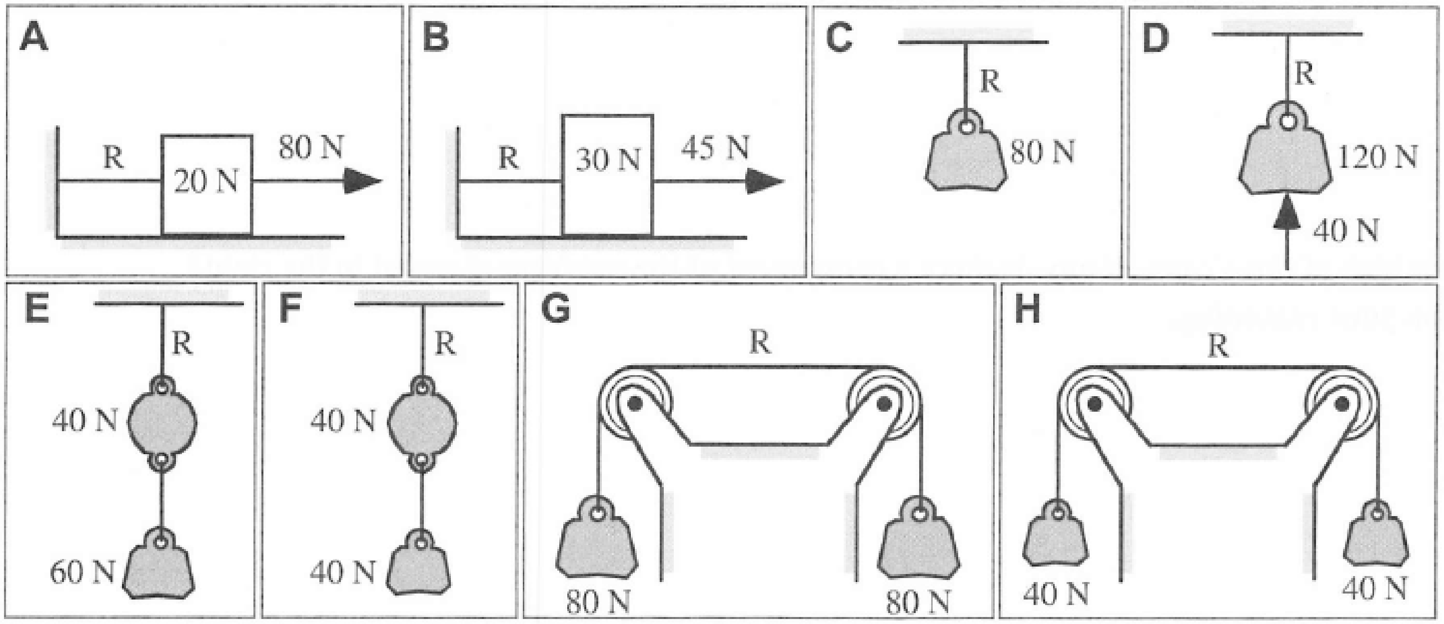
B3-RT18: BLOCKS AND WEIGHTS AT REST—TENSION

In all of the cases shown, the systems are at rest. In Cases A and B, there is a force to the right acting on the block, which is on a frictionless surface, and in Case D there is a 40 N upward force on the weight.



Rank the tension in the rope labeled R.

