PHYSICS HOMEWORK #21 **NEWTON'S LAWS**

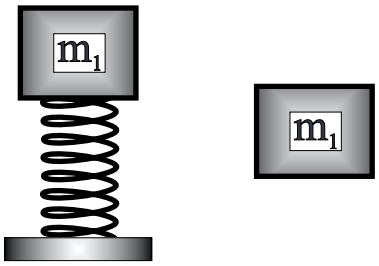
FIRST LAW OF MOTION

Newton's First Law of Motion

In the absence of an unbalanced, external force the velocity of an object remains constant!

1. For each of the following, complete the free body diagram showing all of the forces acting on the mass M. Be sure to show the direction of each force as an arrow and label each force clearly! [For example; T, F_N, F_f, F_g, F_a, F_s etc.]

a.



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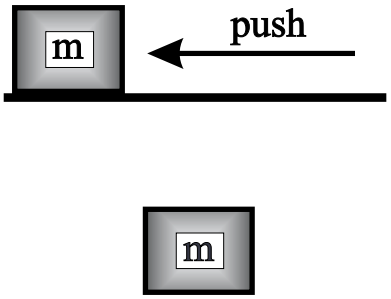

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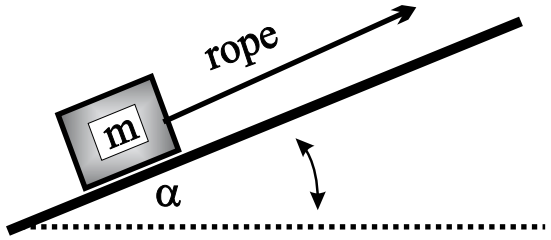

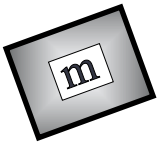

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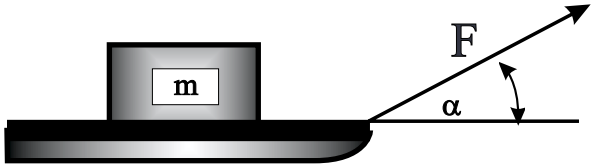
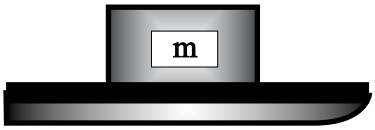
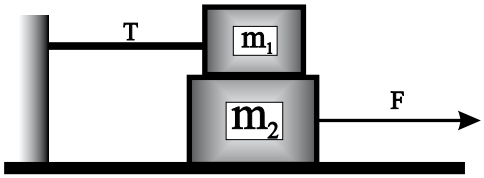




e.

f.



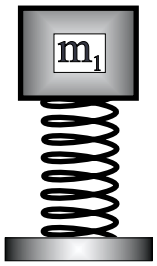
Answers to opposite side #2: 2a. 39.2 N 2b. 39.2 N 3. 539 N 4b. 539 N 4c. 539 N 4d. 85.0 N 5b. 361 N 5c. 253 N 6a. 49.0 N 6b. 49 N 6c. 8.0 N 7a. 16.4 N 7b. 7.32 N 8b. 277 N 8c. 147 N

PHYSICS HOMEWORK #22 NEWTON'S LAWS

FIRST LAW OF MOTION

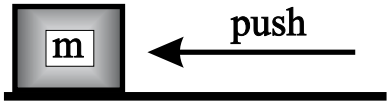
2. A 4.00 kg mass M is sitting at rest on top of a coil spring as shown to the right.
   a. What will be the weight of the 4.00 kg mass?
   b. How much upward force will be exerted on this mass by the spring?

Make a freebody diagram for EVERY problem!



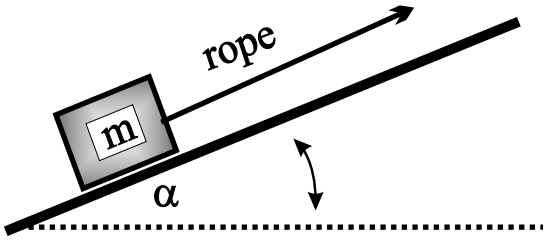
3. A crate, which has a mass of 55.0 kg. is being lifted straight up by a rope at a constant speed. What will be the tension in the rope?

4. A crate, which has a mass of 55.0 kg., is being pushed along a horizontal surface crate by a force of F = 85.0 Newtons so that the crate is moving to the left at a constant speed.

