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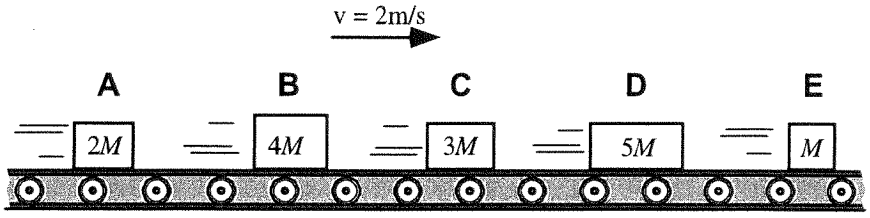
B3 Newton's Laws

#1

B3-RT01: Packages Moving on a Conveyor Belt—Net Force

Various packages with different masses are moving on a constant-speed conveyer belt. At the instant shown below, all packages have the same constant velocity of 2 m/s directed to the right. The packages do not slip on the belt. All masses are given in the diagram in terms of *M*, the mass of the smallest package.



Rank the magnitude of the net force on each package.

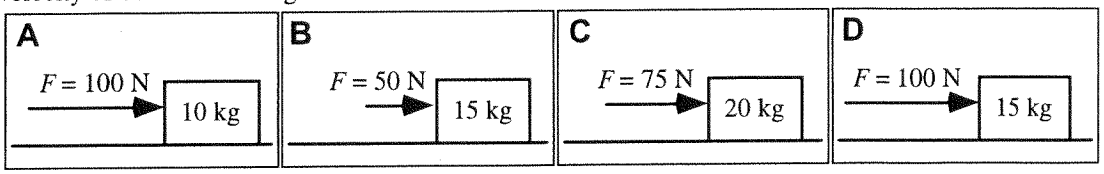
					OR			
1 Greatest	2	3	4	5 Least		All the same	All zero	Cannot determine

Explain your reasoning.

#2

B3-RT08: Force Pushing Box—Acceleration

Various similar boxes are being pushed for 10 m across a floor by a net horizontal force as shown below. The mass of the boxes and the net horizontal force for each case are given in the indicated figures. All boxes have the same initial velocity of 10 m/s to the right.



Rank the acceleration of the boxes.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

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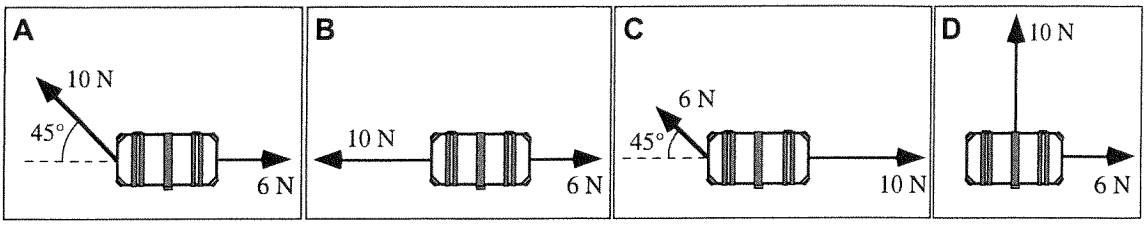
#3 **B3-RT10: Two-Dimensional Forces on a Treasure Chest—Final Speed**

Identical treasure chests (shown from above) each have two forces acting on them. All chests start at rest.



Rank the speed of the treasure chest after 2 seconds.

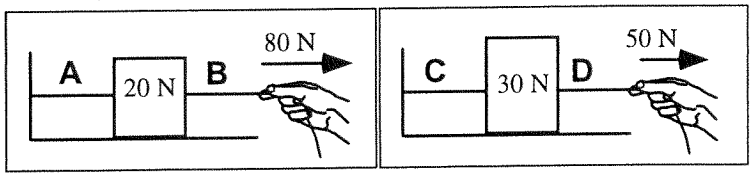
				OR			
					☐	☐	☐
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

Answer: $D > C = A > B$.
We need to find the accelerations of the chests. Since they are all starting from rest and accelerating for the same time, the final speed will be proportional to the acceleration. The acceleration will be proportional to the net force, i.e., the vector sum of the two forces acting on each chest.

