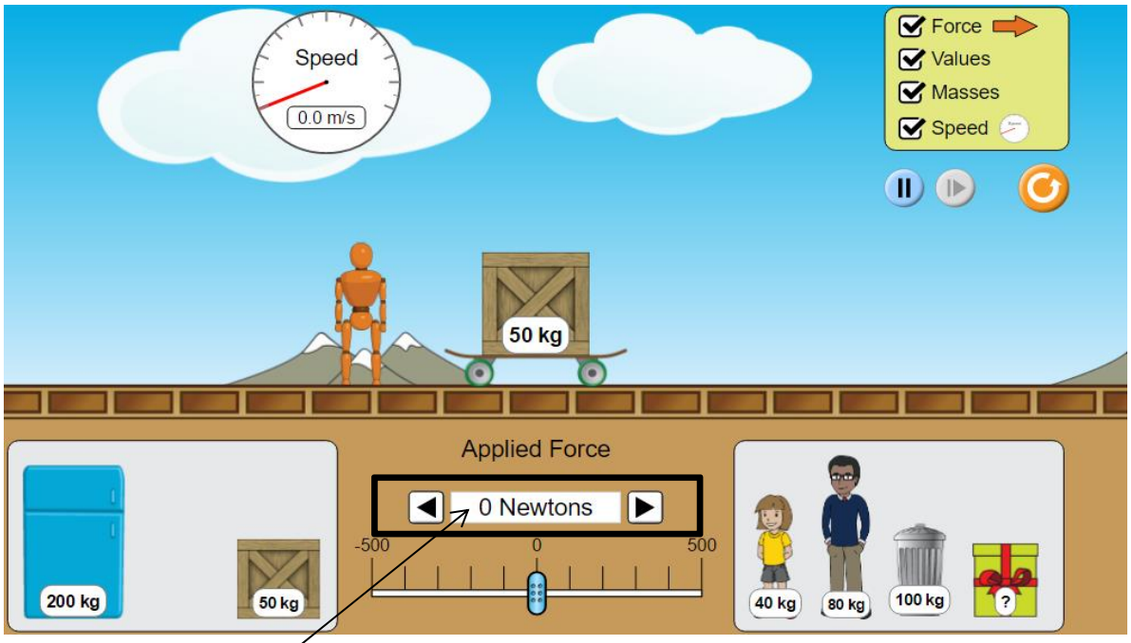
ACTIVITY TOPIC: NEWTON'S SECOND LAW OF MOTION

PART A:

1. Using your mobile learning device, open this link:
   https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html

2. You will see four icons on the screen. Click the second one which says "Motion". You will see the simulation on "Motion" as shown below:



3. Keep all the items inside the yellow box (upper right-hand corner) ticked.

4. Choose a particular item from bottom left/right boxes and position it on top of the skate board.

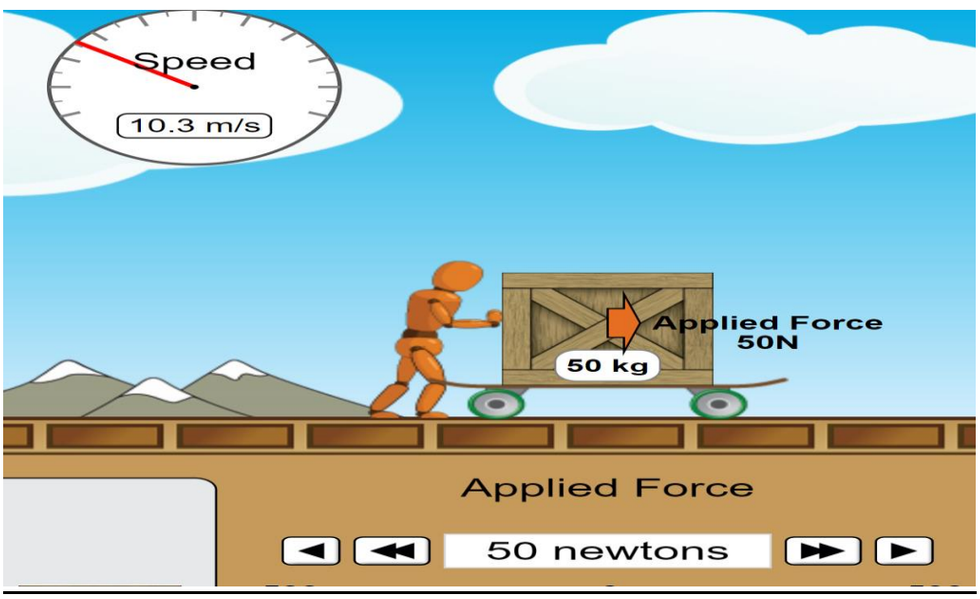
5. Set the "Applied Force" as 50 N ("N" stands for "Newton", a unit of force) by clicking/tapping on the right arrow once. Observe the motion of the box within 10-15 seconds. You may look at how fast the value of speed changes, as shown in the circle on the upper left corner.