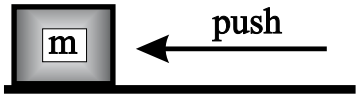


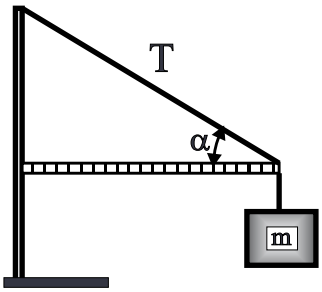
   a. Complete the free body diagram showing all the forces acting on the crate.
   b. What will be the magnitude of the normal force acting on this crate?
   c. What will be the magnitude of the gravitational force acting on the crate?
   d. How much frictional force will be acting on the crate as it is pushed along this horizontal surface at a constant speed?

5. A crate, which has a mass of m = 45.0 kg., is being pulled up a frictionless inclined plane, which meets the horizontal at an angle of $\alpha = 35.0^{o}$ relative to the horizontal, by a rope as shown to the right.
   a. Complete the free body diagram showing all the forces acting on the crate as it moves up the incline at a constant speed.
   b. What will be the magnitude of the normal force acting on the crate?
   c. What will be the magnitude of the tension T in the rope?



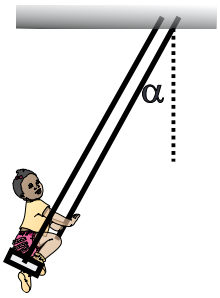
6. A 5.00 kg mass is sitting at rest on a horizontal surface. A horizontal force of F = 8.00 Newtons is applied to this mass so as to cause the mass to slide across the surface at a constant speed.
   a. What is the weight of this mass?
   b. How much upward force is being exerted on the mass by the surface of the table?
   c. What is the magnitude of the frictional force between the mass and the surface of the table?





7. A meter stick is supported from a ring stand as shown to the left where the angle between the meter stick and the supporting string is $\alpha = 24.0^{o}$ and where the tension in the string supporting the end of the meter stick is T = 18.0 N. [The left end of the meter stick is pivoted.]
   a. How much force F_h would be required to just pull the meter stick away from the ring stand?
   b. How much force F_v would be required to lift the end of the meter stick if the string is removed?

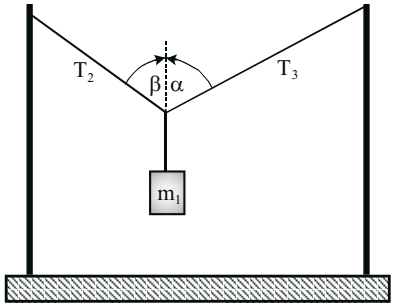
8. A child, who has a mass of 24.0 kg, is sitting on a swing as shown to the right. You pull the child back with a horizontal force F until the angle between the ropes of the swing and the vertical is $\alpha = 32.0^{o}$.
   a. Complete the free body diagram to the right showing all of the forces acting on the child.
   b. What is the tension in the ropes of the swing?
   c. What is the magnitude of the force F that you are applying to hold the child in place?

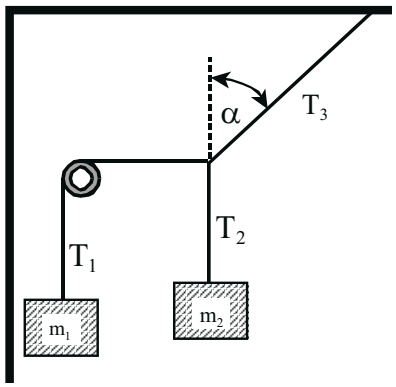


PHYSICS HOMEWORK #23 NEWTON'S LAWS

FIRST LAW OF MOTION

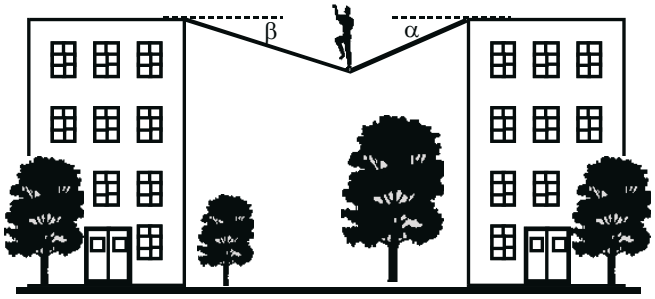
9. A string is tied between two support points as shown to the right. A mass of $m_1 = 3.80$ kg is hung from the string as shown. As a result the string makes an angle of $\alpha = 52.0^o$ and $\beta = 41.0^o$. What will be the tensions, T_2 and T_3, in the string?

