Force components and other dynamics stuff

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Please rename yourself

First name

Where you teach - High School, College, University

Country

Example:

Eugenia, University, USA

Materials for today’s meeting are in

Folder for the meeting

https://drive.google.com/drive/folders/1jNA1isK4ylWRT7W7N3kLNeRpt1xaYScu

ALG Chapter 4

OLG Chapter 4

Goals of Chapter 4 in CP: E&A (see Instructor Guide)

Students should be able to:

1. Explain the difference between a vector, vector component, and scalar components.
2. Find the scalar components of vectors in two dimensions.
3. Resolve the force that a surface exerts on an object into two vector components: parallel (the friction force) and perpendicular (the normal force) to the surface.
4. Apply Newton's second law to situations with multiple connected objects, objects on inclined planes, and objects on rough surfaces (problems involving friction).
5. Test Newton's second law experimentally.
6. Apply the independence of horizontal and vertical motions to analyze projectile motion situations.
7. Determine the coefficient of friction (static or kinetic) experimentally.
8. Apply Newton's laws to explain complex real-life situations.
9. Give examples of situations that cannot be explained using Newton's laws.

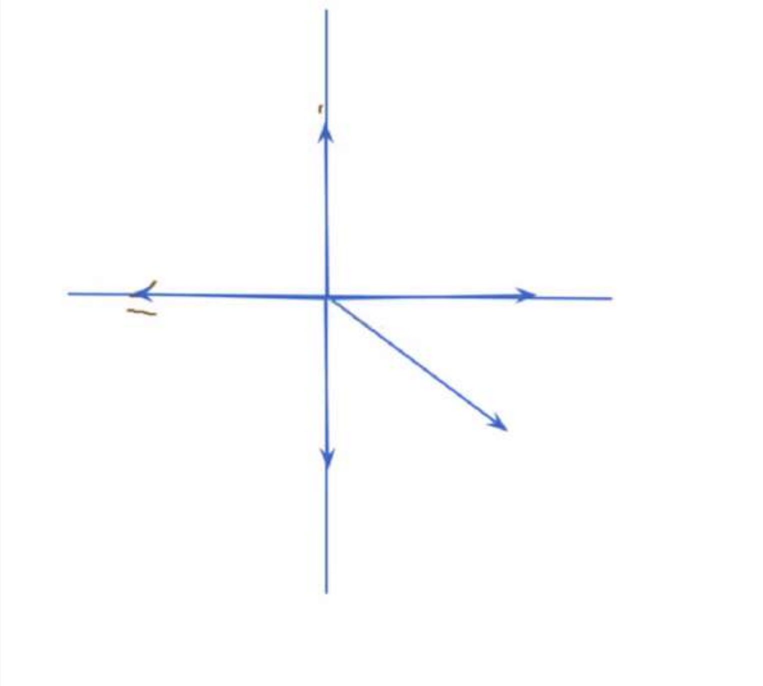
Need to know

Stand still on the floor. Then start walking. Just do one step and pay attention to what is happening to your feet.

Think of what object helps you accelerate and how does it do it? At the end of today you will be able to answer this question.

Team 1 OALG 4.1.1 and 4.1.2 [OALG Chapter 4]

a)

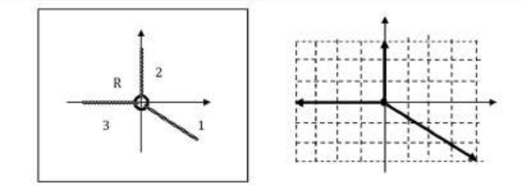


Team 2 OALG 4.1.1 and 4.1.2 OALG Chapter 4

1. Resolve into components.
2. Then analyze x and all forces in y direction.

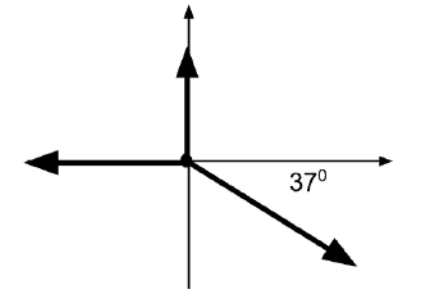
Team 3 OALG 4.1.1 and 4.1.2 OALG Chapter 4

a) The x- component of the 5N force is of the same magnitude as force 3 but in the opposite direction direction.
b) Same argument for y with string 2 force

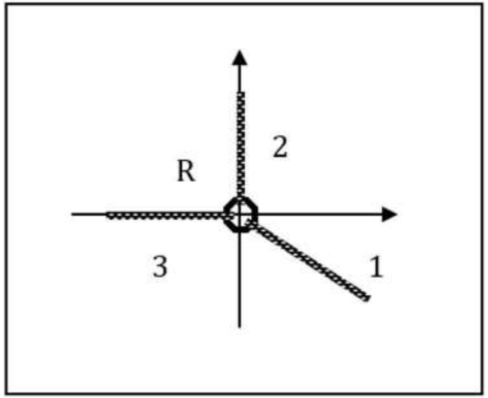


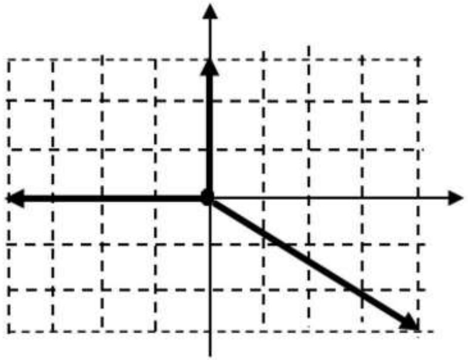
4.1.2

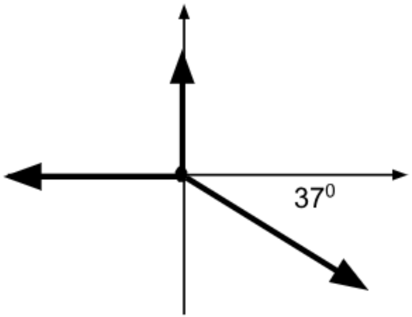
a) 5 cos (37) for x direction
b) 5 sin (37) - 3 (N)



