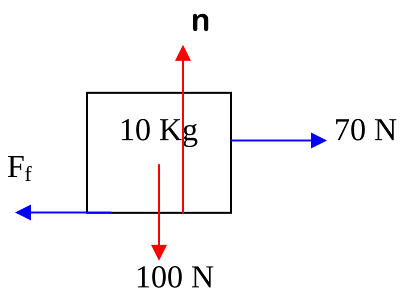
Homework Solutions page 2

Items #1 - #3

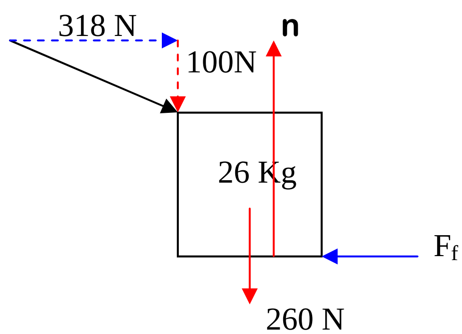
1. From F_{NET}= ma, 72N = 9Kg(a) or a=8m/s^2. Using d=v_ot + ½ at^2, d= ½ (8)3^2=36m. Using $v_f = v_o$ + at, v_f = 8(3) = 24 m/s.
2. From F_{NET}= ma, -24N = 8Kg(a) or a=-3m/s^2. Using $v_f = v_o$ + at, 0 =12 + -8(t) so t =1.5sec.
3. From F_{NET}= ma, 30N = 5Kg(a) or a=6m/s^2. Using $v_f^2 = v_o^2 + 2ad$, $v_f = \sqrt{[4^2+ 2(6)10.67)]}$ or v_f = 12 m/s. Using $v_f = v_o$ + at, 12 = 4 + 6t so t = 1.33 sec.
4. Skip. This is circular motion. We will come back to curving things.
5. Ditto!

Homework Solutions page 3

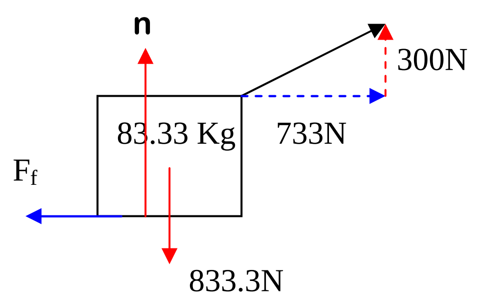
1. From $\Sigma F_{\perp}$: **n** – 100 N = 0 ∴**n** = 100N. Using $F_f = \mu$**n** = 0.50(100N) = 50 N. Using $\Sigma F_{\|}$: 70 N – 50 N = 10Kg(a) or 20N = 10Kg(a) ∴a = 2 m/s^2 Note, the net force is 20N. Using $v_f^2 = v_o^2 + 2ad$ leads to $v_f = \sqrt{(2*2*9)}$ = 6 m/s.



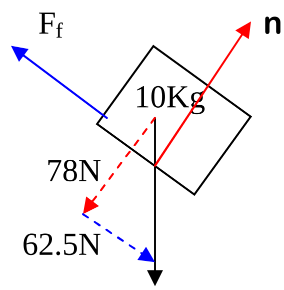
2. $\Sigma F_{\perp}$: **n** –100N – 260N = 0 so **n** = 360N. Using $F_f = \mu$**n** = 0.67(360N) = 240 N. $\Sigma F_{\|}$: 318 N – 240 N = 26Kg(a) or 78N = 26Kg(a) ∴a = 3 m/s^2 Note, the net force is 78N. Using $v_f^2 = v_o^2 + 2ad$ leads to $9^2 = 0^2$ + 2(3)d or d = 13.5m.