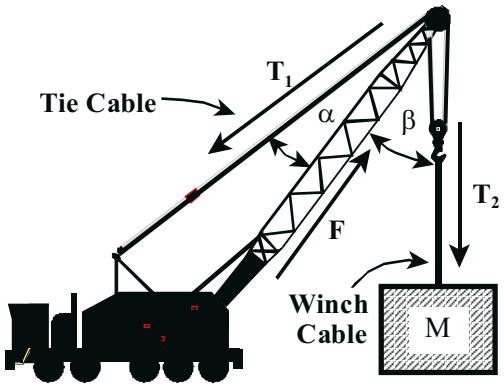




10. A string is tied to a hook in the ceiling. A mass of $m_2 = 6.00$ kg is hung from the end of this string such that the mass hangs from the ceiling. A second string is tied to the first string at a point. This second string is then threaded through a pulley as shown to the left and a second mass of $m_1 = 2.50$ kg is suspended from it.
    a. What will be the tensions in each of the three segments of string?
    b. What is the angle α shown in the diagram?

11. A tightrope walker, who has a mass of m = 65.0 kg., is walking along a tightrope stretched between two buildings. The walker is standing part way across the rope as shown. The angle between the rope and the roof of the left building is $\beta = 19.0^o$ while the angle between the rope and the roof of the right building is $\alpha = 28.0^o$. What will be the tensions T_1 and T_2 in each half of the rope?





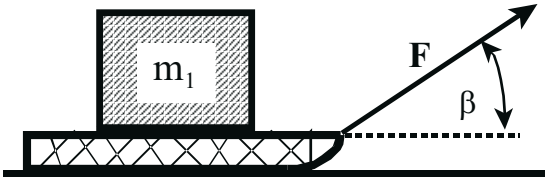
12. Consider a large crane which is being used to lift a heavy load of M = 18,000 kg. To the top of cabin of the crane there is attached a steel cable T_1 which is connected to the end of the boom. The angle between cable T_1 and the boom is $\alpha = 25.0^o$. A second cable T_2 has one end attached to the load while the other end of the cable is attached to a winch at the base of the cabin after passing over a large pulley at the upper end of the boom. The angle between cable T_2 and the boom is $\beta = 56.0^o$. The mass M is being lifted upward at a constant speed.
    a. What will be the tension T_2 in the cable lifting the load?
    b. What will be the tension T_1 in the tie cable?
    c. What will be the magnitude of the thrust force **F** being exerted by the boom?

Answers to opposite side: 13b. 275 N 13c. 226 N 13d. 115 N 14a. 49 N 14b. 23 N 14c. 0.59 14d. 0.47 15. 0.24 16. 223 N 17a. 221 N 17b. 194 N 17c. 171 N 18. 8830 N 19a. 63.2 N 19b. 408 N 19c. 71.6 N

PHYSICS HOMEWORK #24 NEWTON'S LAWS

FORCE OF FRICTION

13. A rope is being used to pull a sled along a horizontal surface at a constant speed with an applied force of F = 125 N as shown to the right. The sled, including the load, has a mass of m_1 = 28.0 kg. The angle between the rope and the horizontal is $\beta = 23.0^o$ as shown.



    a. Complete the free body diagram showing all the forces acting on the sled as it is pulled along this horizontal surface at a constant speed.
    b. What is the magnitude of the gravitational force acting on this sled as it is pulled to the right at a constant speed?
    c. What will be the magnitude of the normal force acting on this sled as it is pulled to the right at a constant speed?
    d. What will be the magnitude of the frictional force acting on the sled as it is pulled to the right at a constant speed?

14. A block of wood, which has a mass of m = 5.00 kg., is at rest on a horizontal surface. A spring scale is attached to a hook on the end of the block. The spring scale is slowly pulled until the block just begins to move. At this point the reading on the scale is 29.0 N. After the block starts sliding the reading on the scale drops back to 23.0 N.
    a. What is the magnitude of the normal force acting on this block?
    b. What is the magnitude of the frictional force on this block as it slides along the surface at a constant speed?
    c. What is the coefficient of static friction μ_s between the block of wood and the horizontal surface?
    d. What is the coefficient of kinetic friction μ_k between the block of wood and the horizontal surface?

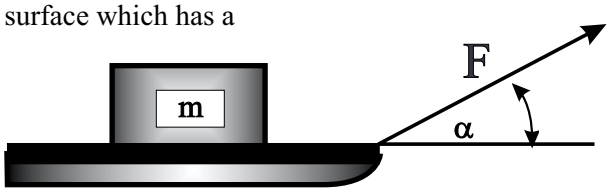
15. A 4.00 kg mass is sitting at rest on a horizontal surface. A horizontal force of 9.30 Newtons is needed to start this mass sliding across the surface. What is the coefficient of static friction μ_s between the mass and the surface of the table?

