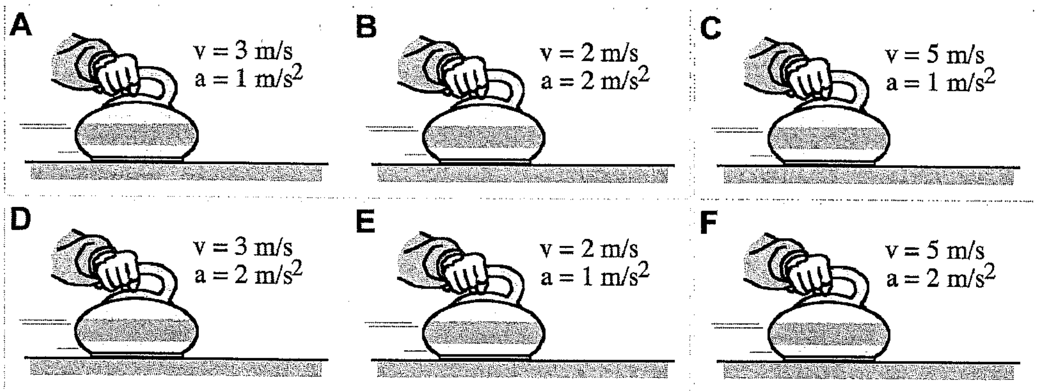
NT5B-RT4: CURLER PUSHING STONE—FORCE ON STONE

The figures below show six identical curling stones (the playing pieces in the sport of curling) that are being pushed horizontally along the ice by the thrower. For each stone, the instantaneous velocity and acceleration of the stones are given. The positive direction is to the right. Assume the ice is frictionless for the curling stones.



Rank these stones on the basis of the magnitude of the force the thrower is exerting on them at the instant shown.

Greatest 1 _______ 2 _______ 3 _______ 4 _______ 5 _______ 6 _______ Least

OR, The magnitude of the force by the thrower is the same for all the stones but not zero. ___

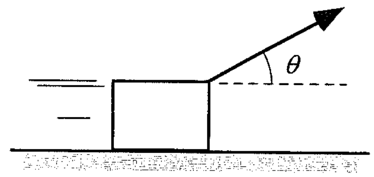
OR, The magnitude of the force by the thrower is zero for all the stones. ___

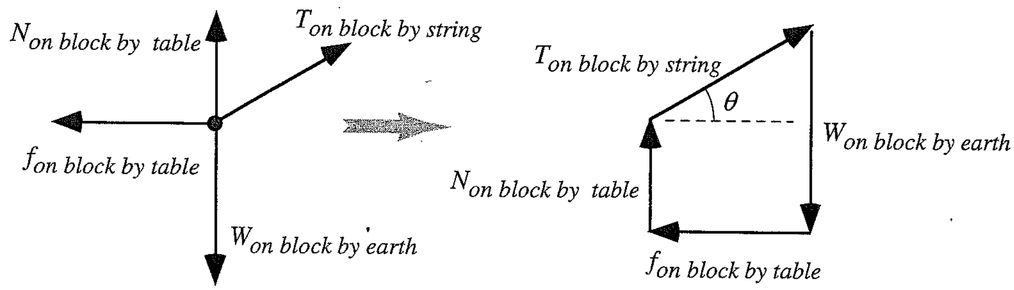
OR, We cannot determine the ranking for the magnitude of the forces. ___

Please explain your reasoning.

NT5B-CCT19: BLOCK MOVING AT CONSTANT SPEED—FORCES ON BLOCK

A student uses a string to pull a block across a table at a constant speed of 2 meters per second. The string makes an angle θ with the horizontal. A second student makes a free-body diagram of the block, and then uses this free-body diagram to generate a vector sum diagram as shown.





Three students are comparing the magnitudes of the forces in the vector sum diagram:

Anja: *The vector sum diagram allows us to compare the magnitudes of all four forces: The weight is the largest, then the tension, then friction, then the normal force.*

Barb: *Well, the weight is definitely greater than the normal force. But there should be a net force to the right in the vector sum because that's the way the block is moving, and there isn't. I don't think we can use it to rank the other forces.*

Cole: *I think we can use it to say that the weight is greater than the normal force. Also, the tension is greater than the friction, since the friction is the same length as the dashed line, and this is equal to the tension times the cosine of theta (θ). But we can't compare the vertical forces with the horizontal ones.*

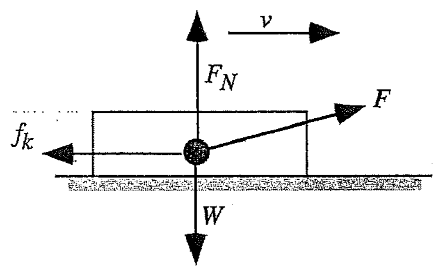
Which, if any, of these students do you agree with?