6. Without changing the chosen item on the skateboard, set the applied force into higher values (from 50 N, to 100 N, 150 N, 200 N…) by clicking/tapping on the right arrow. Observe the motion of the object for at least 10 seconds for each value of applied force. Carefully notice how fast the value of the speed changes for each value of force applied.

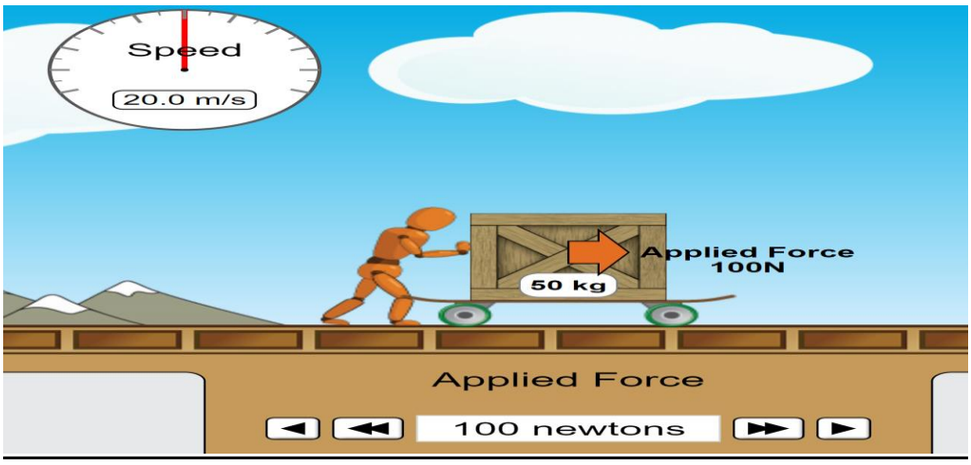
PART A - GUIDE QUESTIONS:

Screenshot of lab simulator

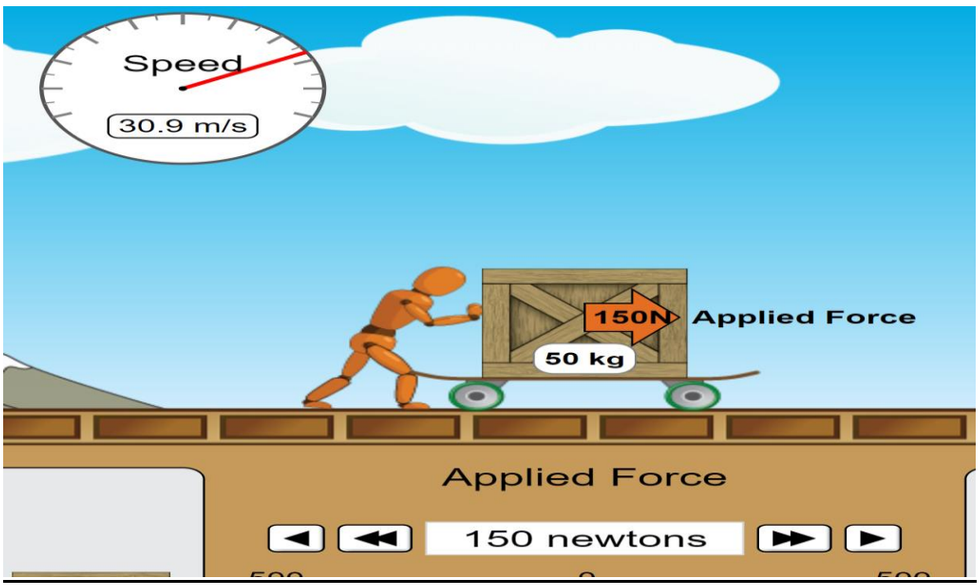
After 10sec for 50N force



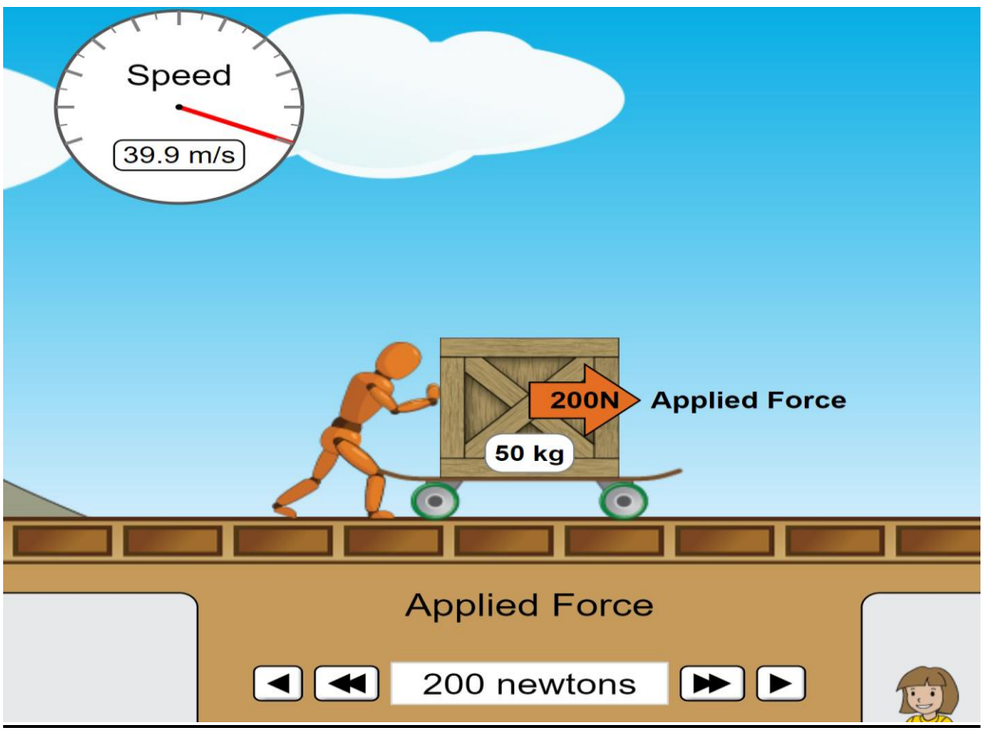
After 10sec for 100N force



After 10sec for 150N force



After 10sec for 200N force



a. What happens to the change in the value of the speed as you increased the amount of force applied on your chosen item?

As the amount of force applied to the chosen item on the skateboard is increased, the value of the speed changes more rapidly. Specifically, the object accelerates faster, meaning its speed increases at a higher rate over the same period of time.

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b. What does this observation tell you about the relationship between the external force applied and the object's acceleration (the rate of change in velocity)?

This observation demonstrates that there is a direct relationship between the external force applied and the object's acceleration. According to Newton's Second Law of Motion, F=ma, where F is the force applied, m is the mass of the object, and a is the acceleration. This means that for a given mass, increasing the applied force results in a proportional increase in acceleration. Thus, as more force is applied to the object, its acceleration increases, leading to a faster change in velocity (speed).

PART B:

1. Click the "reset" button (the round, orange button on the upper right-hand corner) of the same simulation to clear all the current settings.

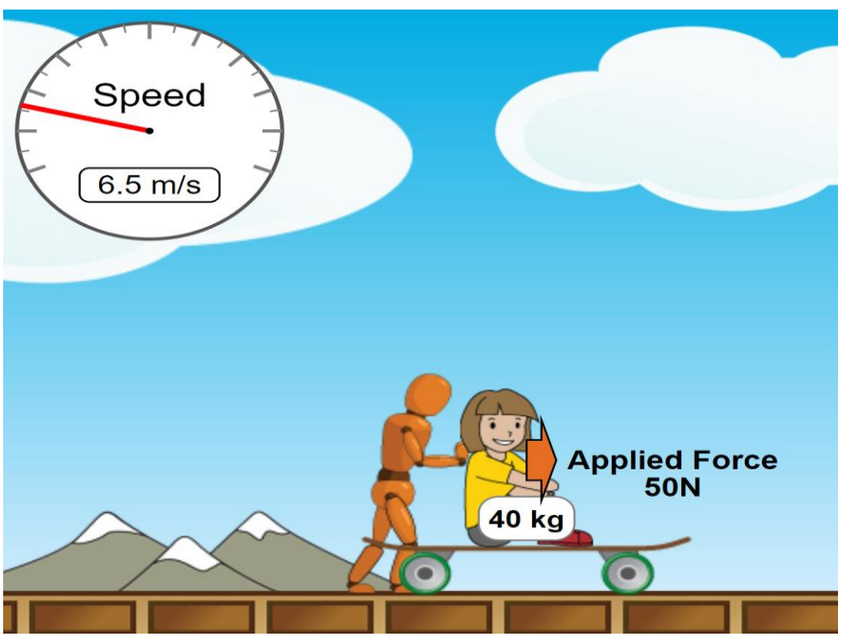
2. Tick all the items (force, values, masses, speed) inside the yellow box. Remove the crate from the top of the skateboard and place it inside the box (lower left).