16. A 35.0 kg crate is sitting on a horizontal surface where the coefficient of sliding friction is μ_k =0.650. How much force must be applied to this crate in order to slide the crate across the surface at a constant speed?

17. A sled, which has a mass of m = 22.5 kg., is sitting on a concrete driveway. The coefficient of static friction between the sled and the driveway is μ_s =0.880 while the coefficient of kinetic friction is μ_k = 0.775.
    a. What will be the normal force acting on his sled?
    b. How much horizontal force must be applied to this sled in order to start it sliding across the driveway?
    c. How much horizontal force must be applied to keep this sled in motion along the driveway at a constant speed?

18. A car, which has a mass of 1250 kg., is moving along an icy highway at a speed of 35.0 mph. The coefficient of kinetic friction between the tires of the car and the road is μ_k = 0.720. The driver applies the brakes so as to lock the wheels. How much frictional force is available to bring the car to a halt?

19. A sled, which has a mass of m = 45.0 kg., is sitting on an icy horizontal surface which has a coefficient of kinetic friction of μ_1 = 0.155. A rope is attached to the front end of the sled such that the angle between the rope and the horizontal is $\alpha = 28.0^o$ and a force F is applied to the rope so as to pull the sled along the horizontal surface at a constant speed.

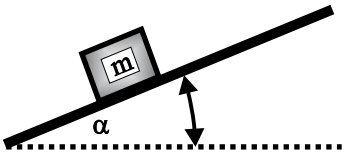


    a. What is the magnitude of the frictional force F_f acting on this sled?
    b. What is the magnitude of the normal force F_N acting on the sled?
    c. What is the magnitude of the force F applied to the rope of the sled?

Answers to opposite side: 9. 29.4 N, 24.5 N 10a. 24.5 N, 58.8 N, 63.7 N 10b. 22^o
11. 824 N, 769 N 12a. 176,000 N 12b. 346,000 N 12c. 412,000 N

PHYSICS HOMEWORK #25 NEWTON'S LAWS
FIRST LAW & FRICTION

20. A crate, which has a mass of 65.0 kg., is sitting at rest on an inclined plane as shown to the right. The angle between the incline and the horizontal is $\alpha = 13.0^o$.

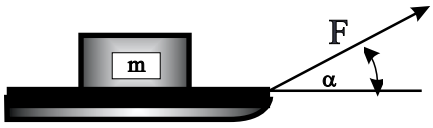


a. Complete the free body diagram showing all the forces acting on the crate.
b. What is the magnitude of the normal force acting on this crate?
c. What is the magnitude of the frictional force acting on this crate?

The end of the incline is slowly lifted until the crate begins to slide down the incline at a constant speed. At this point the angle between the incline and the horizontal is $\alpha = 34.0^o$.

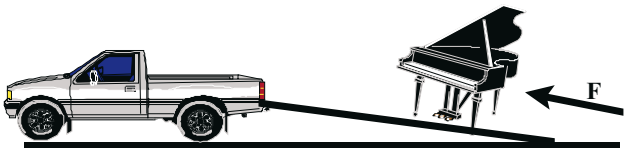
d. What is the coefficient of static friction between the crate and the surface of the incline?

21. A sled, which has a mass of m = 125 kg., is sitting on an icy horizontal surface. A rope is attached to the front end of the sled such that the angle between the rope and the horizontal is $\alpha = 33.0^o$ and a force of 95.0 N is applied to the rope. As a result the sled moves along the horizontal surface with a constant speed.

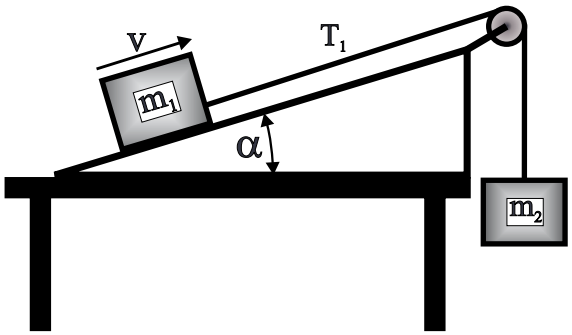


a. Complete the free body diagram showing all the forces acting on the sled.
b. What is the magnitude of the frictional force acting on this sled?
c. What is the magnitude of the normal force acting on the sled?
d. What is the coefficient of sliding friction between the sled and the icy horizontal surface?

