).

-10.00 +4.00 -5.00 +6.00 +2.00

3 Two identical masses M1 and M2 (M1 = M2 = M) are dropped from rest from different heights to the ground (neglect air resistance). M1 takes time t to reach the ground, while M2 takes time 2t to reach the ground. If M1 is dropped from height H1 and M2 is dropped from height H2, find the ratio H1/H2.

1/4 1/9 3 4 9

3* Two identical masses M1 and M2 (M1 = M2 = M) are dropped from rest from different heights to the ground (neglect air resistance). M1 is dropped from height H, while M2 is dropped from height 4H. If M1 takes time t1 to reach the ground and M2 takes time t2 to reach the ground, find the ratio t2/t1.

2 1/9 3 1/2 9

3** Two particles are thrown from the top of a building with the same initial speed at the same instant of time. Particle(1) is thrown up and particle(2) is thrown down (Neglect air resistance). Comparing their final speeds just before they hit the ground, one of the following statements is CORRECT:

The final speed of both particles will be exactly the same.
The two particles arrive the ground at the same time.
The final speed of Particle(1) is higher.
Particle(1) arrives the ground earlier than Particle(2).
The final speed of Particle(2) is higher.

4 A 3-kg Physics textbook hangs vertically from a wire in an elevator. If the tension in the wire is 33 N, the acceleration (in m/s^2) of the elevator is: [Hint: Take the upward direction as positive (+)]

+1.2 -1.2 +20.8 -20.8 +9.8

4* A 2-kg Physiology textbook hangs vertically from a cable in an elevator. If the tension in the cable is 16 N, the acceleration (in m/s^2) of the elevator is: [Hint: Take the upward direction as positive (+)]

-1.8 +1.8 +17.8 -17.8 -9.8

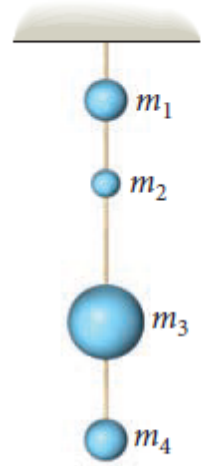
5 You push a box of mass m_1 with an unknown force *F* and thus give it an acceleration of 6.0 m/s^2. With the same force *F*, you push a box of mass m_2 and give it an acceleration of 2.0 m/s^2. What acceleration (in m/s^2) would your force, *F*, give to a box of mass $(m_2 – m_1)$?

3 1.5 2 5.5 6

6 A 4-kg block slides down a hill that is inclined at 20° with respect to the horizontal with an acceleration 1.1 m/s^2 directed up the hill. The coefficient of kinetic friction between the block and the hill is:

0.48 0.24 0.21 0.82 0.34

7 As shown, four masses connected with wires, are hanging from a ceiling. The masses are: m_1 = 5.5 kg, m_2 = 2.4 kg, m_3 = 9.9 kg, and m_4 = 3.6 kg. The tension (in N) in the wire connecting masses m_1 and m_2 is approximately:

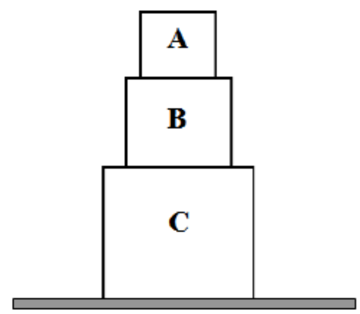


156 209 54 24 132

8 A 50 kg block is at rest on a horizontal frictionless surface. Then a horizontal force F acts on the block and accelerates it to the right. If the block travels 30 m in 7 s, find the magnitude of the force F (in N).