								OR		
1 Greatest	2	3	4	5	6	7	8 Least		All the same	Cannot determine

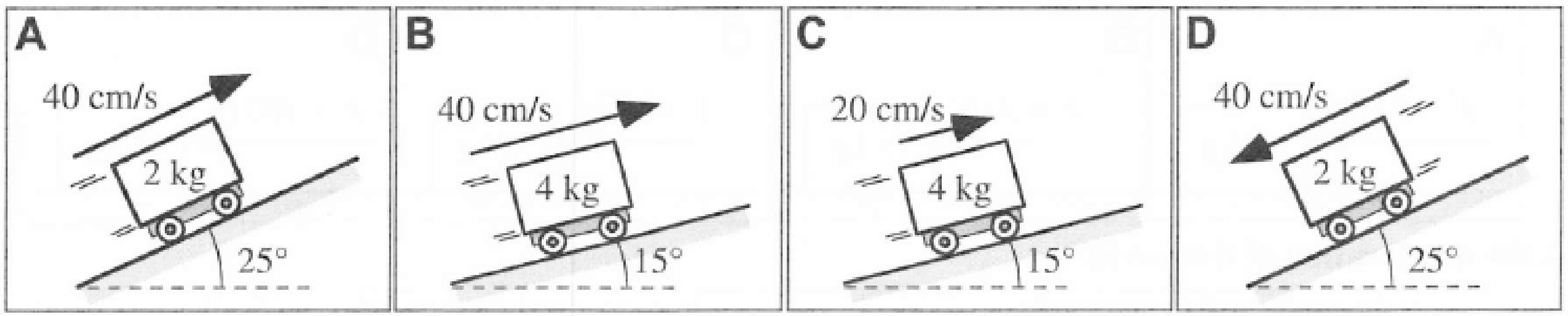
Explain your reasoning.

Answer: E > A = C = D = F = G > B > H.

Since in all of these cases the systems are at rest the net forces acting on the systems are zero. So for cases A, B, C, E, and F the tension is balancing the applied force. For case D the tension plus the 40 N applied force must balance the 120 N weight. For cases G and H the tension is equal to the weight of the hanging blocks.

B3-RT06: Carts on Inclines—Net Force

Carts that have a motor and brakes are traveling either up or down inclines at constant speeds. The carts are identical but they carry either a 2 kg or 4 kg load and are on one of two inclines. Incline angles, cart masses, and speeds are given in each figure.



Rank the magnitude of the net force acting on the cart.

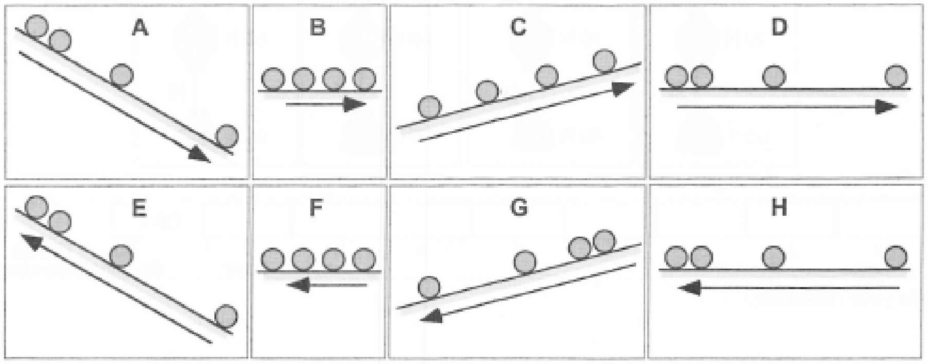
				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

Answer: The net force is zero for all of these cases since the carts have constant velocities and therefore no accelerations.

B3-QRT19: BALL STROBE MOTION—NET FORCE

The following drawings indicate the positions, using a strobe flash, of a ball moving from one side of the figure to the other as indicated by the direction of the arrow. Each circle represents the position of the ball at succeeding instants of time. Each time interval between successive positions is equal, and each ball has the same mass. Assume the acceleration, if any, for each situation to be constant.



(a) In which of these cases, if any, is there a net force acting on the ball? _____
Explain your reasoning.