22. You would like to push a piano, which has a weight of 550 lbs, onto the bed of a truck which has a height of 3.5 ft above the road surface. You have available a long inclined plane which is 15.0 ft long and which has a coefficient of rolling friction of $\mu_r = 0.220$. How much force F would you have to apply to roll the piano up the incline and onto the truck bed?



23. A mass of $m_1 = 6.00$ kg is sitting on an inclined plane, which meets the horizontal at an angle of $\alpha = 22.0^o$, as shown to the right. A string is attached to mass m_1, which is strung over a pulley, and is then attached to a second mass $m_2 = 4.00$ kg. A slight push is given to m1 and as a result m_1 slides up the incline at a constant speed v.

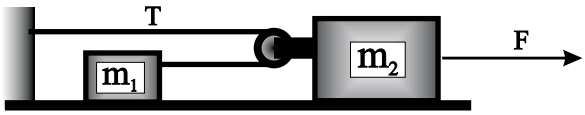


a. What is the magnitude of the tension T_1 in the string connecting the two masses?
b. What will be the coefficient of sliding friction m_k between mass m_1 and the surface of the incline?

Answers to opposite side #26: 24a. 143 N 24b. 40.8 N 25a. 0.683 25b. 46.9 N
26a. 14.9 N 26b. 64.9 N 27. 14.1 N 28. 809 N 29a. 1180 N 29b. 50,400 N

PHYSICS HOMEWORK #26 NEWTON'S LAWS
FIRST LAW & FRICTION

24. Two masses are sitting on a horizontal surface as shown to the right. The coefficient of sliding friction between these two masses and the horizontal surface is $m_k = 0.520$. A string is attached to the end of mas $m_1 = 8.00$ kg. This string is then looped around a pulley and is finally attached to the left vertical surface. The pulley is attached to mass m_2 12.0 kg as shown and then a force F is applied to m_2 such that m_2 moves toward the right at a constant velocity of 5.0 m/sec.

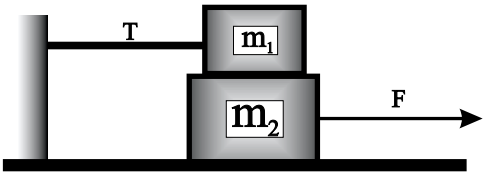


a. What will be the magnitude of the force F needed to pull mass m_2 to the right at a constant speed?
b. What will be the tension T in the string?

25. Two masses, $m_1 = 3.0$ kg and $m_2 = 7.0$ kg. are sitting on a horizontal surface as shown to the right. The two masses are attached together by a string in which the tension is T. A force F = 67.0 N is applied to the system so as to pull the two masses to the left at a constant speed.

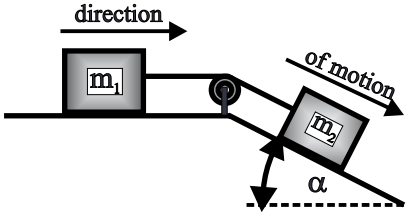
a. What will be the coefficient of sliding friction μ_k for this surface?
b. What will be the tension T in the string connecting the two masses together?

26. Two masses are arranged as shown. Mass m_1 has a mass of 4.00 kg and is attached to the vertical surface on the left with a string in which the tension is T. Mass $m_2 = 6.00$ kg, is sitting on the horizontal surface and is being pulled to the right by a force F so that m_2 is moving to the right at a constant speed. The coefficient of sliding friction between m_1 and m_2 is $\mu_1 = 0.380$ while the coefficient of sliding friction between m_2 and the horizontal surface is $\mu_2 = 0.510$.



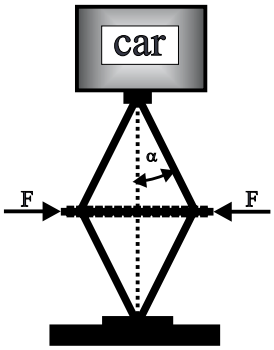
a. What will be the tension T in the string?
b. What will be the magnitude of the force F required to pull m_2 to the right at a constant speed?

27. In the diagram at the right $m_2 = 8.00$ kg. is sliding down the incline at a constant speed. m_1 is being pulled by a string attached between these two masses. The coefficient of kinetic friction between m_1 and the horizontal surface is $\mu_1 = 0.220$ while the coefficient of kinetic friction between m_1 and the incline is $\mu_2 = 0.380$. The angle between the incline and the horizontal is $\alpha = 42.0^o$. What is the mass of m_1 ?



28. The coefficient of kinetic friction between the tires of a car, which has a mass of 1650 kg., and the road is $\mu_k = 0.630$ while the coefficient of static friction is $\mu_s = 0.680$. How much more frictional force is available to the driver of this car when the car is NOT in a skid?

