Force components and other dynamics stuff

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Materials for today’s meeting are in

Folder for the meeting

E&AP meeting October 2022 2D dynamics

ALG Chapter 4 file is

ALG Chapter 4

OALG Chapter 4 file is

OALG Chapter 4

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 [OALG Chapter 4]

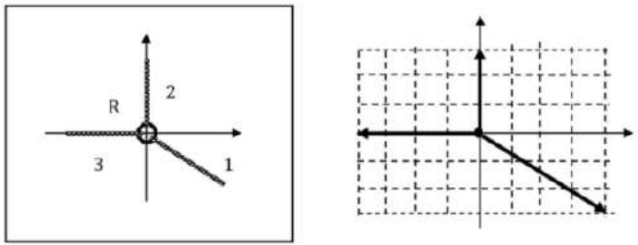
a) The x-component of force 1 is equal in module to x component

of force 3. The net force on the ring in x component is zero.

a) The same for y-direction.The net force on the ring in y component is zero.

a. Based on what you see in the force diagram, explain why the ring does not accelerate in the positive or negative *x*-direction. Be explicit.

b. Repeat the same for the *y*-direction.

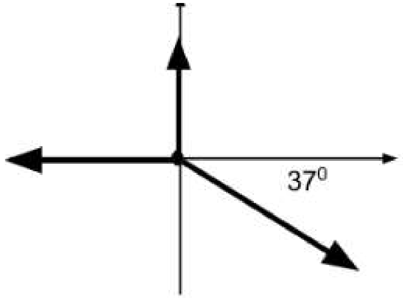


Team 1 OALG 4.1.2

a)through the goniometric functions

b) Fx(1 on R)=5 N*cos(37°) ; Fy(1 on R)=5N*sin(37°) The magnitude of the other force are the same.

The sketch on the right shows the same three strings pulling on the ring as in the previous activity. However, an angle is now shown for the pulling direction of string 1 relative to the x-axis.



a. How could you calculate the effect of string 1 pulling in the x-direction?

b. How could you calculate string 1's effect pulling in the y-direction? That is, how could you calculate the x- and y-components of $\vec{F}_{1 \text{ on } R}$ if you know only the magnitude of the force (5 N) and the direction of the force relative to the x-axis ($37°$ below the positive x-axis)? What are the magnitudes of the other two forces?

Team 2 OALG 4.1.1 and 4.1.2 OALG Chapter 4

4.1.1 part a. force 3 goes 4 units/squares to the left, force 2 does not have any units/squares in the x direction, and force 1 goes 4 units/squares to the right, and so the sum of force is 0 in the x direction.

part b. force 3 goes 0 units/squares in the y direction, force 2 goes 3 units/squares up, and force 1 goes 3 units/squares down, and so the sum of force is 0 in the y direction.

4.1.2 part a. String 1 has a force in the x-direction that equals the magnitude of F1 times the cosine 37 degrees. This will equal the magnitude of F3.

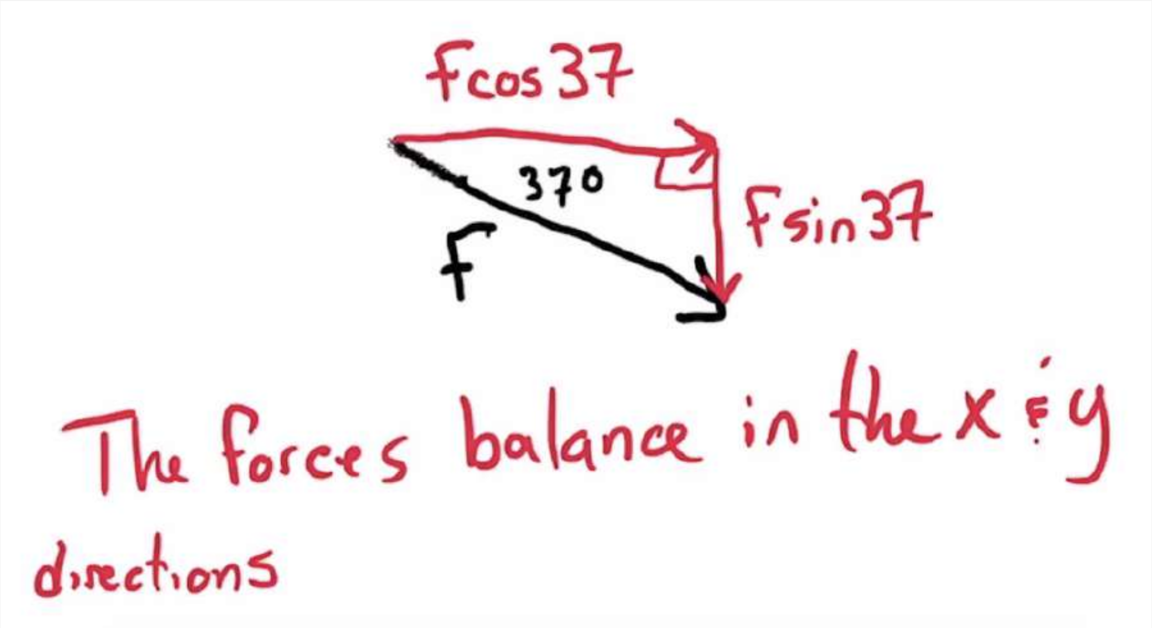
Part a. String 1 has a force in the y-direction that equals the magnitude of F1 times the sine of 37 degrees. This will equal the magnitude of Fd.