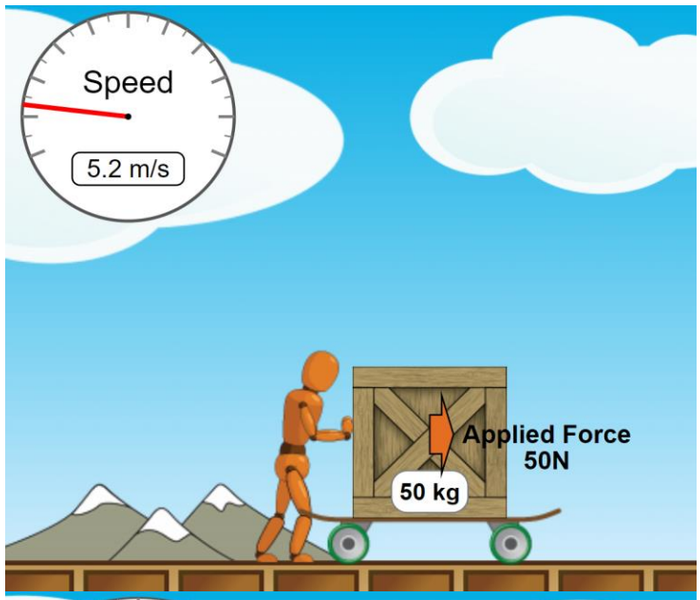
3. Position the 40-kg child on top of the skateboard. You have to observe its acceleration within a 5-second time interval by referring to Step 4. Use a digital stopwatch as a timer.

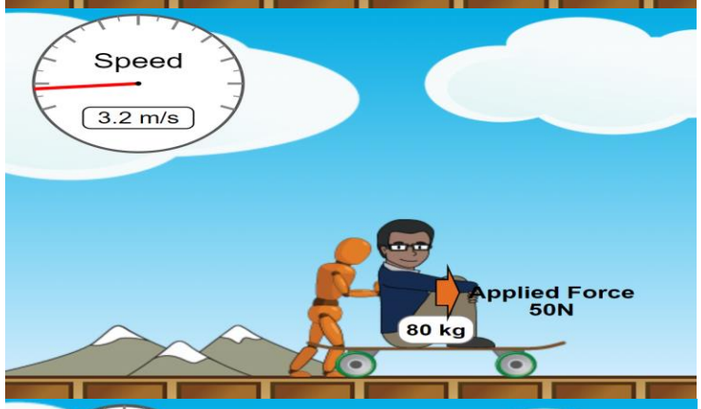
4. Set the force at **50 N.** The skateboard and its load will then start moving. Stop the motion of the body by pressing the "pause" ⏸ button **AFTER FIVE (5)** SECONDS (starting from the time you set the force as 50 N). Check the speed (refer to the speed shown in the circle, upper left) reached by the body within the 5-second time interval. Record this value in Table 1 as the final velocity of that particular item.

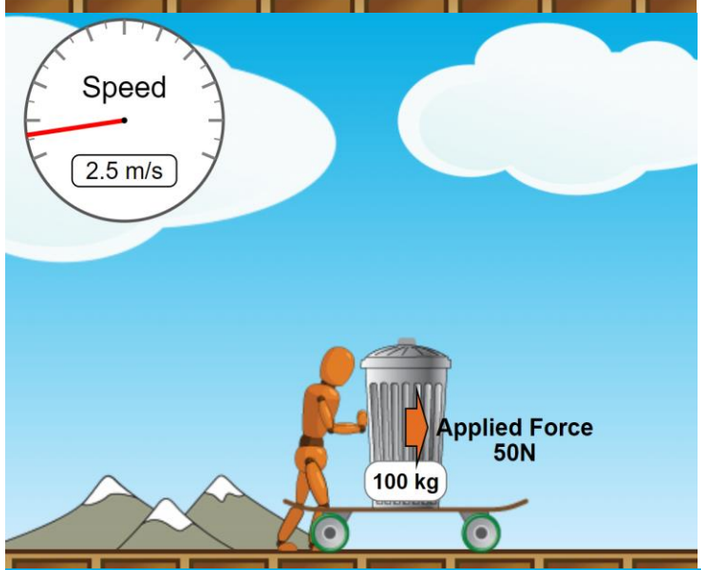
5. Do the same for all the other items listed in the table below. Click "reset" every time you start with a new item, and always tick all the items inside the yellow box. Remove the crate (the default setting) on top of the skateboard before placing a new item, unless the crate itself is the item you need to select. The force must be the same (50 N) for all these items.