3. $\Sigma F_{\perp}$: **n** +300N – 833N = 0 so **n** = 533N. Using $F_f = \mu$**n** = 0.75(533N) = 400 N.$\Sigma F_{\|}$: 733 N – 400 N = 83.3Kg(a) or 333N = 83.3Kg(a) ∴a = 4 m/s^2 Note, the net force is 333N. From $v_f = v_o$+ at the final speed is v_f = 0+4(3) = 12m/s

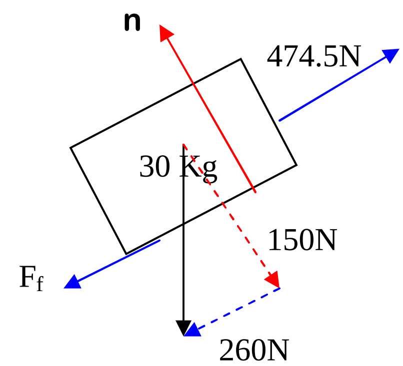


4. From $\Sigma F_{\perp}$: **n** – 78 N = 0 ∴**n** = 78N. Using $F_f = \mu$**n** = 0.281(78N) = 21.9 N. $\Sigma F_{\|}$: 62.5 N – 21.9 N = 10Kg(a) or 40.6N = 10 Kg(a). The net force is 40.6N and acceleration is 4.1 m/s^2. The distance along the ramp is 5m/sin(38.66°) = 8 m. Using $v_f^2 = v_o^2$ + 2ad ,$v_f = \sqrt{(2*4.1*8)}$ v_f = 8.1 m/s.



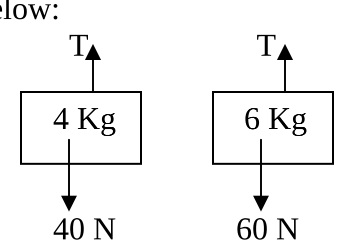
Last problem continued on next page.

5. From $\Sigma F_{\perp}$: $\mathbf{n} - 150\text{ N} = 0$ $\therefore \mathbf{n} = 150\text{N}$. Using $F_f = \mu\mathbf{n} = 5/6(150\text{N}) = 125$ N. $\Sigma F_{\parallel}$: 474.5N –260N –125N= 30Kg(a) or 89.5N = 30 Kg(a). The net force is 89.5N and acceleration is 3.0 m/s^2. The distance up the ramp is 10 m. Using $d=v_o t + \frac{1}{2} at^2$, $10 = \frac{1}{2}(3.0)t^2$ or t = 2.6 seconds. The free-body diagram is shown in the figure to the right.



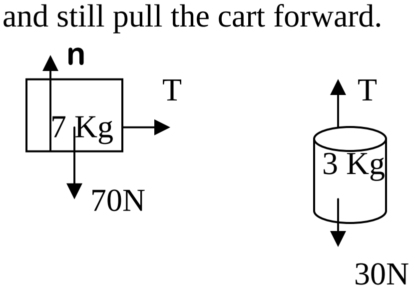
Homework Solutions page 6

1. ΣF_6 : 60N – T = 6Kg(a)
   ΣF_4 : T – 40N = 4Kg(a) These equations come from the diagrams below:

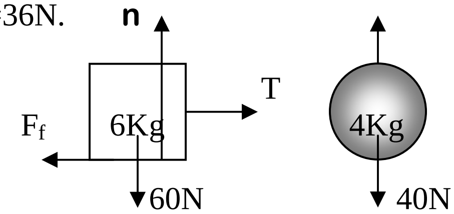


Adding the equations leads to 60N – 40N = 10Kg(a) or a=2m/s^2 and a tension of T = 48 N.

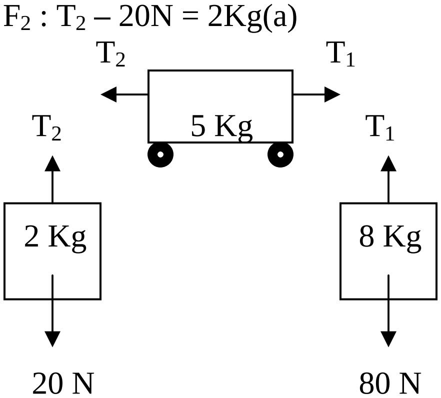
2. ΣF_3 : 30N – T = 3Kg(a)
   ΣF_7 : T – 0 = 7Kg(a)
   Adding the equations leads to 30N =10Kg(a) or a= 3 m/s^2. Subbing for the acceleration back into the equation for the forces on the 7 Kg object gives a value for Tension of 21 N. this is small enough to lower the 30N weight and still pull the cart forward.