Anja _____ Barb _____ Cole _____ None of them_____

Please explain your reasoning.

NT5B-WWT23: PULLING A BLOCK ACROSS A ROUGH SURFACE—FORCE RELATIONSHIPS

A person pulls a block across a rough horizontal surface at a constant speed by applying a force $\boldsymbol{F}$ at a slight angle as shown. A free-body diagram is drawn for the block. The arrows in the diagram correctly indicate the directions, but not necessarily the magnitudes of the various forces on the block. A student makes the following claim about this free-body diagram:

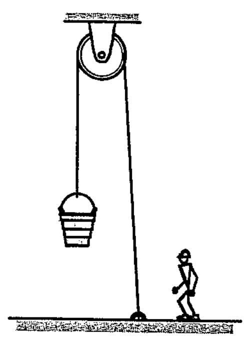


"The velocity of the block is constant, so the net force acting on the block must be zero. Thus the normal force F_N equals the weight W, and the force of friction f_k equals the applied force F."

What, if anything, is wrong with this statement? If something is wrong, identify it and explain how to correct it. If this statement is correct, explain why.

NT5B-WWT18: LIFTING UP A PAIL—STRATEGY

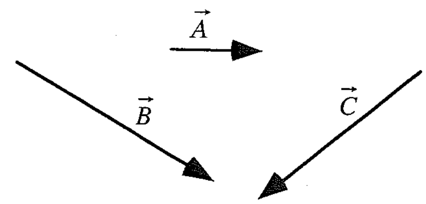
A loaded pail is attached to a rope that passes around an overhead pulley and is tied to a ring on the floor. Linda, a construction worker, plans to untie the rope from the ring, pull on the rope to lift the pail 1 meter higher, and then retie the rope. Linda weighs 800 N and is capable of lifting twice her weight, 1600 N. The loaded pail weighs 1200 N.



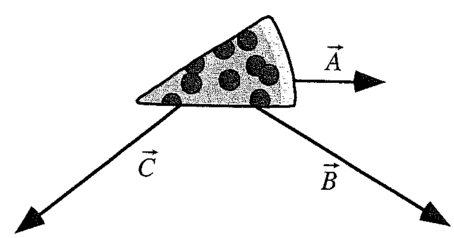
What, if anything, is wrong with Linda's plan? Explain how to correct it or if the plan will work, explain why.

NT5B-QRT27: THREE VECTORS—RESULTANT

a) In the space below, add the three vectors shown to the right and label the resultant vector as $\vec{R}$.



Suppose the three vectors above represent forces exerted on a slice of pepperoni pizza by three people, Abel ($\vec{A}$), Beth ($\vec{B}$), and Celia ($\vec{C}$) as shown in the top view picture to the right. A fourth person, David, also pulls on the pizza. The pizza moves to the left at a constant speed. Assume there is no friction between the pizza slice and the greasy table.

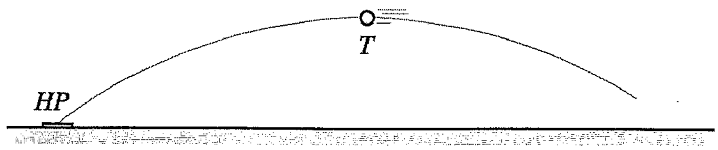


b) In what direction is David pulling on the pizza?