Team 4 OALG 4.1.1 and 4.1.2 OALG Chapter 4





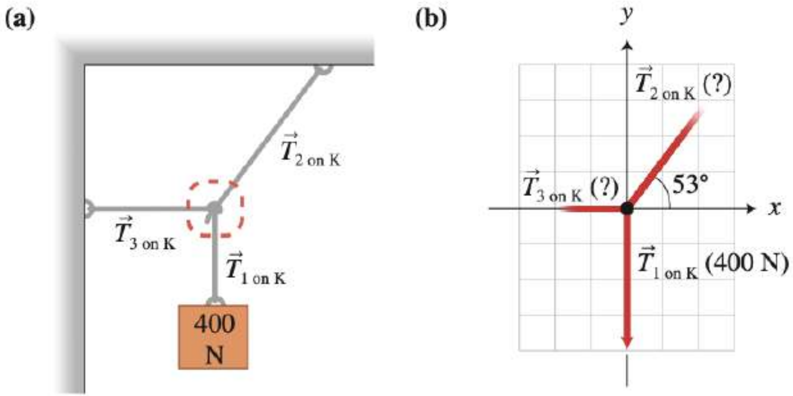


1. 1 force pointing up in the y direction for three units and a diagonal has a y component is pointing down 3 units. Cancelling each other out. This is true in the x direction also but 4 units instead of 3.
2. Create a right triangle and measure the length of the arrow and then find the cosine component using the angle. For the y component, would use the sine component.

Possible practice problems after that

6. * Three ropes pull on a knot shown in **Figure P4.6a**. The knot is not accelerating. A partially completed force diagram for the knot is show in Figure P4.6b. Use qualitative reasoning to determine the magnitude the forces that ropes 2 and 3 exert on the knot. Explain in words how you arrived at your answer.

FIGURE P4.6



7. * **Figure P4.7** shows an unlabeled force diagram for a hockey puck. The length of the sides of the square grid corresponds to a force magnitude of 1 N. Draw a similar square grid on paper and then draw the vector for the force that should be exerted on the puck so that the puck (a) moves with constant speed, (b) moves with constant acceleration toward the north, (c) moves with constant acceleration toward the west, and (d) m constant acceleration toward the east.

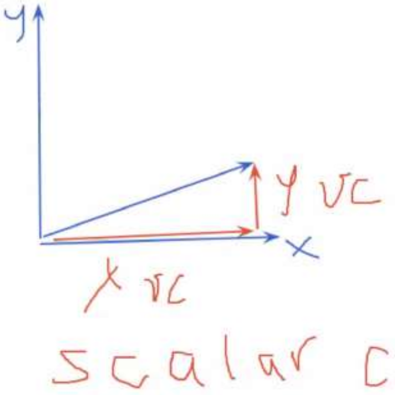
FIGURE P4

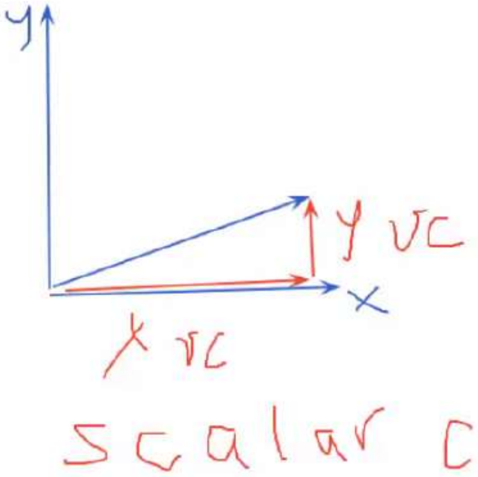
Time for telling: What was the purpose of those 2 activities?

