Newton's Model 3

	Net force	**Motion**
Newton's First Law:	Net force is zero (or, no forwards or backwards forces)	Moves at a constant velocity OR does not move
Newtons Second Law:	Net force is forwards (in direction of velocity)	Speed increases (positive acceleration)
	Net force is backwards (opposite direction of velocity)	Speed decreases (negative acceleration)

For all explanations, refer to Newton's Laws listed above.
Note: all of the situations on this test are *abstract*. They reflect situations that would not occur in your everyday life. As a result, the answers are all very *counterintuitive*.

Part 1: Mr. X exists in outer space. The forces described are the only forces acting on him, common forces you are used to like gravity do not exist.

1a. Mr. X is not moving when he experiences a force of 90 Newtons to the left. Draw a free-body diagram of Mr. X. Explain how Mr. X will move and why, referring to Newton's Model.

1b. All of the sudden, a force of 90 Newton's to the right appears on Mr. X. The force of 90 Newtons to the left is still here. Draw a free-body diagram of Mr. X. Explain how Mr. X will move and why, referring to Newton's Model.

1c. All of the sudden, the force to the right *increases* to 120 Newtons The force to the left is unchanged. Draw a free-body diagram of Mr. X. Explain how Mr. X will move immediately and why, referring to Newton's Model.

1d. Nothing else changes for a long time. There are two forces acting on Mr. X, a force to the right of 120 N and a force to the left of 90 N. What will Mr. X eventually do?

2. Ms. Y is pushing a box.

A) The environment is completely FRICTIONLESS. This means that the force the person is pushing the box with is the *only* force that matters.

B) The box is *already moving* when the she begins pushing it.

C) It is possible more than one answer is acceptable for each question. If so, it is acceptable to pick either correct answer.

2a. If Ms. Y wants the box to *move forward at a constant velocity*, she must:
a) Pull backward
b) Not push at all
c) Push forward
d) Push forward really hard
Explain your answer by referring to Newton's Model:

2b. If Ms. Y wants the box to *decelerate* (slow down), she must:
a) Pull backward
b) Not push at all
c) Push forward
d) Push forward really hard
Explain your answer by referring to Newton's Model:

2c. If Ms. Y wants the box to accelerate forward, she must:
a) Pull backward
b) Not push at all
c) Push forward
d) Push forward really hard
Explain your answer by referring to Newton's Model:

The airplane example:

Two people are in an airplane.

The airplane engine suddenly breaks, and a massive gale eliminates all of its velocity.

The plane is now in free-fall. That is, it is accelerating towards the ground at 9.8 m/s^2.

Person A immediately jumps out of the airplane, and then falls all the way down to the ground.

Person B waits inside the airplane, strapped in his seatbelt, until it is very close to the ground, and then jumps out.

Who strikes the ground with a higher velocity?

A. Person A, the one who jumped out of the plane right away.
B. Person B, the one who waited until just above the ground to jump out.
C. They strike the ground at the same velocity.

Please explain your answer by referring to the following principle:

The only thing that can cause a change in velocity is a *force*.

Answers

1a. Mr. X will accelerate to the left because the only force acting on him is to the left. After he begins moving, his velocity and the force on him will be the same direction and he will increase in speed.

1b. When the second force appears, Mr. X will continue moving the left, but at a *constant velocity*. This is because the net force acting on Mr. X is now zero, which means he continues to move at a constant velocity.

1c. Mr. X will begin slowing down. The net force acting on him is now to the *right*, but his velocity is still to the left.

1d. Over time, Mr. X's speed will eventually decrease to zero. Afterwards, he will begin accelerating in the opposite direction, because at that point the net force acting on him will be in the same direction as his velocity. (both to the right)

2a.
B – Not push at all.
Because the box is already moving, then according to Newton's First Law it will move at a constant velocity if the net force on the block is zero.

2b.
A – pull backward
According to Newton's Second Law, the block will decelerate if there is a force opposite the velocity of the block. Pulling back on the block would achieve this force.

2c.
C – push forward
According to Newton's Second Law, the block will accelerate only if there is a force in the same direction as the velocity of the block. Pushing forward on the block would achieve this force.