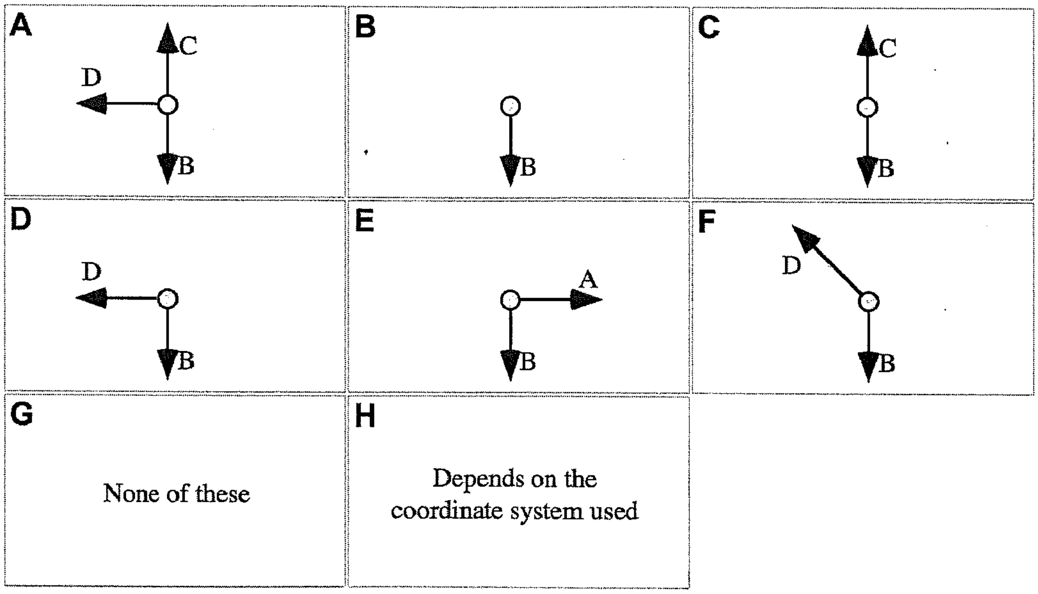
Explain your reasoning.

NT5C-QRT32: THROWN BASEBALL—FREE-BODY DIAGRAM AT THE TOP

A baseball is thrown from right field to home plate (HP), traveling from right to left in the diagram.



A group of physics students watching the game create the following free-body diagrams for the baseball at the top of its path (point *T*). Note that the forces are not drawn to scale.



1a) If they decide to *ignore air friction,* which is the correct free-body diagram for the baseball at point *T?*

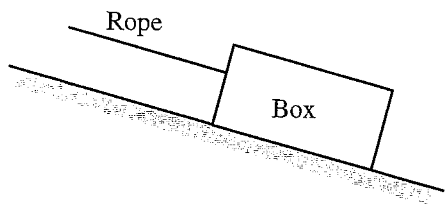
1b) Define all forces on the ball for this force diagram:

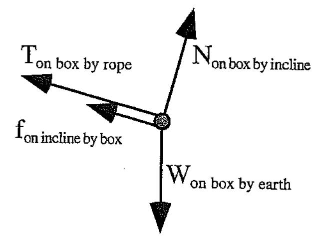
2a) If they decide to *include air friction,* which is the correct free-body diagram for the baseball at point *T?*

2b) Define all forces on the ball for this force diagram:

NT5C-WWT33: Box on Incline—Forces

A heavy box is sitting at rest on an incline. There is friction between the box and the incline and a rope is pulling on the box in a direction up and to the left, parallel to the incline. A physics student draws a free-body diagram below for the box.



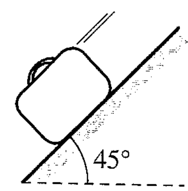


What, if anything, is wrong with this student's free-body diagram? If something is wrong, explain the error and how to correct it. If this free-body diagram is correct, explain why.

NT5C-QRT34: Suitcase Speeding Up as It Slides Down Ramp—Forces on Suitcase

A suitcase is speeding up as it slides down a ramp angled at 45° to the horizontal.

Draw a free-body diagram labeling all the forces on the suitcase, and then rank the magnitudes of the forces you have drawn.

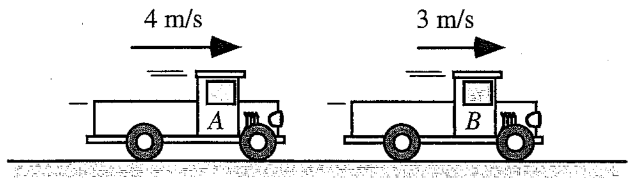


Explain your ranking.

NT5D-CT41: IDENTICAL TOY TRUCK COLLISIONS—FORCE AND ACCELERATION

Shown below are two identical toy trucks traveling at different constant speeds that are about to collide.

