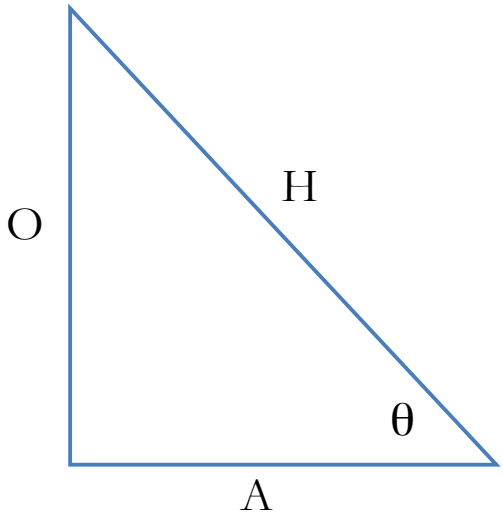
Balanced Force Particle Model Test

$W = F_g = mg$

$f = \mu N$



1. Newton's 1st Law (Balanced Forces)
   $\sum F = 0$

2. Newton's 2nd Law (Unbalanced Forces):
   $\sum F = ma$

3. Newton's 3rd Law (Action-Reaction):
   $F_{12} = -F_{21}$

SOH- CAH- TOA

$\sin \theta = O/H$

$\cos \theta = O/H$

$\tan \theta = O/H$

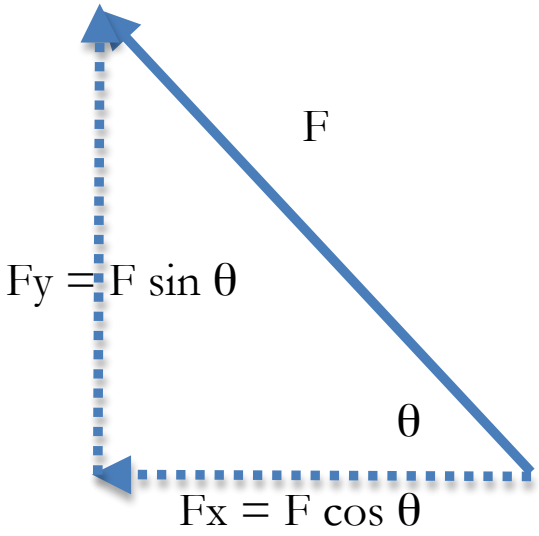
Kinematics Formulas:

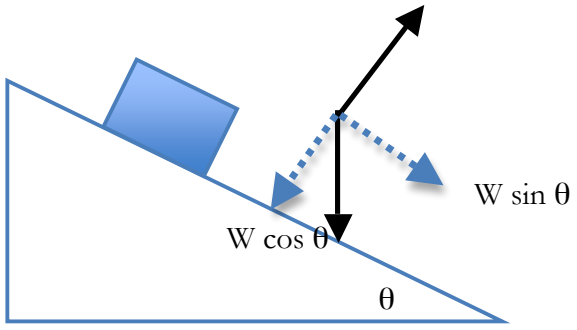
$x = \frac{1}{2} at^2 + v_0 t + x_0$

$v^2 = v_0^2 + 2a(x - x_0)$

$v = at + v_0$

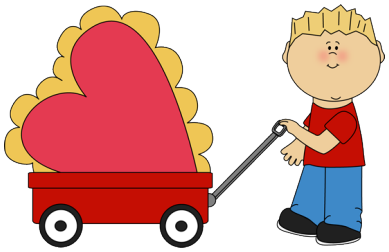
$g = 9.8 \text{ m/s}^2 = 9.8 \text{ N/kg}$



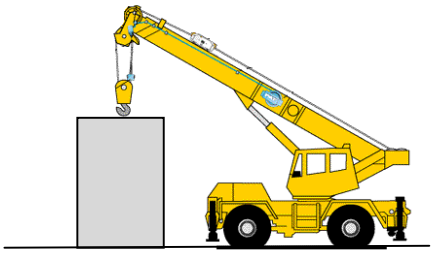


Study Guide:
These first four problems are balanced force problems. I want you to solve them to have you review

1. Show the forces acting <u>on the WAGON</u>. The boy is **PUSHING downward** on the handle and the wagon is moving at a constant speed.



2. A crane is attempting to lift a 2000 kg box. Even though the crane is pulling up with 4000N, the box is not moving. What normal force (in Newtons) is being provided by the ground?