Force vectors

Vector component of a force

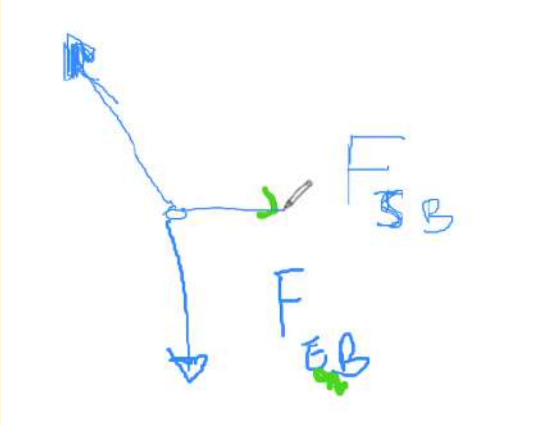
Scalar component of a force

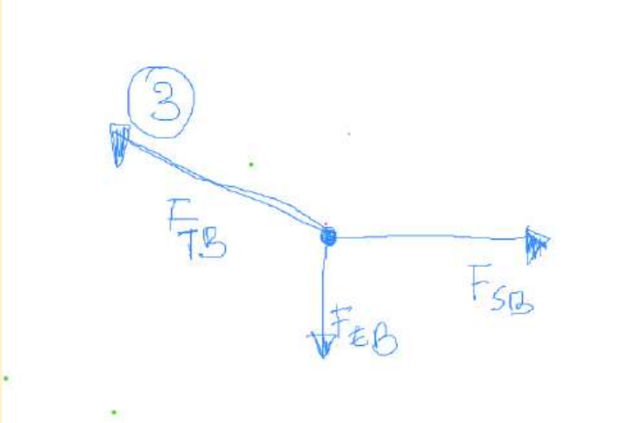


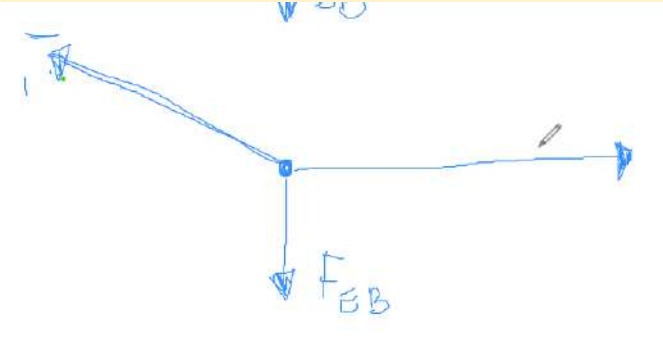


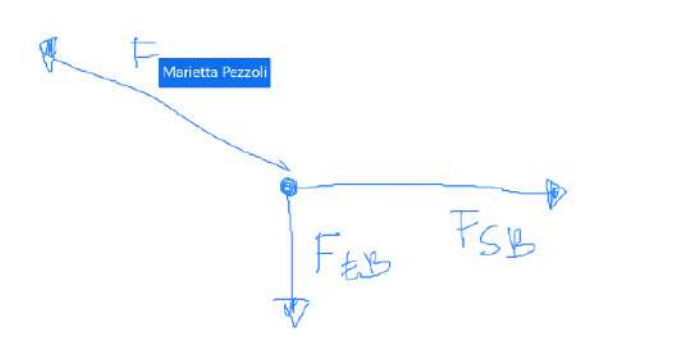
Team 1 OALG 4.3.1 and if finish early, 4.3.2

[OALG Chapter 4]()









Team 1 OALG 4.3.1 and if finish early, 4.3.2

OALG Chapter 4

Team 2 OALG 4.3.1 and if finish early, 4.3.2

OALG Chapter 4

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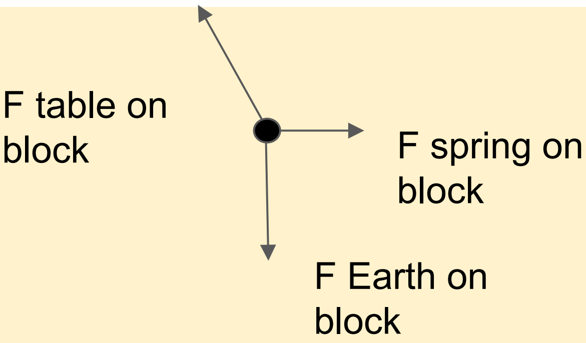
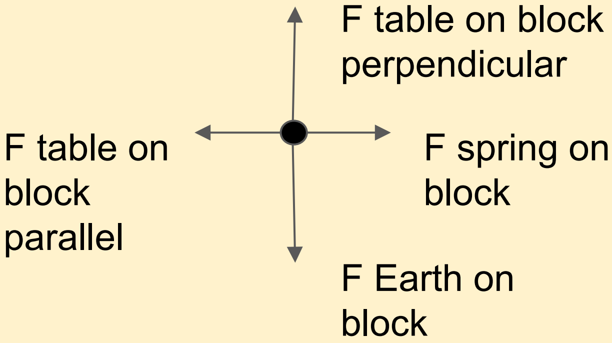
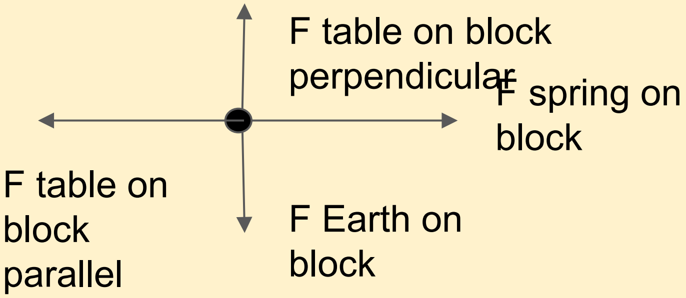
A spring scale pulls lightly on the block that is at rest on a horizontal surface; the block does not move.





The spring scale pulls harder on the block at rest on the horizontal surface; the block still does not move.