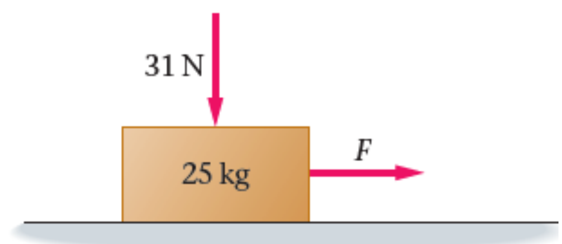
61 122 163 41 82

9 The three blocks (A, B, and C) shown next do rest on the table. The weight for block A is 1 N, the weight of block B is 2 N, and the weight of block C is 5 N. The magnitude of the force (in N) exerted by block C on block B is:



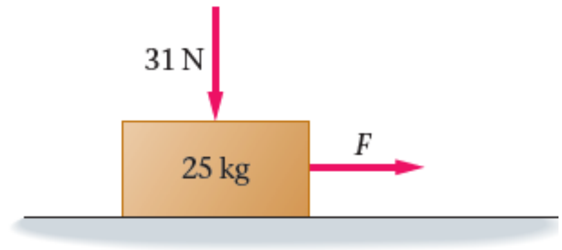
3 8 6 2 0

10 The box shown rests on a rough horizontal surface, where the coefficients of static and kinetic friction between the box and the surface are 0.59 and 0.41 respectively. The two forces shown are then applied on the box. The box will be on the verge of start moving when the horizontal force F (in N) has the magnitude of:



162.8 113.2 144.6 100.5 31

11 The box shown rests on a rough horizontal surface, where the coefficients of static and kinetic friction between the box and the surface are 0.59 and 0.41 respectively. The two forces shown are then applied on the box. The box will move at constant speed when the horizontal force F (in N) has the magnitude of:

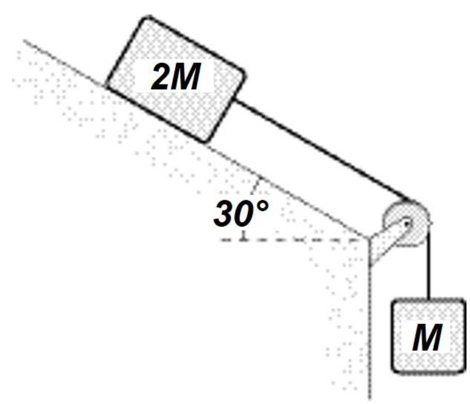


113.2 162.8 144.6 100.5 31

12 A 0.5-kg ball slides initially at speed of 9.8 m/s on a rough horizontal surface. The ball slides 30 m before it stops. The coefficient of kinetic friction between the ball and the surface is:

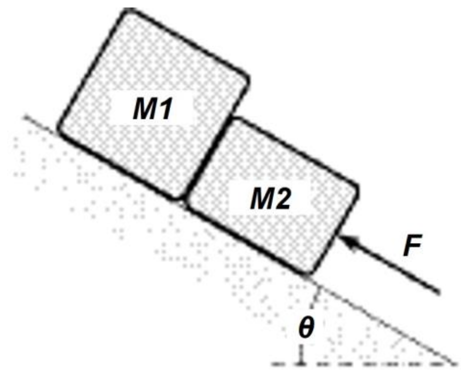
0.16 0.10 0.29 0.41 0.09

13 Two masses M and 2M are connected by a string that passes over a very light frictionless pulley. Mass 2M slides on a 30 degrees inclined plane, while mass M hangs suspended by the string, as shown in the figure. The coefficient of kinetic friction between the mass 2M and the incline is 0.30. Find the magnitude of the acceleration (in m/s^2) of the suspended mass M as it falls.



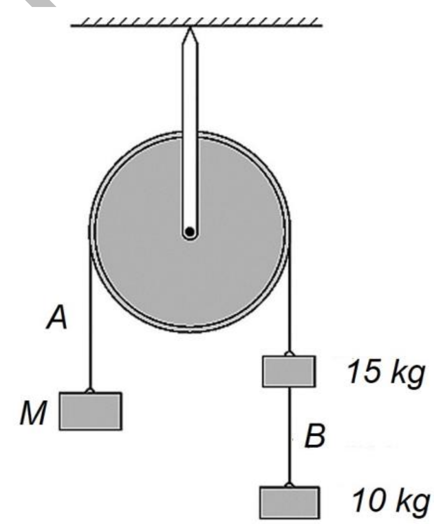
4.8 4.3 5.7 7.9 5.4

14 Two masses M1 and M2 are moving on an inclined plane. A force F parallel to the incline is pushing M2 up as shown in the figure. The surface of the inclined plane is frictionless and the angle θ = 30 degrees. M1 = 3 kg, M2 = 2 kg, and F = 30 N. Find the magnitude of the force (in N) exerted on M1 by M2.