Team 3 OALG 4.1.1 and 4.1.2 [OALG Chapter 4]

4.1.1 a) The forces in y direction balances out (number of boxes downwards the same as upwards)

b) The forces in x direction balances out (number of boxes left the same as right)

4.1.2



Team 4 OALG 4.1.1 and 4.1.2 OALG Chapter 4

What was the purpose of those 2 activities?

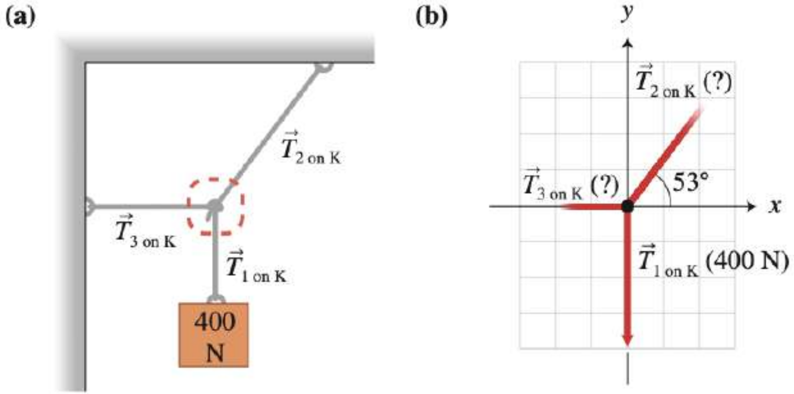
To show how to find the components of the vectors

The grid is a “bridge” to help students understand/ease into components.

Possible practice problems after that

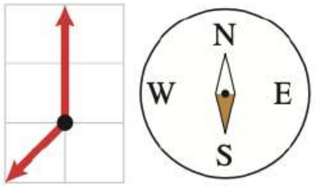
6. * Three ropes pull on a knot shown in **Figure P4.6a**. The knot is not accelerating. A partially completed force diagram for the knot is shown in Figure P4.6b. Use qualitative reasoning to determine the magnitudes of the forces that ropes 2 and 3 exert on the knot. Explain in words how you arrived 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) moves with constant acceleration toward the east.

FIGURE P4.7



Team 1 OALG 4.3.1 and if finish early, 4.3.2

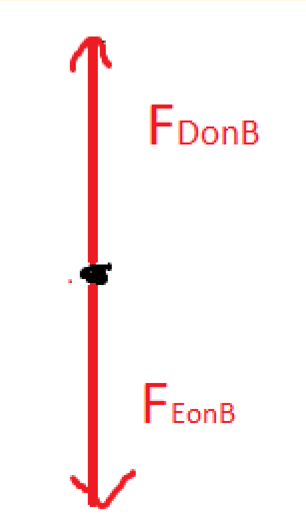
OALG Chapter 4

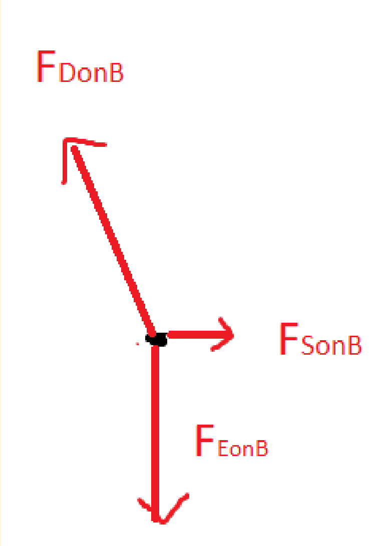
Observational experiments	**Force diagram for the block** Remember that each object interacting with the block exerts one force on it
A block is at rest on the horizontal surface of a desk.	
A spring scale pulls lightly on the block that is at rest on a horizontal surface; the block does not move.	