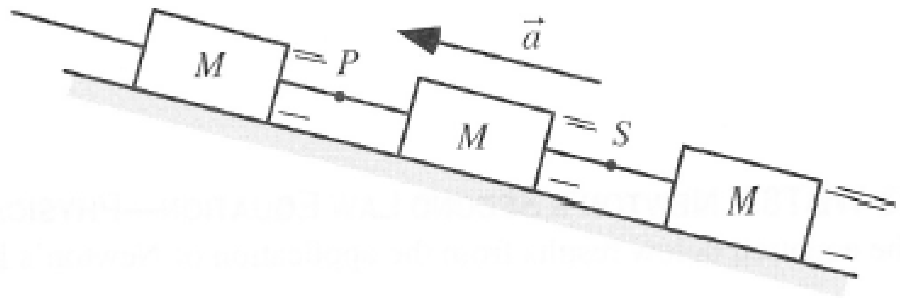
(b) In which of these cases, if any, is there a component of the net force directed to the right? _____
Explain your reasoning.

(c) In which of these cases, if any, is there a component of the net force on the ball directed upward? _____
Explain your reasoning.

Answer: A, D, E, G, H or all except B, C and F.
If the ball is accelerating, then the distance the ball travels in each time interval will change in a systematic way over time. If the balls are accelerating, there is a net force on them.

B3-WWT80: Blocks on a Smooth Incline—Tension

Three identical blocks are tied together with ropes and pulled up a smooth (frictionless) incline. The blocks accelerate up the incline. A student who is asked to compare the tension in the rope at point P to the tension at point S states:



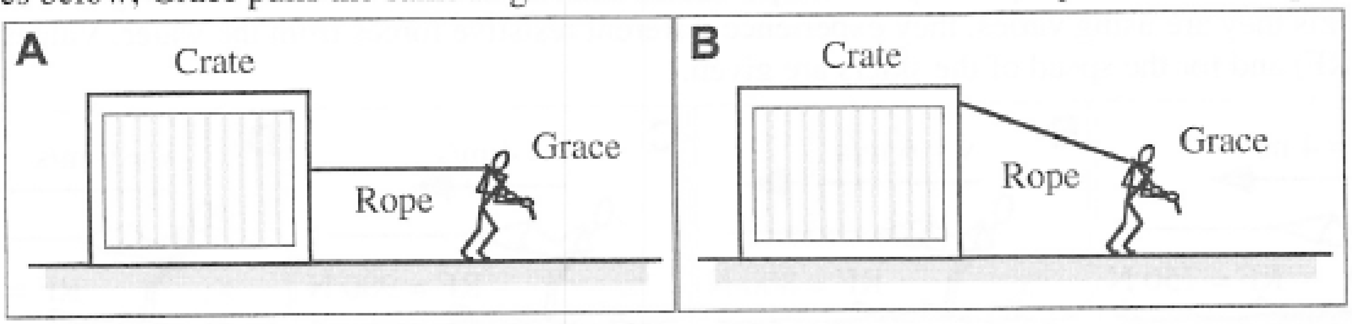
"Each rope is pulling one block. All three blocks are accelerating at the same rate and they are identical. I think the tensions at points P and S will be the same."

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.

Answer: The student's contention is incorrect.
From a free-body diagram of the lower block, the tension at point S must be larger than the component of the weight of that block that is parallel to the ramp in order for the lower block to accelerate up the ramp. From a free-body diagram of the middle block, the tension at point P must be larger than the tension at point S plus the component of the weight of the middle block that is parallel to the ramp in order for the middle block to accelerate up the ramp. So the tension at P must be greater than the tension at S.

B3-CT73: PULLING A CRATE ACROSS FLOOR—APPLIED FORCE

In both cases below, Grace pulls the same large crate across a floor at a constant speed of 1.48 m per second.



