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Validating Newton's first law

1) **Newton's first law states that:**

Set the initial velocity of the cart equal to 1.0 m/s and click run without adding any fans or masses to the cart. Note that there is no friction in this simulation.

2) After running the simulation (no friction), what two observations provide justification for the validity of Newton's 1st law? Circle two of the 4 choices.

- no forces acted on the cart in the direction of the cart's motion after given its initial speed.
- A constant rightward force pushed the cart to keep it moving to the right at constant speed.
- The cart continued to move to the right at constant speed and therefore maintained its state of motion.
- The cart initially ran out of energy and slowed down to a stop because no rightward force was present to keep it moving.

Set the initial velocity of the cart equal to 1.0 m/s and add two fans to the cart. Click the change direction button on one of the fans so that the two fans face opposite directions. Turn them both on, set the initial speed to 1 m/s, and run the simulation.

3) After running the simulation (no friction), what two observations provide further justification for the validity of Newton's 1st law? Circle two of the 4 choices.

- Because two forces are present in this simulation, we see the car speed up to the right.
- Because the two fans are of equal magnitude and opposite direction, we say they are balanced forces which means the net force acting on the cart is zero.
- The cart continued to move to the right at constant speed and therefore maintained its state of motion.
- The cart was given an initial speed and eventually started to slow down to a stop.

Set the initial velocity of the cart to 0 m/s and run the simulation with no fans turned on (case 1). Then set the initial velocity of the cart to 0 m/s but with 2 fans that exert equal and opposite forces on the cart (case 2).

4) Did the cart remain at rest after running the simulation in both cases?

Yes in both cases   No in both cases   Yes in only case 1   Yes in only case 2

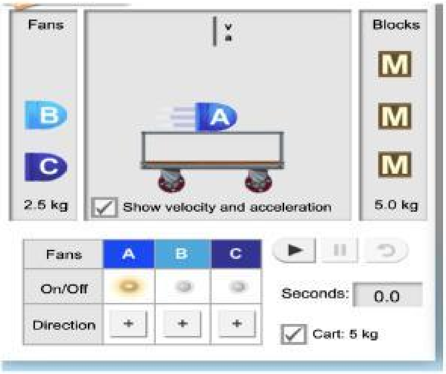
5) Did the object maintain its state of motion under the influence of balanced forces? (Yes/ No)

6) Run the simulation with **just one fan on** so that you have an unbalanced force acting on the cart? Did the object's state of motion (velocity) change due to this unbalanced force? (Yes/No)

Validating Newton's third law

1) **Newton's third law states that:**

Set the initial velocity of the cart equal to 0 m/s, add one fan pointing to the right, and turn that fan on as shown. Note that there is no friction in this simulation.



2) After running the simulation (no friction), what two observations provide justification for the validity of Newton's 3rd law? Circle two of the 4 choices.

- The picture above shows that the fan is pushing the air to the right when the fan is turned on.
- The picture above shows that the fan is pushing the air to the left when the fan is turned on.
- We see the air is pushing the fan in the same direction that the fan is pushing the air which causes the cart to move to the right.
- Because we see the cart speed up to the right, we can conclude that the air must also be pushing back on the fan with a rightward force of equal magnitude.

3) Does Newton's Third law of motion apply to a skydiver that is falling towards planet earth?

- No, the earth pulls down on the man with its gravity but the man can't pull up on the earth.
- No, Both the man and the earth pull on each other in opposite directions, but not with equal gravitational force
- Yes, the gravitational pull that the man exerts on the earth is equal in magnitude and opposite in direction to the gravitational force that the earth pulls down on the man.
- No, because Newton's third law only applies to contact forces (forces that are touching).