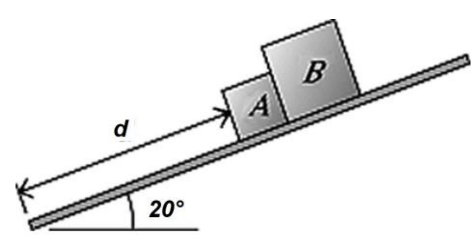
18 15 24 30 36

15 Three masses (M, 15 kg, and 10 kg) are connected by massless wires over a massless frictionless pulley as shown in the figure. If the tension in the wire B connecting the 10.0 kg and 15.0 kg masses is 133 N, find the tension (in N) in wire A.



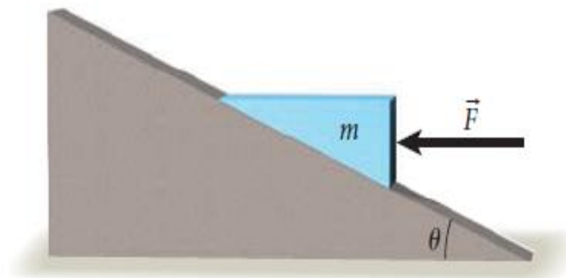
333 517 450 400 350

16 Two masses A (5-kg) and B (10-kg) start sliding down a 20° inclined plane from rest a distance d = 6.6 m along the incline. The coefficient of kinetic friction between each block and the incline is 0.20. How long (in s) does it take mass A to reach the bottom?



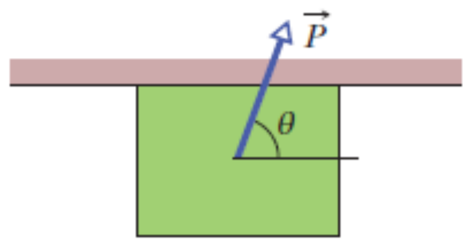
2.96 4.07 8.08 1.51 3.59

17 As shown, the force ***F*** is pushing horizontally on the wedge m which is placed on the incline surface. The coefficient of kinetic friction between the wedge and the incline is 0.16. Knowing that F = 300 N, m = 34-kg, and θ = 20°, the magnitude of the wedge's acceleration (in m/s²) along the incline is:



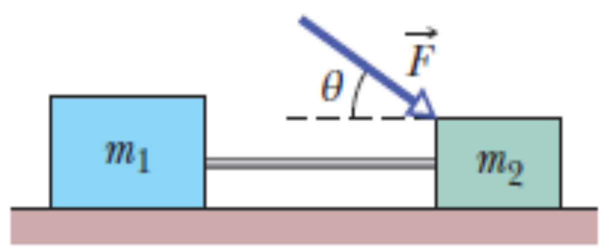
3.0 2.2 0.9 14.3 1.9

18 As shown, the force ***P***, of magnitude 70 N, is applied to a 3-kg block to enforce it to accelerate across the ceiling. The coefficient of kinetic friction between the block and the ceiling is 0.26. Given that the angle θ is 72°, the magnitude of the block's acceleration (in m/s²) is:



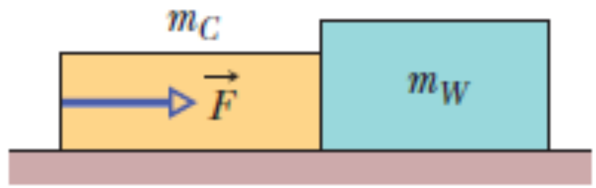
4.0 0.7 0.0 11.2 13.7

19 As shown, the two blocks, m_1 and m_2, are connected by a wire of negligible mass. The force **F**, of magnitude 35 N, is applied to block m_2. The coefficient of kinetic friction between each block and the horizontal surface is 0.26. Given that m_1 = 2-kg, m_2 = 1-kg, and the angle θ = 29°, the tension (in N) in the wire is:



17.5 22.0 4.6 316.7 3.9

20 As shown, the two boxes, m_c (3-kg) and m_w (5-kg), are accelerated along a rough horizontal track. The force **F** (20 N) acts horizontally upon the left side of box m_c. If the magnitude of the kinetic frictional forces on the m_c and m_w boxes are 5 N and 7.5 N respectively, what is the magnitude of the force (in N) exerted by m_c box on m_w box?