Is the magnitude of the force exerted by Grace on the rope (i) *greater* in Case A, (ii) *greater* in Case B, or (iii) *the same* in both cases? ______

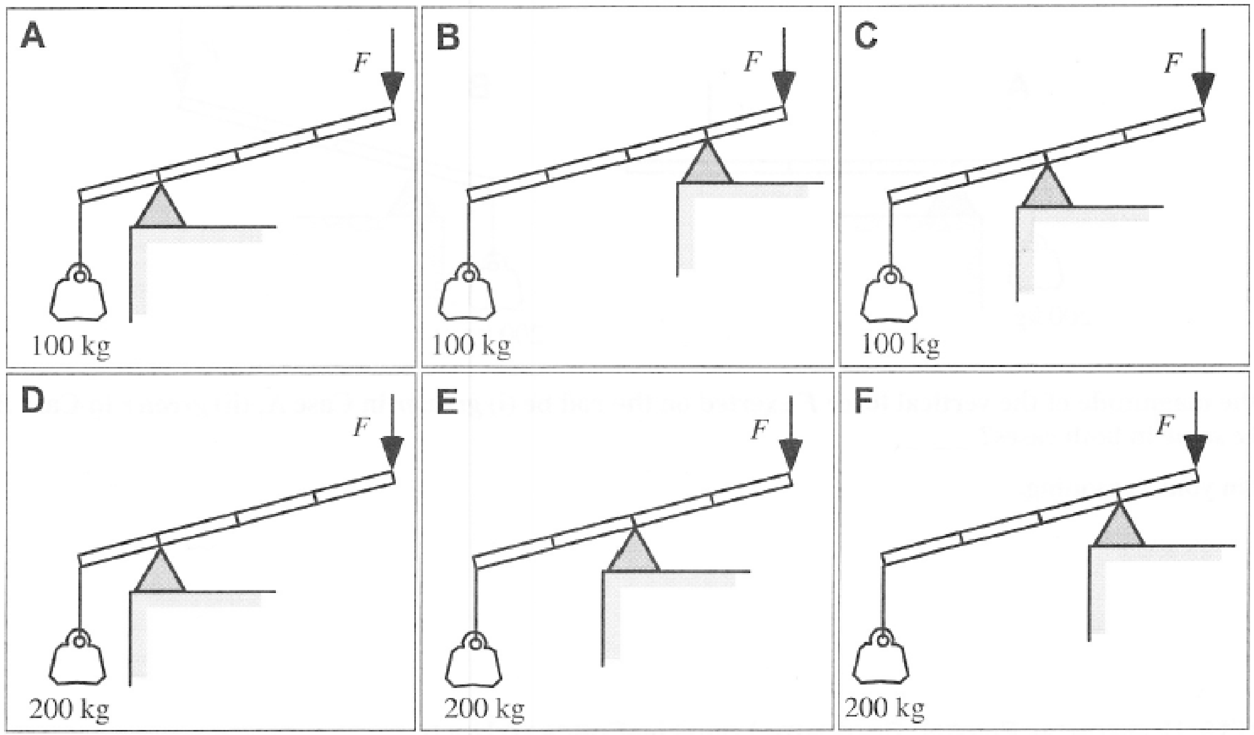
Explain your reasoning.

Answr: Greater in case B.

Since the force that the rope exerts on the crate in case B has a downward vertical component, and the net vertical force is zero (the crate has a constant velocity), the normal force on the crate by the floor is larger than the weight of the crate in case B. In case A, however, the normal force on the crate by the floor is equal to the weight. Since the normal force on the crate by the floor is greater in case B than in case A, the friction force is also greater in case B than in case A. So it must be true that the horizontal component of the tension is greater in case B than in case A, since the net horizontal force is zero (the crate has a constant velocity). The tension in case B is greater than its horizontal component, and the horizontal component of this tension is greater than the tension in case A, so the tension in case B is greater than the tension in case A.

B6-RT16: TILTED PIVOTED RODS WITH VARIOUS LOADS—FORCE TO HOLD RODS

Six identical massless rods are supported by a fulcrum and are tilted at the same angle to the horizontal. A mass is suspended from the left end of the rod, and the rods are held motionless by a downward force on the right end. Each rod is marked at 1-m intervals.



Rank the magnitude of the vertical force *F* applied to the end of the rod.