29. A scissors jack is a common configuration for a simple jack used to lift a car to replace a flat tire. The diagram at the left shows the basic configuration of such a jack. The force F is generally supplied by a screw which is turned by a lug wrench. Assume that the angle in the diagram is $\alpha = 15.0^o$.



a. What will be the magnitude of the force F required to lift a mass of M = 450 kg?
b. What will be the magnitude of the force F if the angle is $\alpha = 85.0^o$?

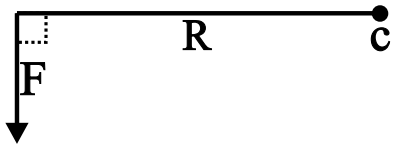
Answers to opposite side: 20b. 621 N 20c. 143 N 20d. 0.675 21b. 79.7 N 21c. 1170 N 21d.0.0679 22. 243 lb 23a. 39.2 N 23b. 0.315

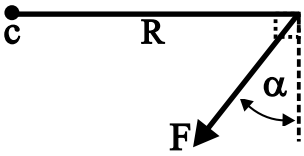
PHYSICS HOMEWORK #27 NEWTON'S LAWS

TORQUES AT EQUILIBRIUM

1. A force of 45.0 Newtons is applied at a right angle to a lever which is 1.50 meters long. What will be the magnitude of the applied torque?

2. A force of F = 54.0 Newtons is applied to a lever which is R = 42.0 cm long as shown in the diagram to the right. What is the magnitude of the applied torque?



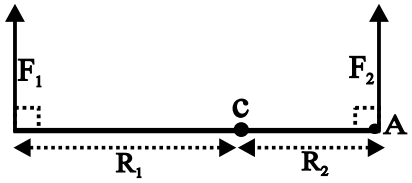


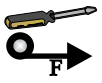
3. What will the magnitude of the applied torque in the diagram to the left where a force of F = 54.0 N is applied to a lever R = 1.25 meters long at an angle of α = 35.0°?

$$\textbf{\textit{Torque}} = \mathrm{T} = \boldsymbol{r} \times \boldsymbol{F} = |\boldsymbol{r}| \cdot |\boldsymbol{F}| \cdot \sin(\Theta)$$

4. How much force F would have to be applied perpendicularly to a lever arm of r = 88.0 cm. in order to generate a torque of 72.0 N m?

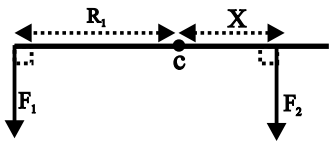
5. A force of F_1 = 22.0 N is applied at a distance of R_1 = 32.0 cm from the center of rotation as shown to the right. How much force must be applied at point A, which is R_2 = 16.0 cm from the center of rotation, in order to produce rotational equilibrium?



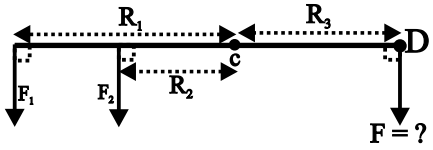


6. A screw driver has a handle which has a diameter of 3.50 cm. How much force F must be applied tangentially to the handle of the screwdriver to generate a torque of 7.00 Nm?

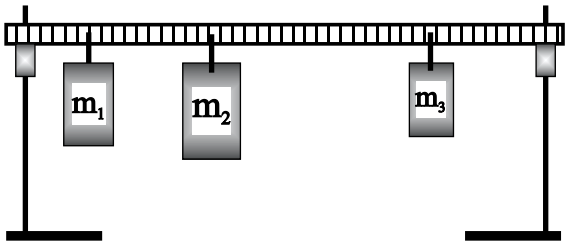
7. Where X in the diagram to the right should the F_2 = 84.0 N force be applied in order to balance the F_1 = 24.0 N force which is applied R_1 = 75.0 cm. from the center of rotation as shown?



8. How much force F should be applied at point D in the diagram below in order to produce rotational equilibrium in the diagram to the left where F_1 = 14.0 N, F_2 = 24.0 N, R_1 = 40.0 cm., R_2 = 18.0 cm. and R_3 = 34.0 cm.?



9. The diagram below shows a meter stick resting on two ring stands. Different masses are hung from the meterstick, which has a mass of 135 grams. A mass of m_1 = 250 gm is suspended from the meter stick at the 20.0 cm mark, a mass of m_2 = 500 grams is suspended from the 40.0 cm mark of the meterstick and m_3 = 150 grams is suspended from the 70.0 cm mark of the meterstick as shown.What will be the **magnitude** and **point of application** of the single **upward force** that can lift this meterstick? [Complete the diagram to the right & select a center of rotation!]