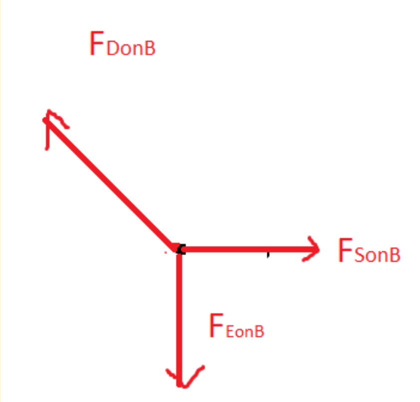
Team 1 OALG 4.3.1 and if finish early, 4.3.2

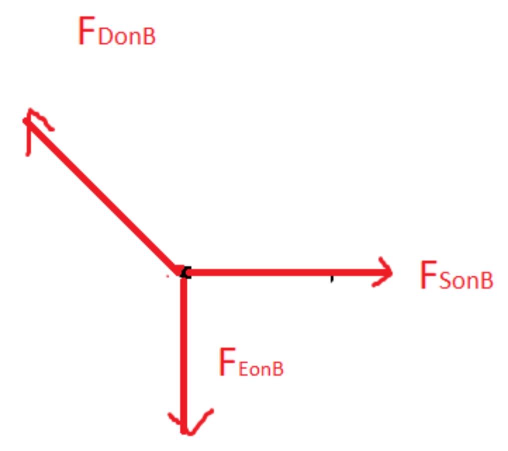
[OALG Chapter 4]

Team 2 OALG 4.3.1 and if finish early, 4.3.2 [OALG Chapter 4]

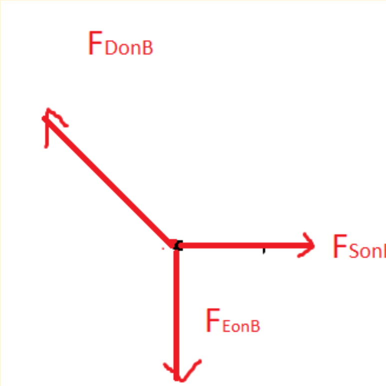








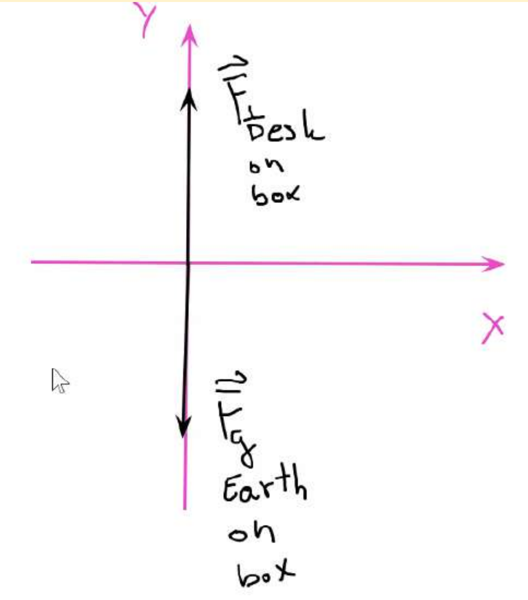
b) the magnitude and the direction are changing. c) …