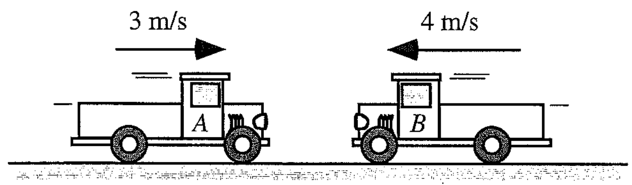
1) The trucks are traveling in the same direction.



Will the magnitude of the force exerted on truck *A* by truck *B* be *greater than, less than,* or *equal to* the magnitude of the force exerted on truck *B* by truck *A?*

Explain.

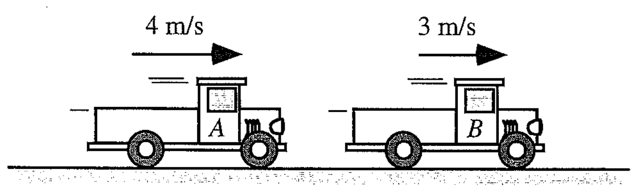
2) The trucks are traveling in opposite directions.



Will the magnitude of the force exerted on truck *A* by truck *B* be *greater than, less than,* or *equal to* the magnitude of the force exerted on truck *B* by truck *A?*

Explain.

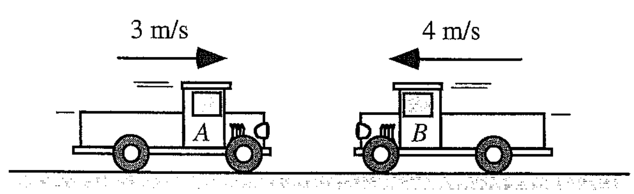
3) The trucks are traveling in the same direction.



Will the magnitude of the acceleration of truck *A* during the collision be *greater than, less than,* or *equal to* the magnitude of the acceleration of truck *B* during the collision?

Explain.

4) The trucks are traveling in opposite directions.

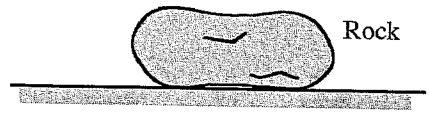


Will the magnitude of the acceleration of truck *A* during the collision be *greater than, less than,* or *equal to* the magnitude of the acceleration of truck *B* during the collision?

Explain.

NT5D-WWT47: ROCK ON TABLE—FORCES AND REACTION FORCES

A rock with a weight of 10 N is resting on a table. A student makes a number of statements about this situation.



1) *"The weight of the rock is a force of 10 N by gravity in the downward direction."*

What, if anything, is wrong with this statement? If something is wrong, identify it and explain how to correct it. If this statement is correct, explain why.

2) *"The reaction force to this weight is a force of 10 N exerted on the rock by the table in the upward direction."*

What, if anything, is wrong with this statement? If something is wrong, identify it and explain how to correct it. If this statement is correct, explain why.

3) *"The normal force exerted on the rock by the table is a force of 10 N; the reaction force to this normal force is a force of 10 N exerted on the rock by gravity in the downward direction."*

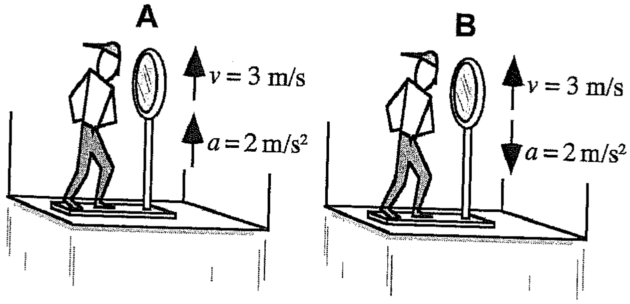
What, if anything, is wrong with this statement? If something is wrong, identify it and explain how to correct it. If this statement is correct, explain why.

4) *"If the 10 N rock is lifted off the table by a hand that exerts a force of 12 N upward on the rock, the reaction force to this 12 N force is a force of 10 N exerted on the hand by the rock in the downward direction."*

What, if anything, is wrong with this statement? If something is wrong, identify it and explain how to correct it. If this statement is correct, explain why.