12.2 3.3 23.4 18.9 9.7

===== ===== ===== ===== ===== ===== ====

You should consider such following questions as a treat!

21 A bicycle moves at 22m/s east for 30 minutes and then reverses direction and moves at 28 m/s for 15 minutes. The bicycle's total displacement (in 10^4 m) is:

1.44 6.48 3.96 9.98 76.06

22 A block is pulled up a hill at 4 m/s and then slides down the hill at 6 m/s. The block's average speed during the whole trip (in m/s) is:

4.8 5 10 7.2 2.8

23 A car is driving east at 40 mile/h for 2.0 h, then north at 50 mile/h for 1.0 h, and finally east at 20 mile/h for 0.50 h. The car's average speed (in mile/h) during the whole trip is:
[Hint: 1 mile = 1600 m]

40 32 55 45 37

24 A 9.8-kg box is thrown vertically upward, from ground level, with an initial speed of 9.8 m/s. The box will return back to the ground level after a time period (in s) of:
[Hint: Ignore air resistance]

2 1 0.5 4 9.8

1^{st}-exam : answer key

[1] Given: $V(0)=0$, Δx during Δt: $t_i=1 \rightarrow t_f=2$, $\Delta t = 1sec \rightarrow \vec{a}$?

$\vec{\Delta x} = \vec{V}_i t + \frac{\vec{a}}{2} t^2 \Rightarrow \vec{\Delta x} = \vec{V}(1) * 1 + \frac{\vec{a}}{2} * 1^2$.

$\vec{V}(1) = \vec{V}(0) + \vec{a} * (1-0) \rightarrow$ " $\vec{V}(1) = \vec{a}$ " $\rightarrow$ solve for a, $\vec{a} = \frac{2}{3}\vec{\Delta x}$.

[2] Given: $\vec{\Delta x}$ during Δt and $\vec{v_f}$, $\rightarrow \vec{a}$?

Note that $\vec{v_i}$ is unknown, therefore, one can't directly get $\vec{a}$ from: $\vec{v_f} = \vec{v_i} + \vec{a} t$ — ① nor from $\vec{\Delta x} = \vec{v_i} t + \vec{a} t^2/2$ — ②. Try: $\vec{\Delta x} = \left(\frac{\vec{v_i} + \vec{v_f}}{2}\right) t$ and solve for $\vec{v_i} = \frac{2\vec{\Delta x}}{t} - \vec{v_f}$, and then plug $\vec{v_i}$ into either of eq ① or ②.

* Note that if you get $\vec{v_i}$ from ① and plug it into ②, then you get the following kinematic eq $\vec{\Delta x} = \vec{v_f} t - \frac{\vec{a} t^2}{2}$ — ③. Note the difference between eq ③ and eq ①. One can directly get $\vec{v_f}$ using eq (3)! Can you interpret the area under the curve of $V_x(t)$?

[3] Given: m_1 dropped from h_1 and took t_1
Given: m_2 " " h_2 " " t_2
$\Big\}$ ratio of $\frac{h_2}{h_1}$ or $\frac{t_2}{t_1}$?

- With constant acceleration, the position $\vec{\Delta h}$ is always a quadratic function in t.

$h = \cancel{v_i t} - g t^2/2 \Rightarrow \frac{h_2}{h_1} = \left(\frac{t_2}{t_1}\right)^2$

- $v_f^2 = v_i^2 + 2\vec{g}\,\vec{\Delta h} \Rightarrow$ with same $|\vec{v_i}|$ (scalar) and same $\vec{\Delta h}$ (vector) $\rightarrow \vec{v_f}$ is the same.