#4 **B3-RT16: Blocks Attached to Wall—Rope Tension**

Two blocks are attached by a rope to a wall. A child pulls horizontally on a second rope attached to each block. Both blocks remain at rest on the frictionless surface. The weights of the blocks and the magnitudes of the forces exerted by the child are given.



Rank the tensions in the ropes.

				OR			
					☐	☐	☐
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

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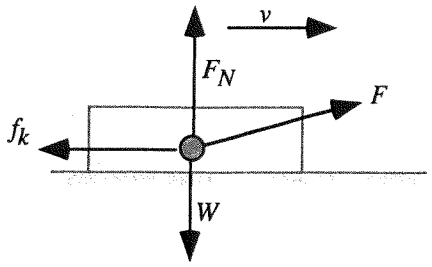
#5 **B3-WWT36: Pulling a Block across a Rough Surface—Force Relationships**

A person pulls a block across a rough horizontal surface at a constant speed by applying a force 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:

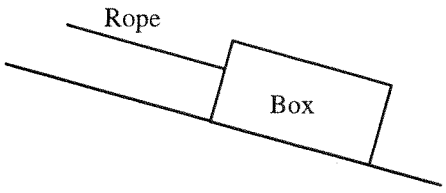


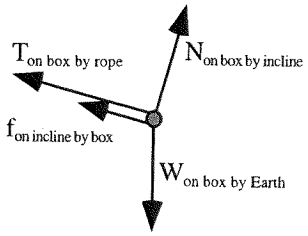
"The velocity of the block is constant, so the net force acting on the block must be zero. Thus the normal force F_N equals the weight W, and the force of friction f_k equals the applied force F."

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.

#6 **B3-WWT43: 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 the free-body diagram below right 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.

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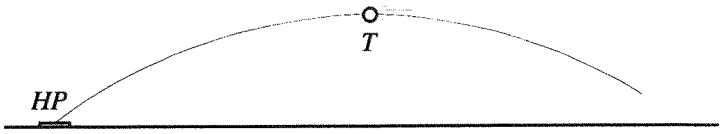
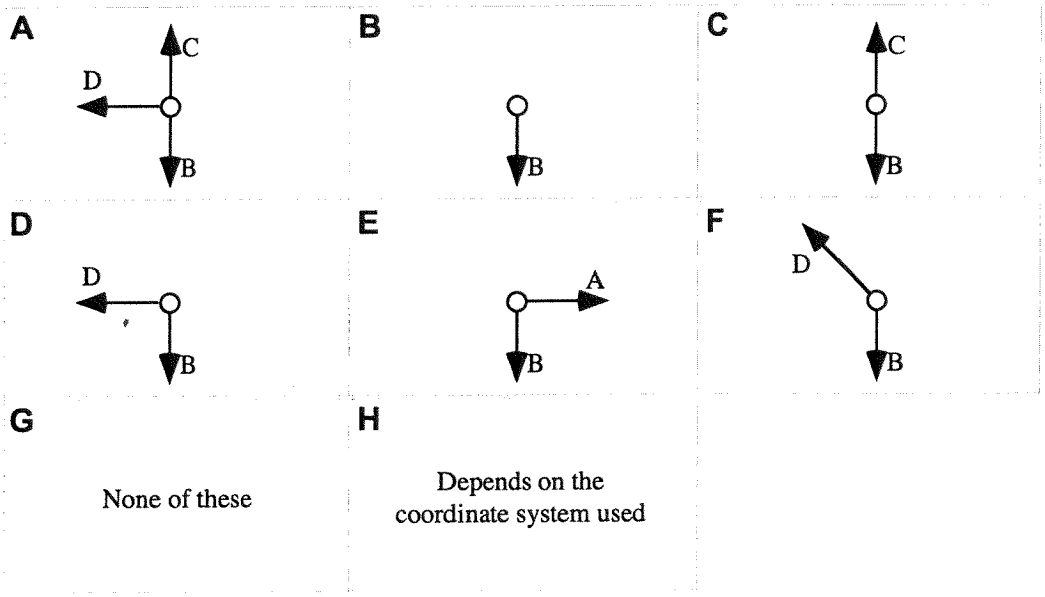
#7

B3-QRT42: 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.