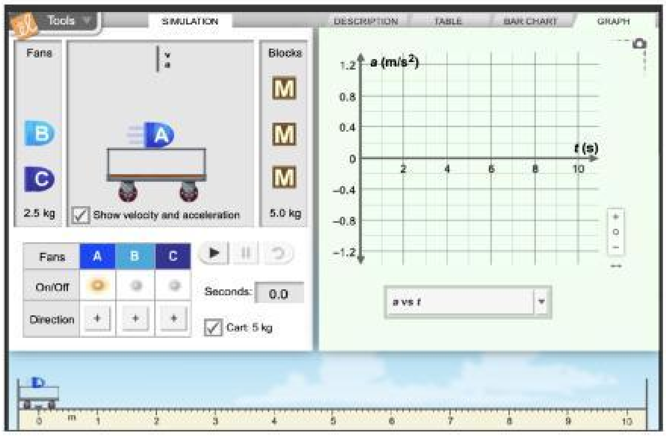
4) Have both Newton's 1st law and Newton's 3rd law been validated so far? (Yes/ No)

Validating Newton's second law

1) **Newton's 2nd law states that:**

GOAL 1: Investigate the effect that changing the mass has on the acceleration while holding the amount of force constant.

Set the initial velocity of the cart equal to 0 m/s, add one fan pointing to the right, and turn that fan on. Click show mass, and then select the acceleration vs. time graph. After running the simulation and recording the acceleration in the data table, calculate the net force using F=ma, add a 5 kg mass and repeat this process. Continue doing this till your data table below is complete. Your simulation should look as shown to the right before running trial 1.



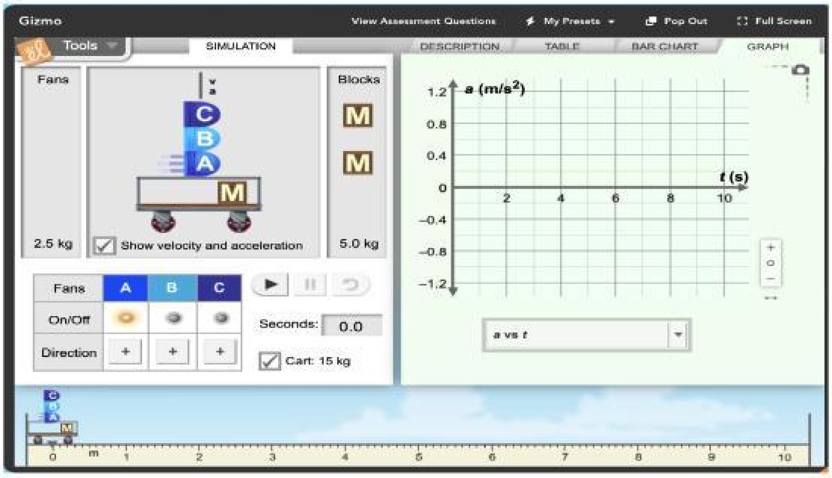
Total mass of the cart with fans and blocks added (shown next to check mark at bottom of simulation)	**Acceleration from a vs. t graph**	**Calculated Net force on the cart** (Use F=m*a)
5 kg		
10 kg		
15 kg		
20 kg		

2) Based on the table above, what happens to the acceleration of the cart when we double the mass?

3) In this study, force is held constant and the acceleration changes as mass changes. Does Newton's 2nd law seem to be validated by the results of this study?

GOAL 2: Investigate the effect that changing the force has on the acceleration while holding the mass of the cart constant.

Set your simulation up so that it looks as shown below. You will hold the mass constant in this investigation as shown in the chart below. After running the simulation with one fan turned on, use the a vs. t graph to determine the acceleration of the object. Then repeat the process with 2 fans turned on, and then with 3 fans turned on. Each fan exerts a 4 Newton force so you should be able to study the relationship between force and acceleration for the cart.



Total mass of the cart with fans and blocks added	**Acceleration from a vs. t graph**	**Calculated Net force on the cart**
15 kg		1 fan turned on **F_{net}=4.0 N**
15 kg		2 fan turned on **F_{net}=8.0 N**
15 kg		3 fan turned on **F_{net}=12.0 N**

3) Based on the table above, what happens to the acceleration of the cart when we double the force (by doubling number of fans turned on)?

4) Does Newton's 2nd law seem to be validated by the results of this study?