* Note that the results are mass independent!

[4] A book hangs from a wire in an elevator: given m and $T \Rightarrow \vec{a}$?

$T = mg(1 + \frac{\vec{a}}{g})$, if $T > mg \Rightarrow \vec{a}$ must be +ve.

, if $T < mg \Rightarrow \vec{a}$ must be −ve.

[5] $(m_1) \searrow F \Rightarrow a_1$, $(m_2) \swarrow F \Rightarrow a_2 \Rightarrow \therefore m_1 = \frac{F}{a_1}$, $m_2 = \frac{F}{a_2} \rightarrow$

$(m_2 - m_1) \swarrow F \rightarrow a$? $\quad a = \frac{F}{m_2 - m_1} = \frac{F}{\frac{F}{a_2} - \frac{F}{a_1}} = \frac{a_1 a_2}{a_1 - a_2}$

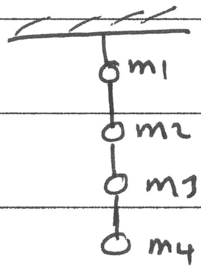
note: $a_{m_1} > a_{m_2 - m_1} > a_{m_2} > a_{m_1 + m_2}$.

[6] The block slides <u>down</u> the hill with an acceleration directed <u>up</u> the hill

If we take +ve down the hill $\Rightarrow +mg\sin\theta - \mu_k mg\cos\theta = -ma$

$\therefore \mu_k = \frac{\sin\theta + (a/g)}{\cos\theta}$.

[7] The 4 masses hang from wires.



$\sum \vec{F}$ in the vertical direction = zero.

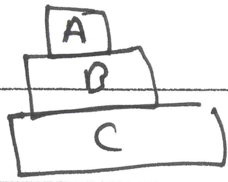
$\Rightarrow T$ in the wire between m_1 and m_2 is

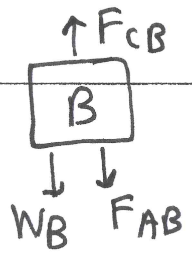
equal to weight of m_2, m_3 and $m_4 \Rightarrow (m_2 + m_3 + m_4)g$.

~~[8]~~ $[m] \longrightarrow F$: $v_i = 0$, $|\vec{\Delta x}| = d$, $t \longrightarrow F$?

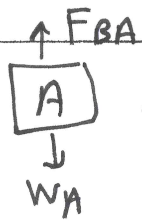
$F = ma$, $d = v_i t + \frac{at^2}{2} \longrightarrow F = \frac{2md}{t^2}$.

[9] The 3 blocks are in equilibrium: F_{CB}?



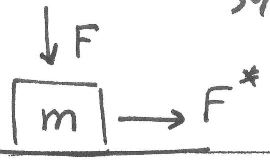


$\therefore F_{CB} = W_B + F_{AB}$ ✓ , ?, $\Rightarrow$



$\Rightarrow F_{BA} (= F_{AB}) = W_A$

$\therefore F_{CB} = W_B + W_A$. $\Rightarrow$ does it agree with your intuition?



10 m is on the verge of sliding:

$\Rightarrow F^* \equiv$ threshold value $= f_{s_{max}} = \mu_s (F + mg)$.

11 m is moving at constant velocity $\Rightarrow \sum \vec{F} = 0 \rightarrow F^* = f_k$.

12 [m] → v_i ———— $v_f = 0$ μ_k?

← d →

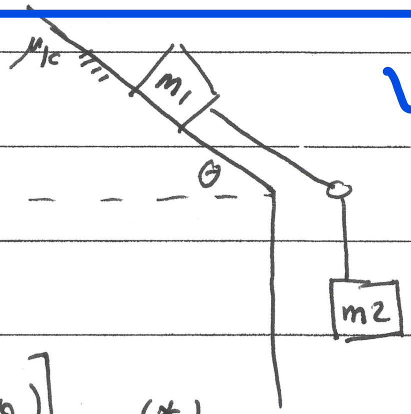
$\sum \vec{F} = -f_k = ma \rightarrow -\mu_k mg = ma \rightarrow \mu_k = -a/g$ (watch out the -ve)

~~$v_f^2 = v_i^2 + 2\vec{a}\Delta\vec{x} \Rightarrow 0 = v_i^2 + 2\vec{a}(d) \Rightarrow a = -\frac{v_i^2}{2d}$~~ $\Rightarrow$

~~$\mu_k = +\frac{v_i^2}{2dg}$, note that v_i (# was given x) $= 9.8 = |g|$.~~
with a value of g

$\therefore \mu_k = g/2d. \Rightarrow$ Do it using work-energy approach!

