What is Net Force?

NaRiKa Corporation

1. Learning Outcomes

It is the purpose of this experiment guide to help learners understand the scientific concept of net force through experiments. Conventionally, learners learn the topic of net force out of their textbooks without conducting experiments. As opposed to such conventional learning method, this experiment guide is intended for learners to measure the strengths of individual forces acting on an object in newton (unit) (symbol: N).

Consequently, on the basis of measured results of experiments learners will be able to describe the concept of net force.

2. Introduction of Equipment for Experiments

1. Newton Meter

Spring scales with divisions based on the SI unit (the international system of units) called newton (N) has been commonly used for the topic of “Force and Motion” such as "composition (addition) and decomposition (resolution) of forces," "balance of forces," and "action and reaction". Experiments in this guide use Newton Meter, of which measurement range is ±19.99 N (with 0.01 N resolution). Notably, the minimum scale is as fine as 0.01N over the whole measurement range (see the instruction manual for more information).

A05-4065 Newton Meter GN-1

Minimum scalable divisions differ by the type of spring scales (see Table 1). Therefore, learners must select suitable spring scale depending on experiment objectives and/or mass of the object to measure. On the other hand, Newton Meter saves their time for preparation because of the wider measurement range compared to spring scale, as well as the consistent minimum scale over the whole measurement range.

Table 1. Newton Meter vs. Narika's Newton Spring balance (SO series)

Newton Meter GN-1			Narika's Newton Spring balance		
Cat. No.	Measurement range	Resolution	Cat. No.	Measurement range	Minimum scale
A05-4065	- 19.99 ~ + 19.99 N	0.01 N	A05-4053-W1	0 ~ 2 N	0.02 N
			A05-4053-W2	0 ~ 5 N	0.05 N
			A05-4053-W3	0 ~ 10 N	0.1 N

Additionally, most of commonly available Newton scales are designed to measure strength of pulling forces only. In contrast, Newton Meter measures both pushing and pulling forces.

3. Net Force

1. Purpose of this experiment:

Concept of the net force is usually the first topic taught in the unit of the nature of force. In this guide, learners will study the concept of the net force through their experiments to confirm: 1) when two forces are applied on an object in the same direction, the net force on the object is the sum of each individual force, 2) when two forces are applied to an object in opposite directions by pushing against each other, the net force is found by subtracting the strength of the smaller force from that of the larger force; thus, the object will move to the side on which smaller force is applied, and 3) when two forces of the same strength are applied to an object in opposite directions by pushing against each other, the net force on the object is equal to zero (0); thus, the object stays at rest.

2. What to prepare:

A05-4065 Newton Meter GN-1: 3 units
Wood block (100 g, 10 x 10 x 5 cm): 1 pc

3. Questions

1. A kid is pushing the refrigerator with a force of 100 N to the right, but it does not move. Therefore, a teacher helps him to move it. When the teacher pushes it with a force of 200 N, it moves. In this case, how much net force is applied to the refrigerator (see Fig. 1 and Fig. 2.)? Answer in the cell below.

N

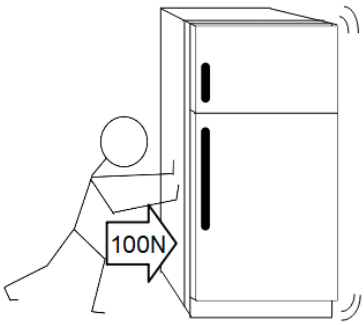

Fig. 1

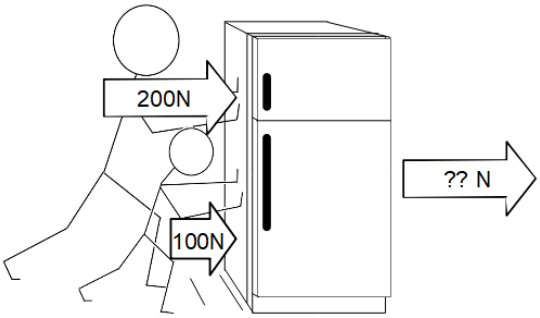

Fig. 2

2. When the teacher pushes on the refrigerator to the right with a force of 100 N, another teacher pushes on it from the opposite directions with a force of 200 N. In this case, which side does the refrigerator move to? How much net force (N) acts on the refrigerator (see Fig. 3)?
Answer in the cell below.