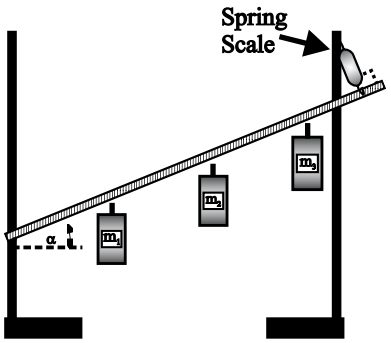


ANSWERS TO OPPOSITE SIDE : 10a. - 0.54 N m b. - 8.57 N m c. 8.57 N m d. 9.20 N 11. 175 gm 12. 96.3 lb 13. 5.50 N 14a. 9.02 N b. 0.673 m 15. left = 294 lb, right = 96.1 lb

PHYSICS HOMEWORK #28 NEWTON'S LAWS

TORQUES AT EQUILIBRIUM

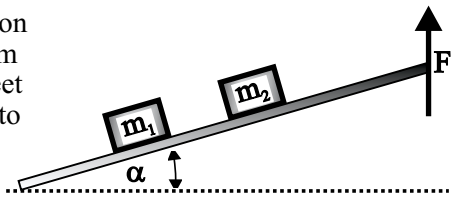
10. A meterstick is pivoted at one end by a nail inserted through the 2.0 cm mark. The angle between the meterstick and the horizontal is $\alpha = 24.0^{o}$. A spring scale is attached perpendicularly to the meterstick through a hole located at the 95.0 cm mark as shown. The mass of the meter stick is 125 grams, mass $m_1 = 200$ grams is hung from the 38.0 cm. mark, $m_2 = 700$ grams is hung from the 62.0 cm. mark and $m_3 = 500$ grams is hung from the 83.0 cm mark.



    a. What will be the magnitude of the torque exerted on the system by the weight of the meterstick?
    b. What will be the total clockwise torque acting on this system?
    c. What will be the total counter-clockwise torque acting on this system?
    d. What will be the reading on the spring scale?

11. A meter stick is suspended on a nail sticking through a hole drilled through the 50.0 centimeter mark. A mass of 250 grams is suspended from the 22.0 cm mark, a mass of 550 gm is suspended from the 65.0 cm mark and 150 gm is suspended from the 100 gm mark. How much mass should be suspended from the 0.0 cm mark in order to generate equilibrium? [Draw diagram!]

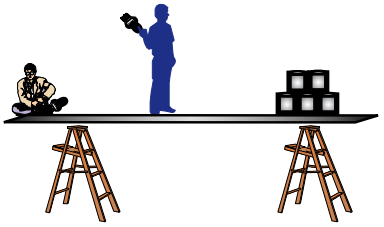
12. A board, which is 7.0 feet long and weighs 24 pounds, is sitting on the floor. Sitting on this board are two crates. The first crate weighs 115 pounds and is sitting 2.5 feet from the left end of the board while the second crate weighs 55 pounds and is sitting 1.5 feet from the right end of the board. How much upward force F would you have to apply to the right end of the board in order to lift that end of the board off of the floor?



13. A meterstick, which has a mass of 138 grams, has a nail through a hole drilled at the 100 cm mark. A mass of 150 grams is hung from the 82.0 cm mark, a mass of 550 gm is suspended from the 45.0 cm mark and a mass of 250 gm is suspended from the 35.0 cm mark. How much upward force must be applied at the 0.0 cm mark in order to achieve equilibrium? [Draw diagram!]

14. A mass of 220 gm is hung from the 25.0 cm mark of a meterstick, a mass of 475 gm is hung from the 95.0 cm mark and the weight of the meter stick is 2.20 N. [Draw diagram!]
    a. How much upward force would be required to keep this system at translational equilibrium?
    b. Where along the meterstick could you apply this force in order to generate rotational equilibrium?

15. A board , which is 14.0 feet long, is placed on the top of two stepladders as shown to the right. The weight of the board is 42 lb. One painter, who weighs 128 lb., is sitting on the left end of the board, while another painter, who weighs 155 lb., is standing 6.0 feet from the left end of the board. A stack of paint cans, which weigh 65 lb., sits 3.0 feet from the right end of the board. The ladders are each located 3.0 feet from the ends of the board. How much weight will each ladder have to support?