13 Given: m_1, μ_k, θ and $m_2 \rightarrow a$?



Let's assume the flow tube:

$m_2 g - T = m_2 a$, and

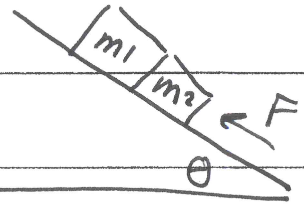
$T + m_1 g \sin\theta - \mu_k m_1 g \cos\theta = m_1 a$

Solve for $a = g \left[\frac{m_2 + m_1(\sin\theta - \mu_k \cos\theta)}{m_1 + m_2} \right]$ —— (*)

In the exam, $m_1 = 2m_2 \Rightarrow$ plug in and get the answer!

▪ What does eq (*) reduce to if $\theta = \mu_k = 0$? Does the algebraic expression in such case agree with your hunch?

[14] Given F, θ, m_1 and m_2. (smooth incline).



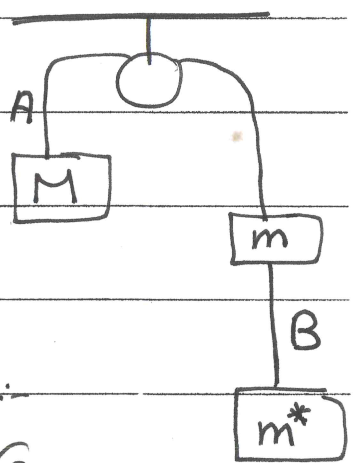
Find F_{21} : by 2 on 1

$F - (m_1+m_2)g\sin\theta = (m_1+m_2)a$ — system.

now: for m_1: $F_{21} - m_1 g\sin\theta = m_1 a$ $\therefore$ $F_{21} = m_1[g\sin\theta + a]$.

calculate a from the system's eq and plug it in ↗. ✓

[15] For the assembly shown,



m, m^* and T_B are given → T_A?

Let's assume the flow to be ↷

$T_A - Mg = Ma$ — ①

$T_B + mg - T_A = ma$ — ②

> 3 unknowns! ⇒ look for the 3rd eq.

⇒ $m^*g - T_B = m^*a \Rightarrow a = (m^*g - T_B)/m^*$ — ③

plug a into ② [why not into ①?] ⇒ run through a little algebra, if you don't mind!!

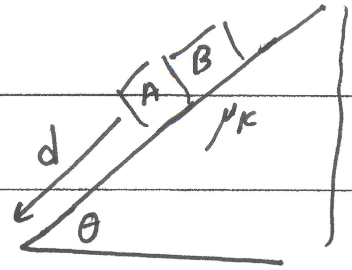
$T_A = T_B\left[1 + \frac{m}{m^*}\right]$.

- Note that if $\underline{\underline{a}}$ is found to be -ve, this means that the actual flow of the system is opposite to our assumption; no big deal!
- Can you get M?

16 Given: m_A, m_B, μ_k and d.

Both blocks started from rest.

$\Rightarrow$ t needed to move d?