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

(b) Define all forces on the ball for this force diagram.

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

(d) Define all forces on the ball for this force diagram.

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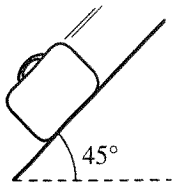
#8 **B3-CRT45: SUITCASE SLIDING DOWN RAMP AT CONSTANT SPEED—FORCES ON SUITCASE**

A suitcase is moving at a constant speed as it slides down a ramp angled at 45° to the horizontal.



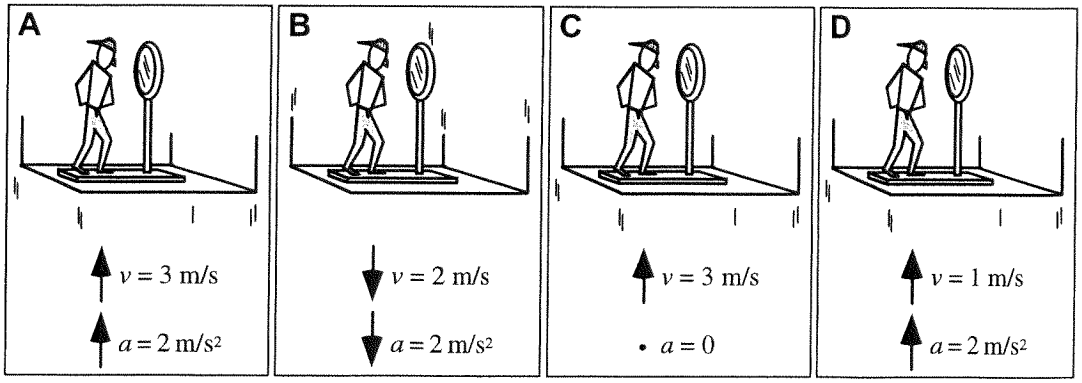
Draw a free-body diagram below, labeling and defining all the forces on the suitcase.

Rank the magnitudes of these forces on the suitcase.

Explain your ranking.

#9 **B3-RT60: PERSON IN A MOVING ELEVATOR—SCALE READING**

A person who weighs 600 N is standing on a scale in an elevator. The elevator is identical in all cases. The velocity and acceleration of the elevators at the instant shown are given.



Rank the scale reading.

				OR			
1	2	3	4		All	All	Cannot
Greatest			Least		the same	zero	determine

Explain your reasoning.

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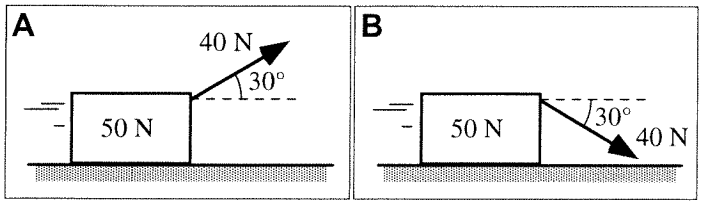
#10 **B3-CT87: Box Moving over Horizontal Surface—Frictional Force on Box**

A 50 N box has an applied force on it of 40 N that makes an angle of 30° with the horizontal. The box is moving to the right at a constant speed in both cases.



Will the frictional force exerted on the box by the rough surface be (i) *greater* in Case A, (ii) *greater* in Case B, or (iii) *the same* in both cases? _____

Explain your reasoning.

Answer: Greater in case B.
The boxes are not accelerating vertically, so the net vertical force must be zero. The tension in the string in Case A has an upward vertical component, reducing the normal force required to balance the weight of the box. In Case B the tension has a downward vertical component, so the normal force must be greater than the weight. Since the force of friction is proportional to the normal force, the frictional force is greater in case B.