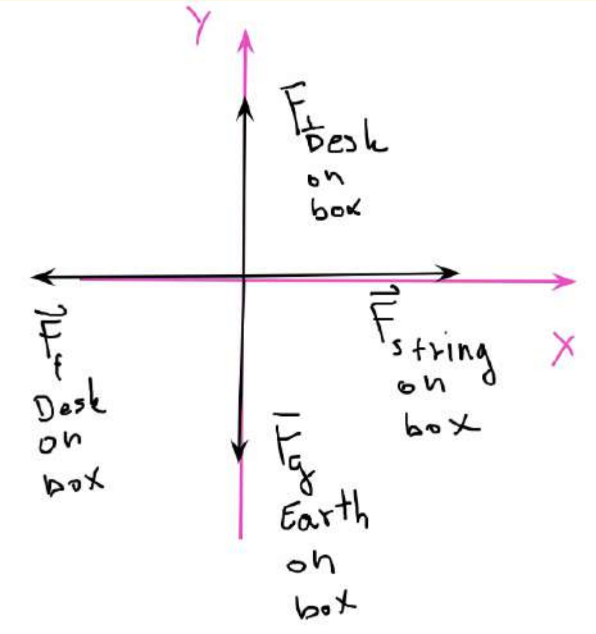


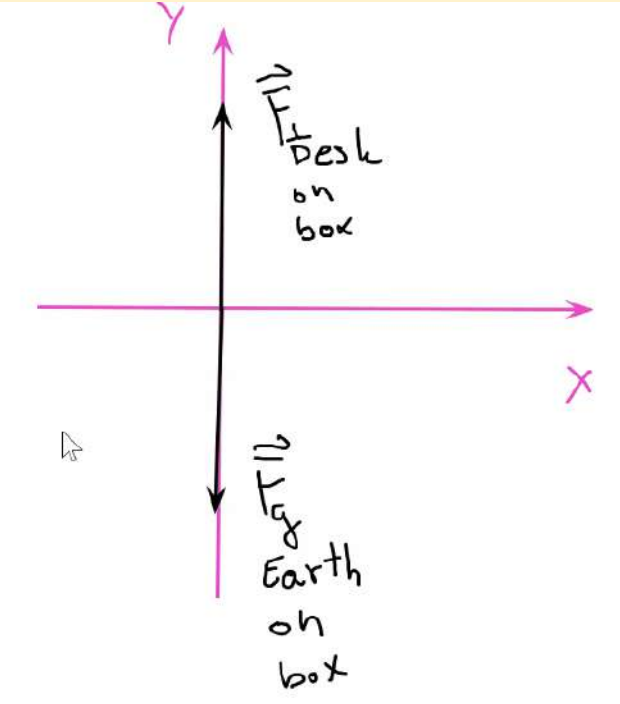
Team 3 OALG 4.3.1 and if finish early, 4.3.2 [OALG Chapter 4]

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.	**2 N**
The spring scale pulls harder on the block at rest on the horizontal surface; the block still does not move.	**2.5 N**
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	**3.2 N**

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

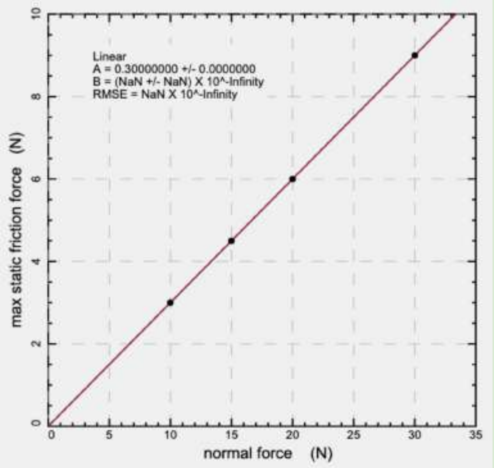
OALG Chapter 4

What was the point of this activity? What did you learn from it?

The force of the the table on the block changes as the spring force increases.

The support of the grid in understanding the components (we start from image not from math)

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
the surface on the block.

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

c. Use the video in Activity 4.3.2 to estimate the coefficient of static friction in each of the experiments. The mass of
the wooden block is 154 g (do not forget to convert to kg).

B. (max static friction) = (0.3 N/N)(normal force)

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

C. from the video we identify the Max f friction and from the relationship in B. obtain the coefficient

Team 2 OALG 4.3.3

a. Use the data in the table to draw a graph of the maxin

block.

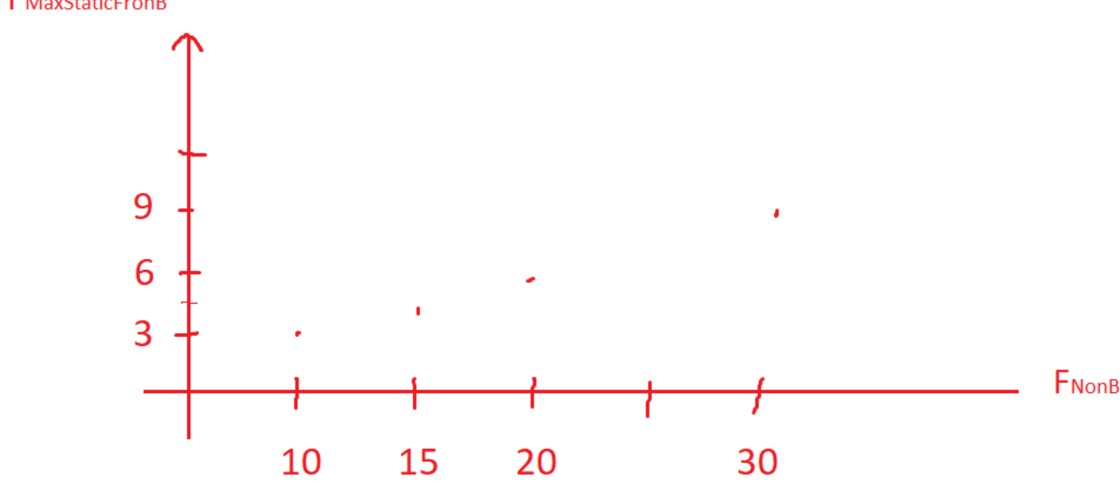
b. Devise a mathematical relationship between the norm