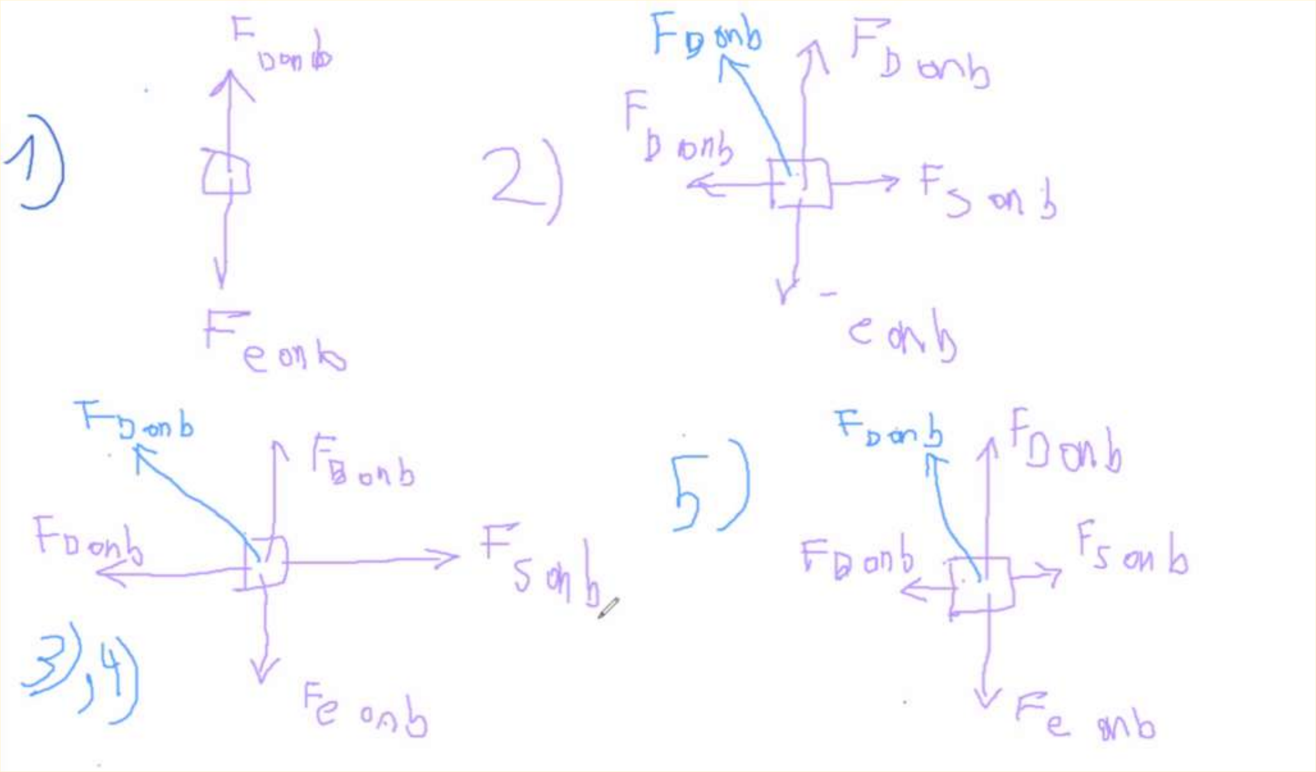
Team 2 OALG 4.3.1 and if finish early, 4.3.2

OALG Chapter 4

The spring scale pulls harder on the block at rest on the horizontal surface; the block still does not move.
The spring scale pulls even harder on the block at rest on the horizontal surface, right at the instant it starts to move.
The spring scale pulls the block at a slow constant velocity across the horizontal surface.

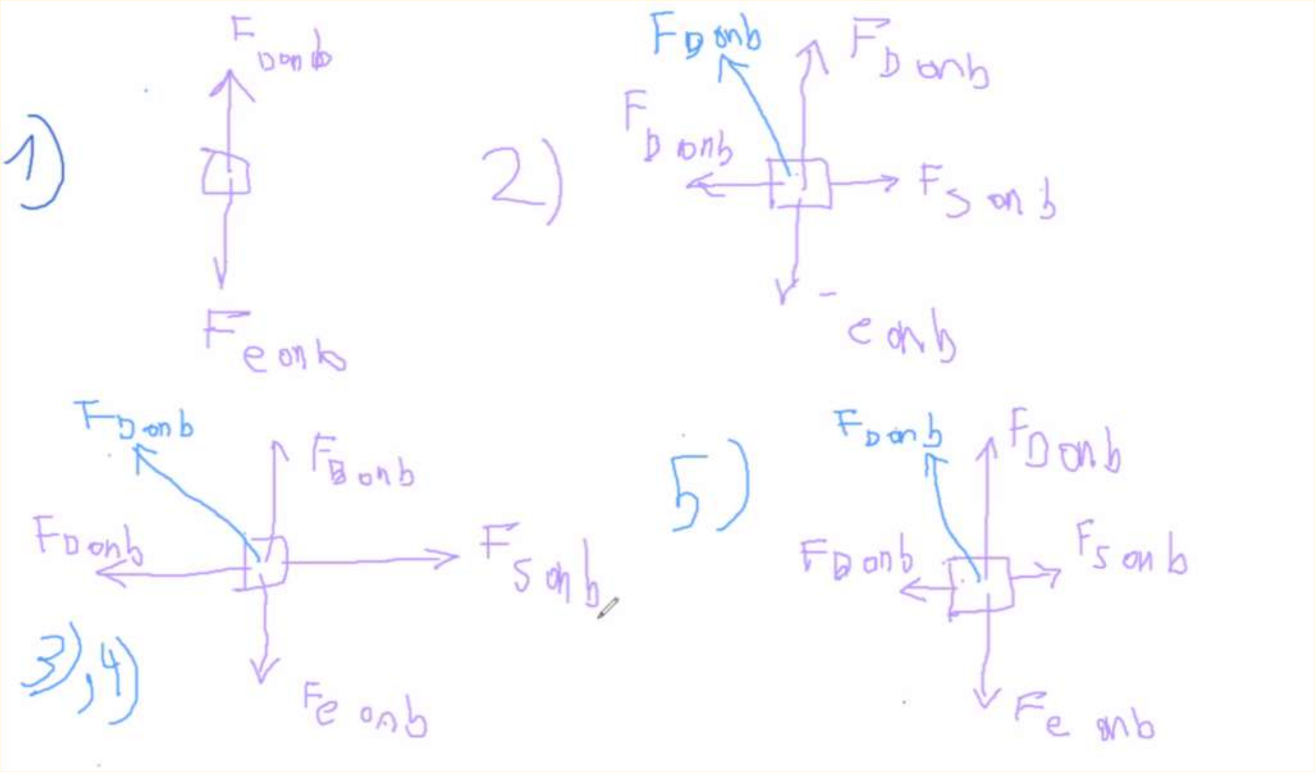
Team 3 OALG 4.3.1 and if finish early, 4.3.2