$(m_A+m_B)g\sin\theta - \mu_k(m_A+m_B)g\cos\theta = (m_A+m_B)a$ mass cancelled out

$\Rightarrow$ $a = g[\sin\theta - \mu_k\cos\theta]$ $\Rightarrow$ ~~kinematics: $d = v_i t + at^2/2$~~

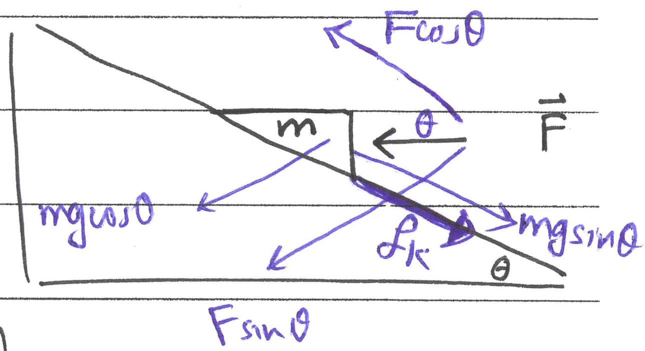
$\therefore$ ~~$t = \sqrt{\dfrac{2d}{a}}$~~.

Try solving the problem using work-energy approach!

17 Given: $|F|, m, \mu_k$ and $\theta \rightarrow a$?

$F\cos\theta - mg\sin\theta - \mu_k[F\sin\theta + mg\cos\theta] = ma$

solve for a:

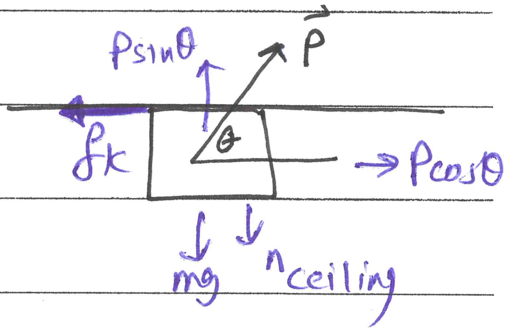


$$a = \frac{F}{m}[\cos\theta - \mu_k\sin\theta] - g[\sin\theta + \mu_k\cos\theta].$$

18 Given: $|\vec{P}|, \theta, \mu_k$ and $\theta \rightarrow a$?

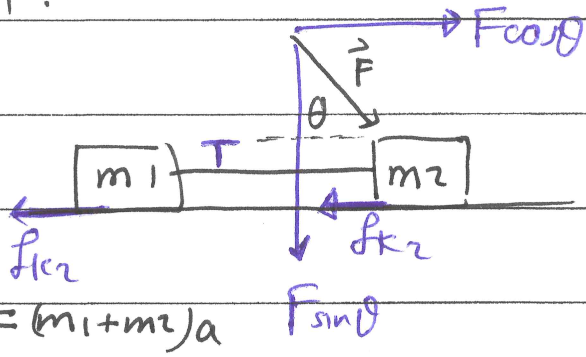
$P\cos\theta - \mu_k[P\sin\theta - mg] = ma$

solve for a:



$$a = \frac{P}{m}[\cos\theta - \mu_k\sin\theta] + \mu_k g.$$

[19] Given: $|\vec{F}|$, θ, μ_k, m_1 and m_2 → T?



for the system:-

$$F\cos\theta - \mu_k m_1 g - \mu_k (m_2 g + F\sin\theta) = (m_1+m_2)a$$

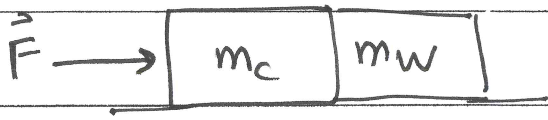
solve for a, then

for m_1, for instance, $T - \mu_k m_1 g = m_1 a$ → plug a in and solve for T.

If you run through a little algebra, you can have the expression for T:

$$T = \left[\frac{m_1(\cos\theta - \mu_k \sin\theta)}{m_1+m_2}\right]F.$$

[20] Given: $|\vec{F}|$, f_{kc}, f_{kw}, m_c and m_w → F_{cw}?



⇒ as a system: $F - (f_{kc} + f_{kw}) = (m_c + m_w)a.$

$$\therefore\ a = \frac{F - (f_{kc} + f_{kw})}{(m_c + m_w)}.$$

for m_w → $F_{cw} - f_{kw} = m_w a$

$$\therefore\ F_{cw} = f_{kw} + \left(\frac{m_w}{m_c+m_w}\right)\left[F - (f_{kc} + f_{kw})\right].$$