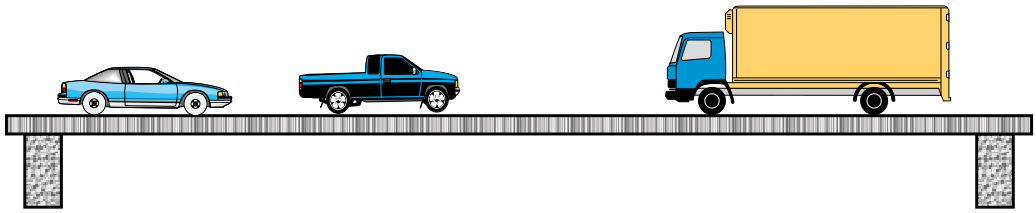
ANSWERS TO OPPOSITE SIDE: 1. 67.5 Nm 2. 22.7 Nm 3. -55.3 Nm 4. 81.8 N 5. 44.0 N 6. 400 N 7. 0.214 m 8. 29.2 N 9. 10.2 N up, 0.409 from left end

PHYSICS HOMEWORK #29

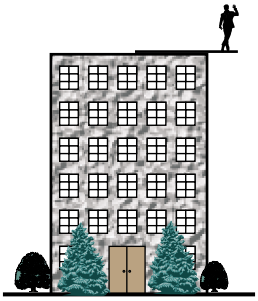
NEWTON'S LAWS
TORQUES AT EQUILIBRIUM

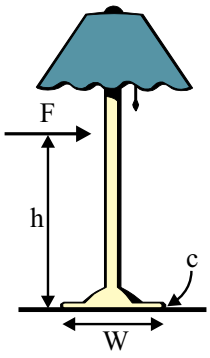
16. A metal bar, which is 4.50 meters long and has a weight of 450 N is suspended from a metal cable. A mass weighing 1250 N is suspended from the right end of the bar while a mass weighing 425 N is suspended from the left end of the bar. Assuming that this bar is at equilibrium, where must the cable be attached to the bar?

17. Consider a bridge which is 38 meters long, weighs 34 tons and is supported at each end by a concrete pier. The following vehicles can be found sitting on the bridge starting from the left; 4.0 meters a car weighing 2.2 tons, 12.0 meters a truck weighing 4.6 tons, and 27.0 meters a truck weighing 19.6 tons.
    a. How much upward force must be supplied by each pier to in order to support the weight of the bridge and the three vehicles?
    b. Where along the length of the bridge could a single upward force be applied so as to lift the bridge without tilting?
    c. What is the magnitude of the single upward force that could support the weight of this bridge?



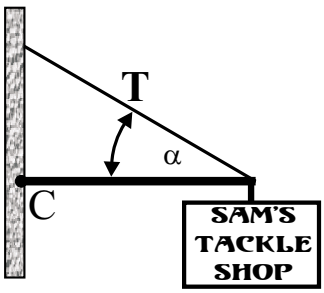
18. Suppose that you were on top of a building where there was a board which weighed 375 lb and was 18.0 feet long. The end of the board sticks out a distance of 7.00 feet beyond the edge of the building and the board is oriented perpendicularly to the edge of the roof. Assuming that you weigh 155 lb and you are going to "walk the plank", how far beyond the edge of the building will you be when you fall to your death on the pavement 325 feet below?





19. Consider the lamp to the left which has a mass of 3.80 kg and a base which has a width of W = 28.0 cm. The coefficient of friction between the base of the lamp and the floor is $\mu = 0.38$. A force F is applied to the lamp at a height of h = 33.0 cm. above the floor so as to slide the lamp across the floor at a constant speed.
    a. What is the magnitude of the frictional force acting on this lamp as it slides across the floor?
    b. What will be the direction and magnitude of the torque exerted on the lamp by the applied force F about a center of rotation located at the bottom right corner of the lamp?
    c. What will be the direction and magnitude of the torque exerted on the lamp by the weight of the lamp about the indicated center?
    d. What is the maximum height h above the base that you can exert the force F without the lamp tilting?

20. A sign hangs in front of a store as shown to the right. The sign consists of a bracket, which has a mass of 6.20 kg. and a length of 1.40 m., attached to the building and supported by a cable attached to the end of the bracket at an angle of $\alpha = 28.0^{o}$ The sign, which has a mass of 14.2 kg., is hanging from the end of the bracket as shown.
    a. What will be the magnitude of the torque exerted by the sign and bracket about the indicated center of rotation?
    b. What is the tension T in the cable?



Answers to this side: 16. 3.12 m from left end 17a. right = 27.8 tons, left = 32.6 tons b. 20.5 m
17c. 60.4 tons 18. 4.84 ft beyond edge of building 19a. 14.2 N b. 4.67 Nm c. 5.22 Nm d. 0.368 m left
20a. -238 Nm b. 361 N