component exerted by the surface. *If you are having diff*

Testing Experiment Table 4.3 and Equation 4.3 on page

that the surface exerts on an object on top of it. F(MaxS

dependence



c. Use the video in Activity 4.3.2 to estimate the coefficient of static friction in each of the experiments. The mass of the wooden block is 154 g (do not forget to convert to kg).

1st experiment; Max friction force is 1,05N, normal force is 0,154kg*9,81 m/s^2, the ratio between them is the coefficient.

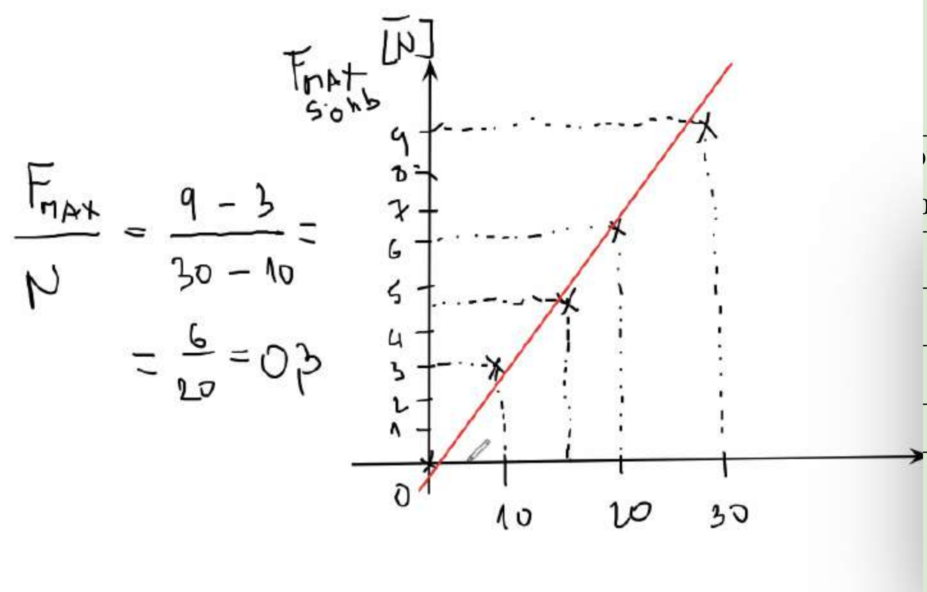
Extra downward force exerted on the 1-kg block	N exerted by the surface on the block, $N_{\text{s on b}}$	Maximum static friction force, $f_{\text{s on b}}$
0 N	10 N	3 N
5 N	15 N	4.5 N
10 N	20 N	6 N
20 N	30 N	9 N

Team 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. 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.*

c. Use the video in Activity 4.3.2 to estimate the coefficient of static friction in each of the experiments. The mass of the wooden block is 154



…wnward force …n 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

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

$F_{f\ SonO} = \text{const} \times F_{normal\ SonO}$

Mu is unitless

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]

An activity that we can do with interested students if we want, asking:

- When does the hand come off the phone?
- What’s the highest velocity the phone reaches?
- How far does the phone slide?
- What’s the friction force acting on the phone?

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

OALG 4.5.1 Observe and find a pattern

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

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?

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?

Do not expect students to have answers to questions **before** their **direct experiences** and do enough thinking to create a **hypothesis:** ex: run with a ball and discover which direction they must throw the ball to be able to catch it (the hypothesis will emerge that horizontal and vertical motions are independent of each other).

Use grids before using trigonometry for components!

The idea of components can be introduced by using grids.

Using components on a grid to solve for non perpendicular vectors.

The importance of example of role of friction in walking.

The sequence for students to learn the independence of motions (starting from observational experiment)

Stressing components to understand physical situation.

That it is important to approach normal force and friction force as components of a single force, rather than two different forces.