OALG Chapter 4



Team 3 OALG 4.3.1 and if finish early, 4.3.2

[OALG Chapter 4](#)

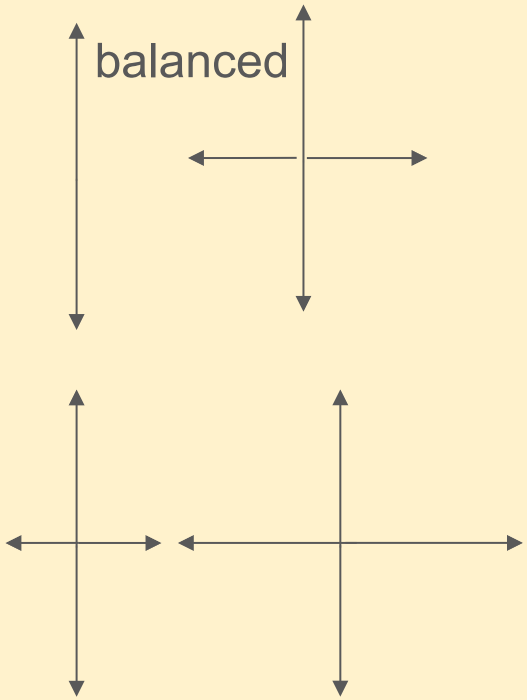


Team 4 OALG 4.3.1 and if finish early, 4.3.2

[OALG Chapter 4]

Forces are always

Observational experiments	**Force diagram for the block** Remember that each object interacting with the block exerts one force on it
A block is at rest on the horizontal surface of a desk.	
A spring scale pulls lightly on the block that is at rest on a horizontal surface; the block does not move.	
The spring scale pulls harder on the block at rest on the horizontal surface; the block still does not move.	
The spring scale pulls even harder on the block at rest on the horizontal surface, right at the instant it starts to move.	
The spring scale pulls the block at a slow constant velocity across the horizontal surface.	
Patterns	



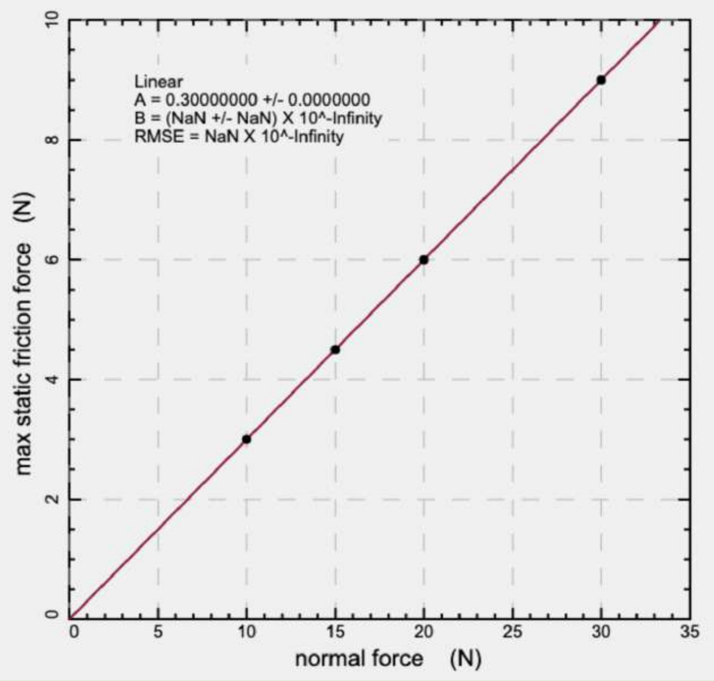
Time for telling: What was the point of these activities? What did you learn from them?

Team 1 OALG 4.3.3

a. Use the data in the table to draw a graph of the maximum static friction force versus the normal force exerted by the surface on the block.

b. Devise a mathematical relationship between the normal force components exerted by the surface and the maximum static friction force component exerted by the surface. *If you are having difficulties, read and interrogate Section 4.3 in the textbook, paying attention to Testing Experiment Table 4.3 and Equation 4.3 on page 93. Figure 4.6 is especially important for understanding the nature of the force that the surface exerts on an object on top of it.*

Extra downward force exerted on the 1-kg block	***N* exerted by the surface on the block, $N_{\text{s on b}}$**	**Maximum static friction force, $f_{\text{s on b}}$**
0 N	10 N	3 N
5 N	15 N	4.5 N
10 N	20 N	6 N
20 N	30 N	9 N



Team 2 OALG 4.3.3

a. Use the data in the table to draw a graph of the maximum static friction force versus the normal force exerted by the surface on the block.

b. Devise a mathematical relationship between the normal force components exerted by the surface and the maximum static friction force component exerted by the surface. *If you are having difficulties, read and interrogate Section 4.3 in the textbook, paying attention to Testing Experiment Table 4.3 and Equation 4.3 on page 93. Figure 4.6 is especially important for understanding the nature of the force that the surface exerts on an object on top of it.*