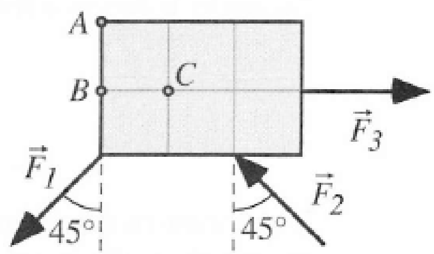
						OR		
1 Greatest	2	3	4	5	6 Least		All the same	Cannot determine

Explain your reasoning.

Answer: F > B > E > C > D > A.

In order for the rods to be held stationary the clockwise torques must balance the counter-clockwise torques. All of the forces that act on the rods are vertical forces, so we can take the distances as the number of meters between each force and the pivot. For cases C and E the force applied to the rod has to be equal to the weight of the mass. The applied force for cases D and A are less than the weight of the mass since the mass has a shorter lever arm and thus produces a smaller torque. Cases F and B need the largest applied force since that force acts with a short lever arm and the hanging masses have large lever arms.

Three forces of equal magnitude are applied to a 3-m by 2-m rectangle. Forces $\vec{F}_1$ and $\vec{F}_2$ act at 45° angles to the vertical as shown, while $\vec{F}_3$ acts horizontally.



(a) Is the torque by $\vec{F}_1$ about point *A* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*?

______

Explain your reasoning.

(b) Is the torque by $\vec{F}_1$ about point *B* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? ______

Explain your reasoning.

(c) Is the torque by $\vec{F}_1$ about point *C* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? ______

Explain your reasoning.

(d) Is the torque by $\vec{F}_2$ about point *A* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? ______

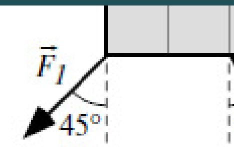
Explain your reasoning.

(e) Is the torque by $\vec{F}_2$ about point *B* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? ______

Explain your reasoning.

(a) Is the torque by $\vec{F}_1$ about point A (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*?

_____



Explain your reasoning.

Answer: Clockwise The component of F_1 that is horizontal would pull the bottom of the rectangle to the left.

(b) Is the torque by $\vec{F}_1$ about point B (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Clockwise. The situation is the same as for A except that the moment arm is shorter.

(c) Is the torque by $\vec{F}_1$ about point C (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Zero. The line of action of the force goes through C so there is a zero moment arm.

(d) Is the torque by $\vec{F}_2$ about point A (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Zero. The line of action of the force goes through A.

(e) Is the torque by $\vec{F}_2$ about point B (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Counterclockwise. F_2 will push the rectangle up making it rotate CCW about B.

(f) Is the torque by $\vec{F}_2$ about point C (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

(g) Is the torque by $\vec{F}_3$ about point A (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

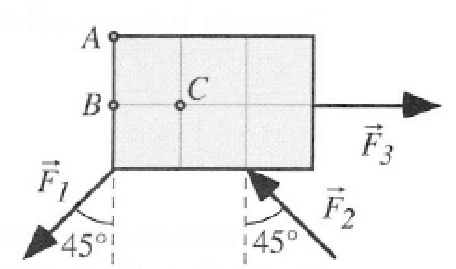
Explain your reasoning.

(h) Is the torque by $\vec{F}_3$ about point B (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

(i) Is the torque by $\vec{F}_3$ about point C (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.



(f) Is the torque by $\vec{F}_2$ about point *C* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Zero. The line of action of the force goes through C.

(g) Is the torque by $\vec{F}_3$ about point *A* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Counterclockwise. F_3 will pull the rectangle up around A.

(h) Is the torque by $\vec{F}_3$ about point *B* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Zero. The line of action of the force goes through B.

(i) Is the torque by $\vec{F}_3$ about point *C* (i) *clockwise*, (ii) *counterclockwise*, or (iii) *zero*? _____

Explain your reasoning.

Answer: Zero. The line of action of the force goes through C.