NT5E-CT49: Person in an Elevator Moving Upward—Scale Reading

In the two cases shown below, a person is standing on a scale in an elevator. The elevators are identical, and the person weighs 500 N. In both cases the elevator is moving upward, but in Case A it is accelerating upward and in Case B it is accelerating downward.

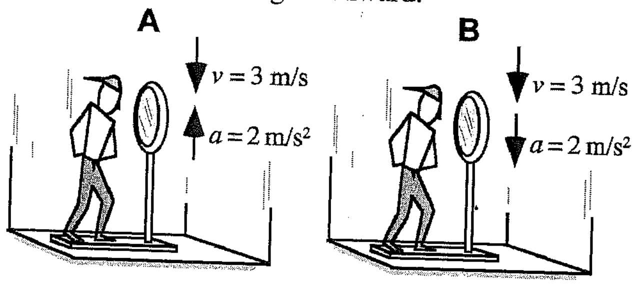


Will the scale reading in Case A be *greater than, less than,* or *the same as* the scale reading in Case B?

Explain.

NT5E-CT50: Person in an Elevator Moving Downward—Scale Reading

In the two cases shown below, a person is standing on a scale in an elevator. The elevators are identical, and the person weighs 500 N. In both cases the elevator is moving downward, but in Case A it is accelerating upward and in Case B it is accelerating downward.

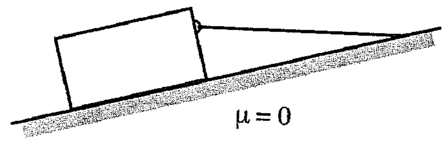


Will the scale reading in Case A be *greater than, less than,* or *the same as* the scale reading in Case B?

Explain.

NT5E-CT53: Block Held on Smooth Ramp—Weight and Normal Force

A block is tethered to a frictionless ramp by a horizontal string as shown. The block is at rest.

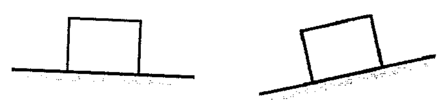


Is the normal force exerted on the block by the ramp *greater than, less than,* or *equal to* the weight of the block?

Explain.

NT5F-WWT54: Two Blocks at Rest—Normal Force

In the situation on the left the block is sitting on a horizontal surface, and in the situation on the right, an identical block is sitting on a rough incline. A student comparing the normal force exerted on the block by the surface in the two cases states:

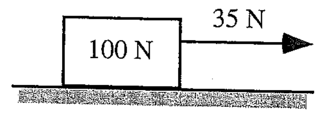


> *"Since both blocks are identical, I think the normal forces are the same because in each case the normal force will be equal to the weight."*

What, if anything, is wrong with this contention? If something is wrong, identify it, and explain how to correct it. If this contention is correct, explain why.

NT5H-LMCT96: Box Pulled on Rough Horizontal Surface—Frictional Force on Box

A 100 N box is initially at rest on a rough horizontal surface. The coefficient of static friction between the box and the surface is 0.6 and the coefficient of kinetic friction is 0.4. A constant 35 N force is applied to the box horizontally as shown.



Identify from choices (a)-(e) how each change described below will affect the frictional force on the box by the surface ***1 second after the horizontal force is first applied.***

Compared to the case above, this change will:

(a) *increase* the frictional force exerted on the box by the surface.
(b) *decrease* the frictional force exerted on the box by the surface but not to zero.
(c) *decrease* the frictional force exerted on the box by the surface to zero.
(d) *have no effect* on the frictional force exerted on the box by the surface.
(e) *have an indeterminate* effect on the frictional force exerted on the box by the surface.

All of these modifications are changes to the initial situation shown in the diagram.

1) The weight of the box is changed to 50 N. ______

2) The weight of the box is changed to 200 N. ______

3) The applied force is increased to 50 N. ______

4) The applied force is increased to 80 N. ______

5) The coefficient of static friction is increased to 0.7. ______

6) The coefficient of kinetic friction is increased to 0.5. ______

7) The coefficient of kinetic friction is increased to 0.5 and the coefficient of static friction is increased to 0.7. ______

8) The weight of the box is changed to 200 N and the coefficient of static friction is increased to 0.7. ______

9) The weight of the box is changed to 200 N and the coefficient of kinetic friction is increased to 0.5. ______

10) The weight of the box is changed to 200 N and the applied force is increased to 50 N. ______