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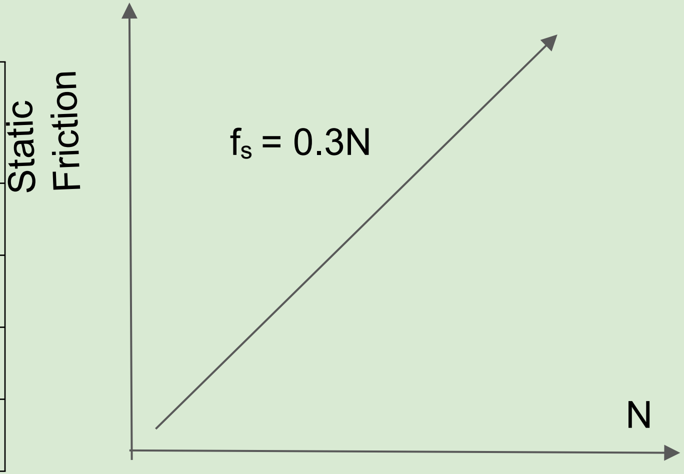
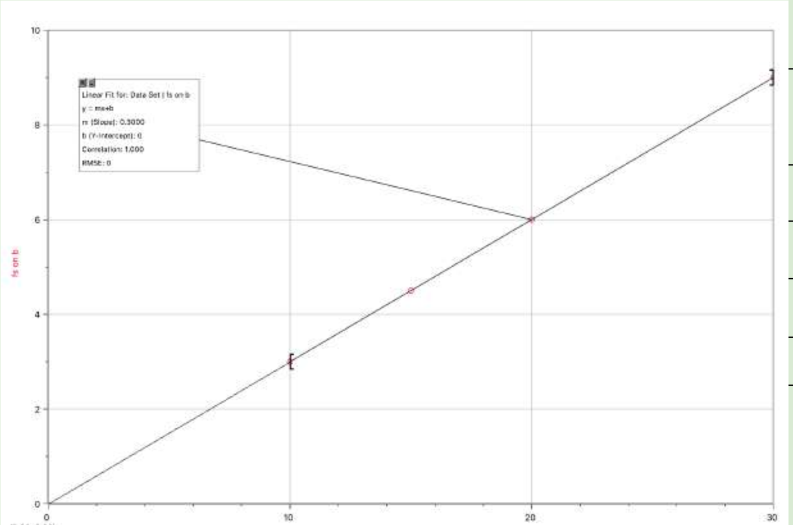


Team 3 OALG 4.3.3

a. Use the data in the table to draw a graph of the maximum static friction force versus the normal force exerted by the surface on the block.

B. N_s_b= constant f_s_on_b



Extra downward force exerted on the 1-kg block	***N* exerted by the surface on the block, $N_{s\ on\ b}$**	**Maximum static friction force, $f_{s\ on\ b}$**
0 N	10 N	3 N
5 N	15 N	4.5 N
10 N	20 N	6 N
20 N	30 N	9 N

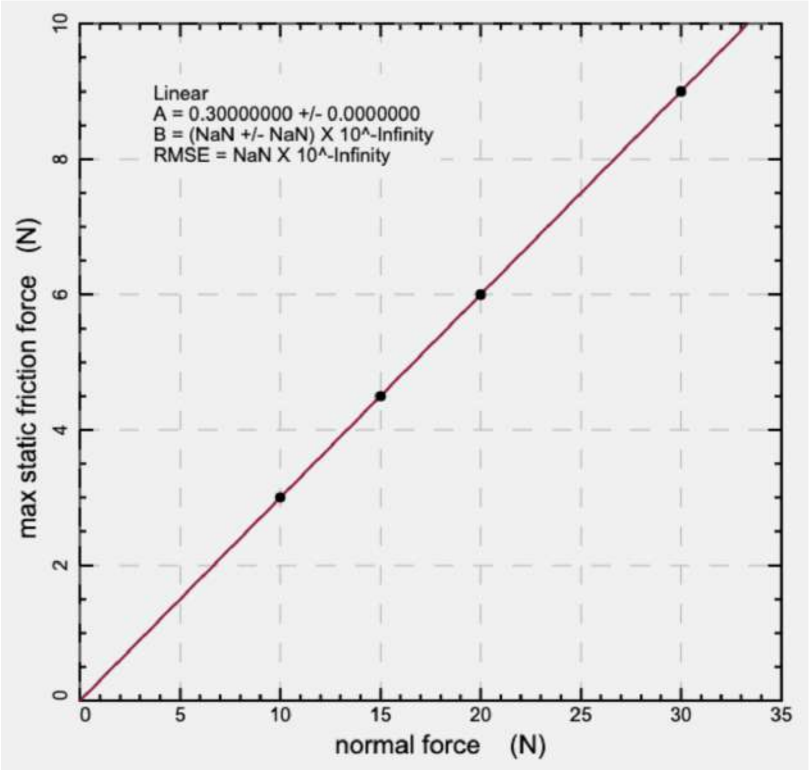
Team 4 OALG 4.3.3

a. Use the data in the table to draw a graph of the maximum static friction force versus the normal force exerted by the surface on the block.

b. Devise a mathematical relationship between the normal force components exerted by the surface and the maximum static friction force component exerted by the surface. *If you are having difficulties, read and interrogate Section 4.3 in the textbook, paying attention to Testing Experiment Table 4.3 and Equation 4.3 on page 93. Figure 4.6 is especially important for understanding the nature of the force that the surface exerts on an object on top of it.*

Sorry, we didn't get to take a screenshot before time ran out

Extra downward force exerted on the 1-kg block	***N* exerted by the surface on the block,** $N_{\text{s on b}}$	**Maximum static friction force,** $f_{\text{s on b}}$
0 N	10 N	3 N
5 N	15 N	4.5 N
10 N	20 N	6 N
20 N	30 N	9 N