6. Compute for the acceleration of all the items considered and record the data in the last column. The acceleration is equal to final velocity – initial velocity divided by time (time equals 5 seconds for all the items).




Speed
5.2 m/s
Applied Force
50N
50 kg


Speed
3.2 m/s
Applied Force
50N
80 kg


Speed
2.5 m/s
Applied Force
50N
100 kg

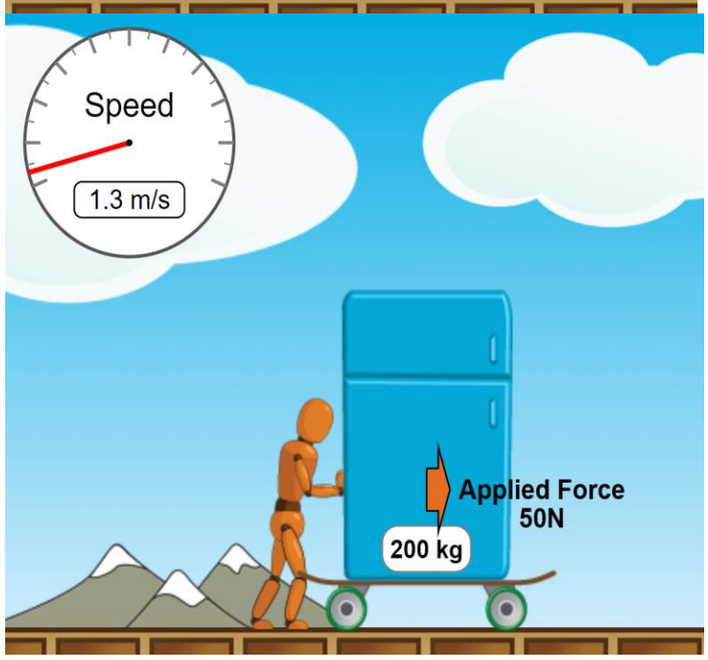

Speed
1.3 m/s
Applied Force
50N
200 kg

TABLE 1: ACCELERATION OF DIFFERENT BODIES AT 50-N FORCE

ITEM	MASS (kg)	INITIAL VELOCITY (m/s)	FINAL VELOCITY (m/s)	ACCELERATION (m/s^2)
child	40	0	6.5	1.3
crate	50	0	5.2	1.04
man	80	0	3.2	0.64
metal trash bin	100	0	2.5	0.5
refrigerator	200	0	1.3	0.26

PART B - GUIDE QUESTIONS:

c. What did you notice with the acceleration values obtained by the different items? What do you think caused the variations in these values?

The acceleration values for the different items decreased as their mass increased. This variation is caused by the relationship described in Newton's Second Law of Motion, F=ma. For a constant force, the acceleration is inversely proportional to the mass of the object. Therefore, heavier items experience less acceleration compared to lighter items when the same force is applied.

d. What variable/s can you manipulate in the simulation to make all the items get the same proximate values for their acceleration? Explain how this idea will work.

To make all items have the same proximate values for their acceleration, we can change the applied force. By adjusting the applied force for each item based on its mass, we can ensure that the acceleration remains constant across different masses. For example, using F=ma, if we want each item to have an acceleration of 5m/s^2, we could set the force as

F= m * 5m/s^2

This way, the force applied to each item compensates for its mass, resulting in similar acceleration values.

CONCEPT CHECK:

Complete the concepts below by filling in the blanks with the appropriate terms and underlining the appropriate word inside the parentheses.

At constant mass, the _acceleration_ of an object varies **(directly,)** with the net external force applied. That is to say, that an object's acceleration increases as the force applied is **(increased),** but its acceleration decreases if the force applied is (**decreased).**

At constant force, acceleration varies (**inversely**) with mass. When subjected to the same amount of net external force, a heavier object will experience (**less**) acceleration than a lighter one.

Newton's Second Law of Motion states that:

The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. This can be expressed with the formula F= ma, where F is the net force applied on the object, m is the mass of the object and a is the acceleration.