A. Please number each sentence

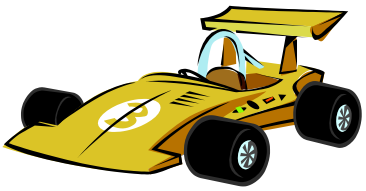
B. On your free body diagram please draw the number of the sentence that made you decide to draw the arrow that you drew.

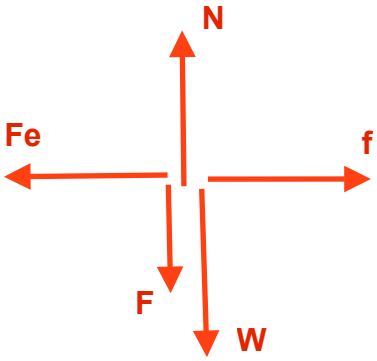
C. Please set up equations BASED ON YOUR FREE BODY DIAGRAM

D. Please solve the problem

answer: 15,600 N

3. Race cars have special wings that add an extra downward force from the air. This race car (500 kg) is gliding at a constant speed. The extra downward force from the effect of the wing is 1200 Newtons. The coefficient of friction between the road and tires is 0.6. What forward force must be applied by the engine to keep the car moving at a constant speed? (8 pts.)





A. Please number each sentence

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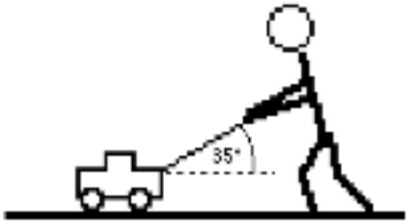
C. Please set up equations BASED ON YOUR FREE BODY DIAGRAM

D. Please solve the problem.

answer Fe = 3600 N

4. You push your lawnmower (mass = 15 kg) across the lawn at constant speed. To do so, you must exert 120 N of force on the handle. The handle makes a 35° angle with the horizontal. What is the coefficient of friction between the lawn mower and the ground? (8 pts.)



A. Please number each sentence

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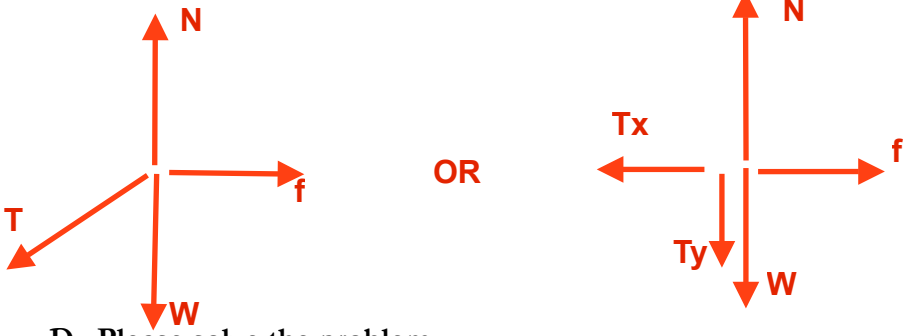
C. Please set up equations BASED ON YOUR FREE BODY DIAGRAM



D. Please solve the problem.

answer: $\mu = 0.46$

Elevator Lab Review:

(5.) If the elevator has an acceleration of 0.25 m/s^2 when it first **starts moving upward**, what is the normal force (*ALSO CALLED THE APPARENT WEIGHT*) on a 60 kg person?

answer: N = 603 N

N - W = ma
N - 60(9.8) = 60(0.25)
N = 588+15 = 603 N

(6.) If the elevator has an acceleration of 0.25 m/s^2 when it **approaches the top**, what is the apparent weight on that person?

answer: N = 573

N - W = ma
N - 60(9.8) = 60(-0.25)
N = 588-15 = 573 N

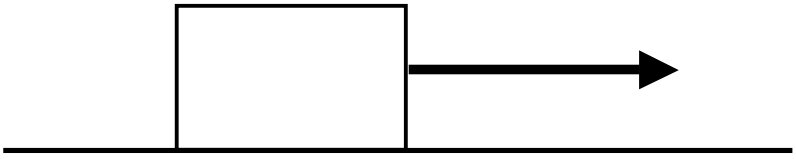
(7.) If the elevator has an acceleration of 0.25 m/s^2 when it **starts moving back downward**, what is the normal force on that person?

answer: N = 573

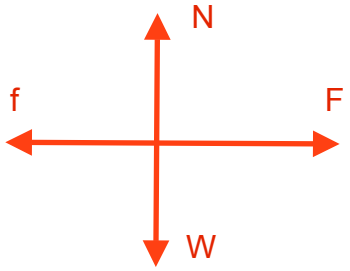
(8.) If the elevator has an acceleration of 0.25 m/s^2 when it **approaches the bottom**, what is the normal force on that person?

answer: N = 603 N

9. Old Problem: A 6 kg block is pulled on a rough surface as shown with a force of 9 N .



a) Draw a free body diagram of the block.



b) Suppose the static coefficent of static friction of the block is 0.3. Does the block move?