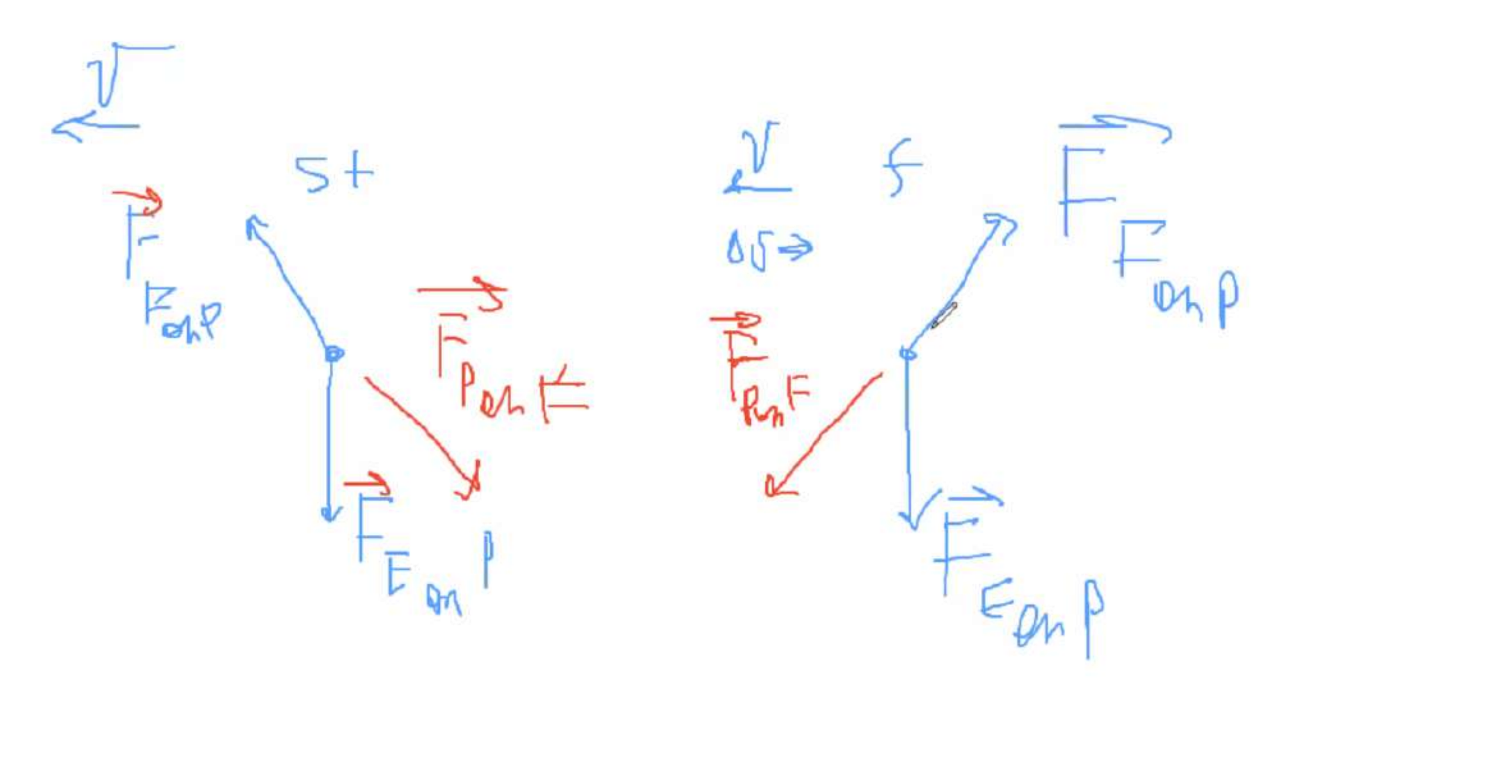

Linear
A = 0.30000000 +/- 0.0000000
B = (NaN +/- NaN) X 10^-Infinity
RMSE = NaN X 10^-Infinity
max static friction force (N)
normal force (N)
0
2
4
6
8
10
0
5
10
15
20
25
30
35

What would be our mathematical relation for the friction component of the force exerted by the surface on the system?

f_s = constant (N)

12. A box containing some stones is resting on a rough inclined surface. Which of the following actions will definitely *not* make the box start moving down the incline? Multiple answers could be correct.
   (a) Push the box in the direction that is down the incline.
   (b) Remove the box, polish the inclined surface with sandpaper, and put the box back.
   (c) Increase the angle of the incline.
   (d) Take some stones out of the box.
   (e) Put more stones into the box.
13. For the following two questions, the answer options are the same. Select two correct answers for each question from the list below.
   I. A box containing some stones is resting on a rough inclined surface. What do you need to do to increase the force of static friction exerted on the box?
   II. A box containing some stones is moving with constant acceleration down a rough inclined surface. What do you need to do to increase the force of kinetic friction exerted on the box?
   (a) Increase the angle of the incline.
   (b) Decrease the angle of the incline.
   (c) Put more stones into the box.
   (d) Take some stones out of the box.
14. A block is resting on a rough inclined surface. You observe that by increasing the angle of the incline, you can make the block start moving down the incline. Which answer best explains why the block starts moving?
   (a) By increasing the angle of the incline, you increase the component of the force exerted by Earth on the block, which pulls the block down the incline.
   (b) By increasing the angle of the incline, you decrease the maximum static friction force exerted on the block by the surface.
   (c) By increasing the angle of the incline, you simultaneously increase the component of the force exerted by Earth on the block and decrease the maximum static friction force exerted on the block.