3. ΣF_4 : 40N – T = 4Kg(a)
   ΣF_6 : T – 30N = 6Kg(a) The second term in the second equation comes from the use of $F_f = \mu\mathbf{n} = 0.5(60\text{N})$. The result of adding equations is 10N=10Kg(a) or a=1m/s^2. Subbing for the value of "a" gives a tension of T=36N.

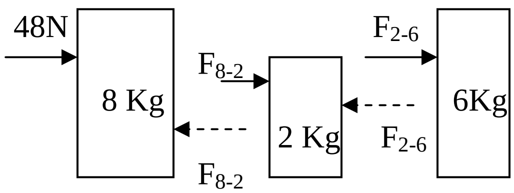


4. ΣF_8 : 80N – T = 8Kg(a)
   ΣF_5 : T – 30N – 24N = 5Kg(a) The second term in the 5 Kg equation is for the part of the weight parallel to the surface. The third term in 2nd equation is the friction found from $F_f = \mu\mathbf{n}$. By adding the equations, 26N=13Kg(a). The acceleration is 2m/s^2 and T=64N.
5. Use the same equations as before but take out the -24N friction term.
6. ΣF_8 :80N – T_1 = 8Kg(a)
   ΣF_5 : $T_1 - T_2$ = 5Kg(a)
   ΣF_2 : T_2 – 20N = 2Kg(a)

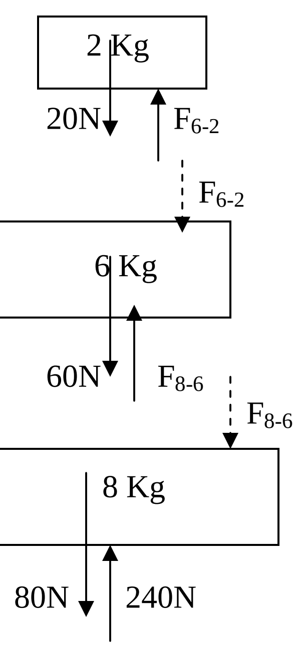


Homework Solutions for page 11

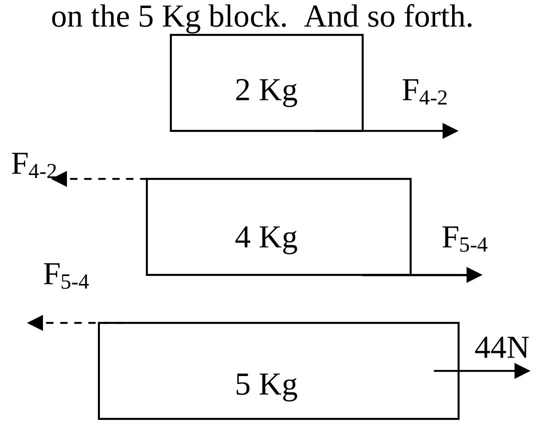
1. $\Sigma F_8 : 48N - F_{8\text{-}2} = 8Kg(a)$
   $\Sigma F_2 : F_{8\text{-}2} - F_{2\text{-}6} = 2Kg(a)$
   $\Sigma F_6 : F_{2\text{-}6} - 0 = 6Kg(a)$
   Summing these equations leads to $48N = 16Kg(a)$ and $a = 3\ m/s^2$. The force between the 2Kg block and 6Kg block is 18N. The force between the 8Kg block and 2Kg block is 24N.