No it does not.

c) How much force is needed to pull the block?

17.64 N

10. New Problem: A 6 kg block is pulled on a rough surface as shown with a force of 60 N
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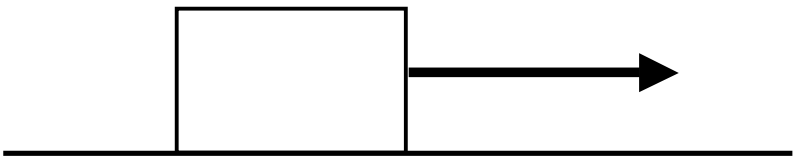


a) Draw a free body diagram of the block.

see problem 9a

b) Suppose the static coefficent of static friction of the block is 0.3. Does the block move?

Yes it Does

c) Suppose the coefficient of kinetic friction is 0.1, What is the acceleration of the block?

a = 9.02 m/s2

11. A person with a weight of 600 N rides on an elevator. When the elevator first moves the scale reads 650 N.

a. Draw a free body diagram of the person on the elevator. Make sure you draw the correct length of the arrows

b. What is the mass of the person? (hint: W = mg)

61.2 kg

c. What is the acceleration of the person?

0.82 m/s2

d. Which 2 things could the elevator be doing?

a. At the top and slowing down to a stop
b. At the top and starting to come back down speeding up
c. At the bottom and starting to move up
d. Returning to the bottom and slowing down.

e. Prove that your 2 choices are correct using free body diagrams

For the elevator to have normal force on the object bigger than the weight the acceleration must then be upward (in the direction of the force that "wins") Thus the elevator must be speeding up going up or else.

The second possibility is that this larger upward normal force is stopping the elevator as it goes down. it is bigger than the weight which is making it fall and thus stops the elevator at the bottom

12. A 4600 kg helicopter accelerates upward at 2.0 m/s2. Determine the lift force exerted on the propellers by the air. **Make a quantitative force diagram. Write a net force equation for the axis along which forces are not balanced.**

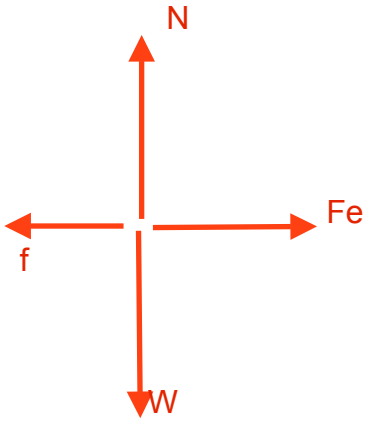
F = 54,820 N

13. The maximum force that a grocery bag can withstand without ripping is 250 N. Suppose that the bag is filled with 20 kg of groceries and lifted with an acceleration of 5.0 m/s2. Do the groceries stay in the bag? **Make a quantitative force diagram. Write a net force equation for the axis along which forces are not balanced.**

The force is 296 N.
The bag breaks

14. A race car has a mass of 650 kg. It starts from rest and travels 60.0m in 4.0s. The car is uniformly accelerated during the entire time.
   a) How big is the net force acting on the car?
   b) If the coefficient of friction as it moves is 0.2 What is the force of friction?
   c) Using the answers to a) and c) determine the force the engine applies to the car as it accelerates
   d) What is the difference between the net force acting on the car and the engine force acting on the car?

Make a quantitative force diagram. Write a net force equation for the axis along which forces are not balanced.



a) 4875 N

b) f = 1274 N

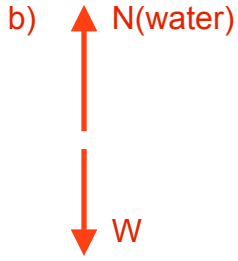
c) Fe = 6149 N

d) Net force is the total force that acts on the car. The Engine force is what the engine is producing. the net force is LESS because it is the engine force and whatever the friction "takes away"

15. . A 65 kg person dives into the water from the 10 m platform. a. What is her speed as she enters the water?
b. She comes to a stop 2.0 m below the surface of the water. Find the force on the swimmer by the water.