Team 1 OALG 4.3.5 [OALG Chapter 4]



Team 2 OALG 4.3.5 [OALG Chapter 4]

Team 3 OALG 4.3.5 OALG Chapter 4

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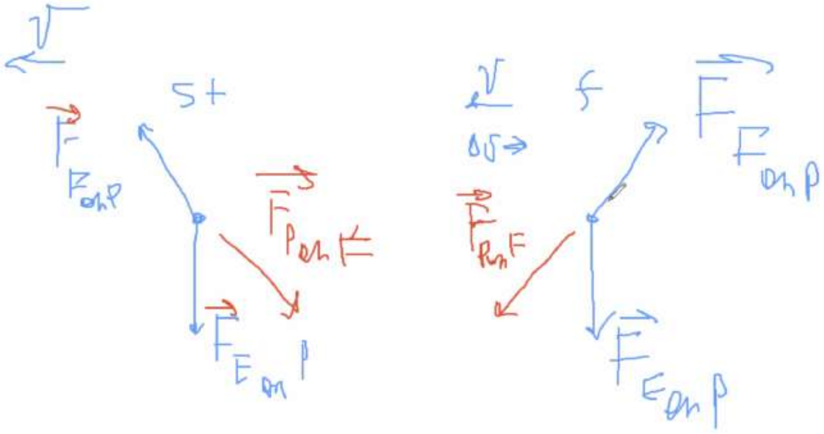
Team 4 OALG 4.3.5 OALG Chapter 4

Back to the need to know - all together

How do we walk?

Draw a force diagram for the foot that starts the step (back foot) and for the foot that stops the step (front foot)



Together Variation of ALG 4.5.1

OALG 4.5.1 Observe and find a pattern

[https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-4-5-1]

a. Observe the motion of the ball and the cart and describe what you observe in simple words.

b. Observe the motion of the cart with respect to the floor. Describe the motion of the cart relative to the floor.

c. Observe the motion of the ball with respect to the cart. (It is helpful if you can view your video frame by frame.) Describe the motion of the ball relative to the person.

d. Observe the motion of the ball with respect to the floor. What pattern do you see? What can you say about the motion of the ball and the cart with respect to each other that is always true?

e. Come up with an explanation for the direction of the throw that lets the ball land successfully in the cart.

Together ALG 4.5.1 (variations of kinesthetic activities and videos, benefits and drawbacks)

OALG 4.5.1 Observe and find a pattern

http://islevideos.net/experiment.php?topicid=2&exptid=95

If you have a ball (or any object you can throw up and catch) at home, try to do this experiment yourself first . The goal of the experiment is for you to run at constant speed and throw the ball up while running so that the ball lands in your hands when it comes back down. If you have a friend at home, they can take a video of the experiment (as soon as you do it successfully.) Then, carefully analyze the motion of the ball. If you do not have a ball or room to run, use the video above.

a. Observe the motion of the ball and the person, and describe what you observe in simple words.

b. Observe the motion of the person with respect to the floor. Draw a motion diagram representing the motion of the person. Describe the motion of the person relative to the floor.

c. Observe the motion of the ball with respect to the person. (It is helpful if you can view your video frame by frame.) Draw a motion diagram representing the motion of the ball with respect to the person. Describe the motion of the ball relative to the person.

d. Observe the motion of the ball with respect to the floor. What pattern do you see? What can you say about the motion of the ball and the person with respect to each other that is always true? Draw a motion diagram representing the motion of the ball relative to the floor.

e. How is the motion diagram you constructed in part d. related to the motion diagrams in parts b. and c.? Is there a relationship? What is it? Come up with an explanation for the direction of the throw that lets the ball land successfully in the runner's hands.

All together ALG 4.5.2

4.5.2 Test your idea

Lab: *Equipment per group:* whiteboard and markers, small balls, projectile launcher, meter stick.

a. Work with the members of your group to design an experiment to test the explanation that you devised in Activity 4.5.1 part e.

b. Once you have designed the experiment, make a prediction of the outcome based on the explanation under test and write it on the whiteboard. Is the prediction based on the explanation?

c. Conduct the experiment and record the outcome.

d. What is your judgment about the explanation you were testing?

Dribble a basketball while walking or running. Only push the ball straight down and see if it comes back up to meet your hand or if it falls behind as you walk/run

All together ALG 4.5.3

4.5.3 Test an idea

***PIVOTAL Class:** Equipment per group:* whiteboard and markers.

You friends came up with an idea to explain the patterns in their experiments in Activity 4.5.1. They said that the runner needed to throw the ball exactly upwards with respect to herself because the vertical and horizontal motions of the ball are independent of each other. Use this explanation to predict the outcome of the following experiment, then watch the video, describe the outcome, and draw a conclusion about the explanation.

Testing experiment	**Prediction**	**Outcome**
At time zero, ball 1 is dropped. Simultaneously, ball 2 is shot horizontally when a compressed spring is released. Which ball hits the surface first? [See the figure in the Testing Experiment Table 4.6, page 103 in the textbook.]	Make sure you draw motion diagram(s) on your whiteboard to justify the prediction in terms of the idea you're testing	[https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-4-5-3]
Conclusion		

What did you learn today?

Kinesthetic activities for figuring out what happens when walking

Importance of the sequence: let students explore and, explain, and only then move to to traditional problems

The role of friction in walking: Pushing back when you start(static and KE) and pushing forward when you stop KE and static) walking.

Grids for components! Difference between vector components and scalar components of a vector.

Components of force help students relate to the component in projectile motion

I learned to first introduce the interaction between an object and a surface as a single force and then show how to model it as perpendicular components called normal and friction (perpendicular and parallel to the surface).

The importance of one force on force diagram for each object interacting with our chosen object. Move projectile motion later so you can use forces to explain it!

Friction and normal force are vector components of one force (e.g. from desk on block)

Something I learned– introduce vector components first using a grid and simple experiment ideas for demonstrating the independence of vertical and horizontal motion. Something I will remember –stay strong in not introducing normal force and friction until 2-D dynamics & waiting to introduce projectile motion until this unit.

Friction and normal force as a component of force of the table on the object.