2. These blocks will accelerate upward because the applied force is greater than the total weight of the system.
   $\Sigma F_8 : 240N - 80N - F_{8\text{-}6} = 8Kg(a)$
   $\Sigma F_6 : F_{8\text{-}6} - 60N - F_{6\text{-}2} = 6Kg(a)$
   $\Sigma F_2 : F_{6\text{-}2} - 20N = 2Kg(a)$
   Summing these equations leads to $240N - 160N = 16\ Kg(a)$; $a = 5\ m/s^2$
   By subbing the value for acceleration back into the other equations leads to $F_{6\text{-}2} = 30N$ and $F_{8\text{-}6} = 120\ N$.

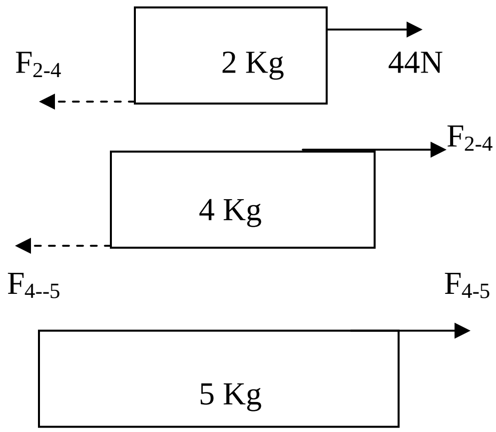


3. These blocks will accelerate downward because the applied force is less than the total weight of the system. Now the downward forces are positive
   $\Sigma F_8 : F_{8\text{-}6} + 80N - 128N = 8Kg(a)$
   $\Sigma F_6 : F_{6\text{-}2} + 60\ N - F_{8\text{-}6} = 6Kg(a)$
   $\Sigma F_2 : 20N - F_{6\text{-}2} = 2Kg(a)$
   Summing these equations leads to $160N - 128N = 16\ Kg(a)$; $a = 2\ m/s^2$
   By subbing the value for acceleration back into the other equations leads to $F_{6\text{-}2} = 16N$ and $F_{8\text{-}6} = 64\ N$. The free-body diagrams are the same as in #2 except for the reduced applied force.
4. The action-reaction pair of forces in this problem is the force of friction between the blocks. The friction at the top of the 5Kg block pulls the 4Kg block to the right. The reaction is that the 4Kg block pulls to the left on the 5 Kg block. And so forth.



$\Sigma F_2 : F_{4\text{-}2} - 0 = 2Kg(a)$
$\Sigma F_4 : F_{5\text{-}4} - F_{4\text{-}2} = 4Kg(a)$
$\Sigma F_5 : 44N - F_{5\text{-}4} = 5Kg(a)$
The sum of the equations leads to $44N=11Kg(a)$ or $a = 4\ m/s^2$. The force, $F_{5\text{-}4}$, has a value of 24N. This is the friction on the top of the 5Kg block that drags the 4Kg block to the right. The friction on the top of the 4 Kg block that pulls the 2Kg block along is 8 N. Using the $F_f = \mu \mathbf{n}$ with $F_f = 24N$ and $\mathbf{n} = 60N$ gives that $\mu \geq 0.4$ to prevent slipping.

5. .



ΣF_2 : $44N - F_{4\text{-}2} = 2Kg(a)$

ΣF_4 : $F_{2\text{-}4} - F_{4\text{-}5} = 4Kg(a)$

ΣF_5 : $F_{4\text{-}5} - 0 = 5Kg(a)$

In this case the top block drags the middle block forward while the middle block drags the bottom block forward. The acceleration is still $4 m/s^2$ if the blocks move without slipping; however, the friction coefficients must be larger to keep everything together. The friction between the top and middle blocks is $F_{2\text{-}4} = 36N$. The friction between the bottom and middle blocks is $F_{4\text{-}5} = 20$ N. To keep the top block from slipping off the middle block would require a coefficient of friction value of $\mu = 0.55$. To keep the middle block from slipping off the bottom block would require a coefficient of friction of $\mu = 20N/60N = 0.33$.

When using $F_f = \mu \mathbf{n}$ beware of using the correct value for the normal force. If you are considering the surface on top of the 4Kg block then the normal surface is 20N. If you are considering the surface between the 4Kg block and the 5Kg block then the normal force at that boundary is 60N since that surface is supporting that much weight.