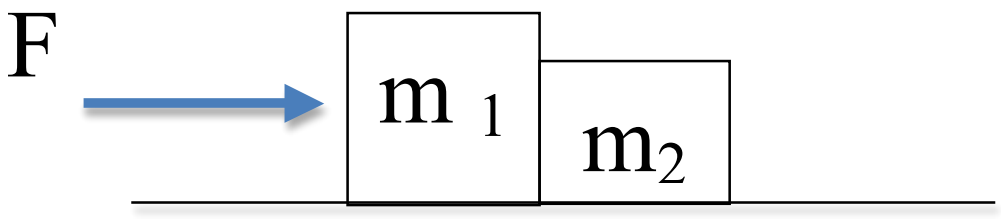
a) v = 14 m/s

b)

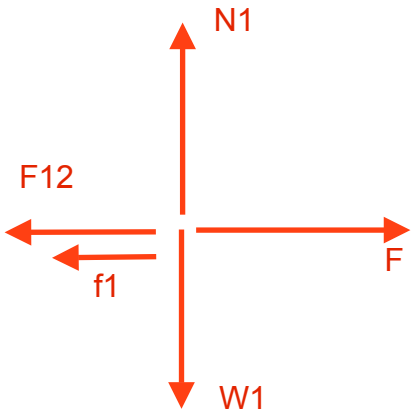


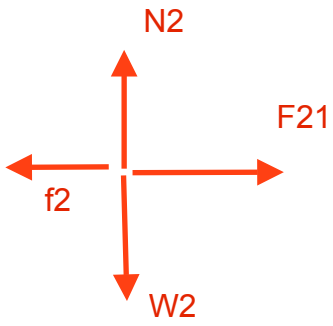
N(water) - W = 3185 N
N = 3822 N

16) m_1 = 8 kg and m_2= 4 kg F = 24 N



Determine the contact force between and the acceleration of the two boxes below, if the coefficient of friction is 0.1:





N1 = W1

F - F12 - f1 = m1• a

24 - F12 - 7.84 = 8• a

N2 = W2

F21 - f2 = m2 •a

F21 - 3.92 = 4 •a

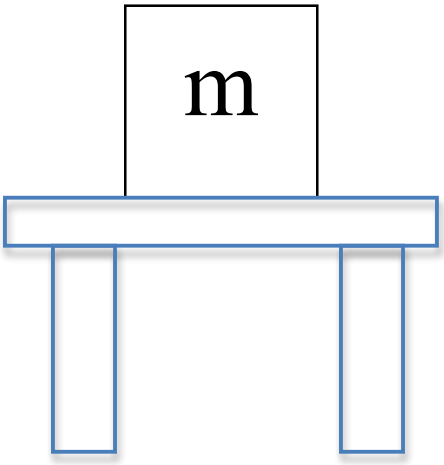
4•a + 3.92 = 16.16 - 8•a

12 a = 20.08

a = 1.67

F12 = F21 = 2.8N

17. Here is the situation: a box on a table. Draw the FBD of the box



What are the 3rd law pairs that need to be drawn on the objects below?

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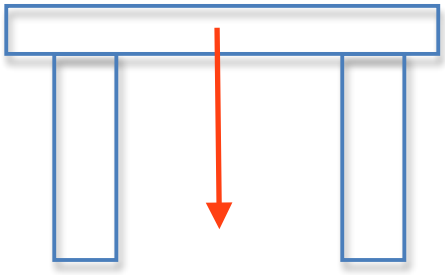

The next problems refer to the following situation.
A little boy hits a baseball which is initially at rest on a baseball tee. The bat is in contact with the ball for 0.1 sec and gives the ball a velocity of 10 m/s. The ball is hit forward in the positive direction.

18. What is the acceleration of the baseball while it is being hit?
(a.) a = 0.1 m/s^2
(b.) a = 0.01 m/s^2
(c.) a = 10 m/s^2
(d.) a = 100 m/s^2
(e.) a = 1000 m/s^2

19. If the mass of the ball is 0.11 kg, what is the net force the bat applies to the ball?
(a.) F_{net} = 0.14 N
(b.) F_{net} = 1.37 N
(c.) F_{net} = 14 N
(d.) F_{net} = 11 N
(e.) F_{net} = 137 N

(20.) A giant fly of mass m = 0.003 kg, is thrown against my 2500 kg car at a speed of 10 m/s as I travel down the highway. The fly hits the grill and and stops against it in 0.02 seconds. Answer the following questions. What final speed does my car reach assuming it was going 30 m/s before the fly hit it?

v = 29.9999 m/s. In other words the speed doesn't change