☐ It moves to the right. ☐ It moves toward to the left. N

3. When the teacher pushes on the refrigerator to the right with a force 100 N, another teacher pushes on it from the opposite directions with a force of 100 N. In this case, what will happen to the refrigerator (see Fig. 4)?

☐ It moves to the right. ☐ It stays at rest. ☐ It moves to the left.

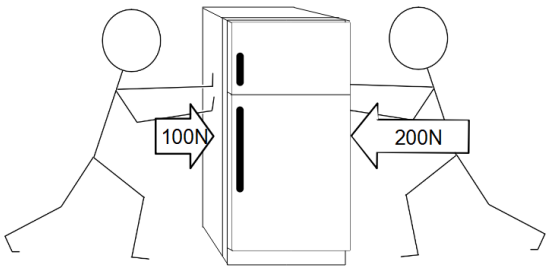

Fig. 3

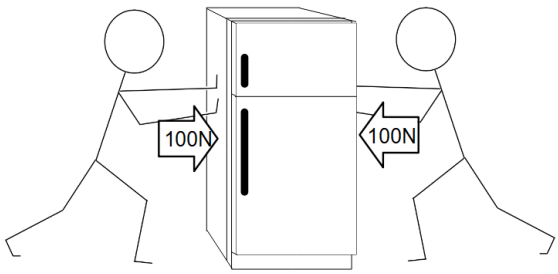

Fig. 4

4. Experiment

Verify what kind of changes in motion will happen to an object using the same setting as the above-mentioned one, but on a smaller scale.

Experiment 1.
Motion and strength of the net force act on an object when pushed by two forces from the same side (see Fig. 2 or Fig. 5).

In this experiment, use a wooden block instead of the refrigerator (Fig. 2). Measure the strength of force that acts on the wooden block with Newton Meters. With two Newton Meters (see No. 1 and No. 2 shown in the Fig. 5), push the wooden block while measuring the strength of the pushing force applied to the block. With another Newton Meter (see No. 3 shown in the Fig. 5), withstand the force applied from the opposite side of the block while measuring the strength of the pushing force applied to (or reaction force from) the block. Therefore, two learners in a pair are needed to use three Newton Meters for this experiment.

1) At first remove the hook attached to each Newton Meter.

2) Place one meter on one side of the wooden block and the other two meters on the opposite side as shown in Fig. 5.

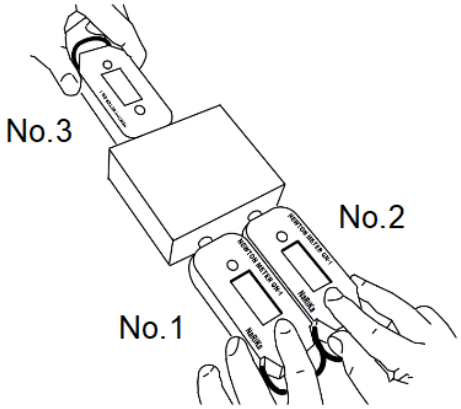

Fig. 5

3) Press the "ON/OFF" button of each meter for two seconds to turn the meter on. Check if numeral "0" is shown on each screen. If not, press the button again.

4) Put all the meters on a desk and press zero-calibration button on each of them (keep the meters at a distance of around 1 mm from the block).

5) As shown in Fig. 5, one person controls both of the No. 1 and No. 2 Newton Meters, while the other person monitors the No. 3 Newton Meter.

6) Slowly and carefully press the No. 1 and No. 2 Newton Meter synchronously against the block, while maintaining the strengths of the forces around the values shown in Table 2.

7) Keep holding the No. 3 Newton Meter still at the same position, and do not push the block back toward the Newton Meter No. 1 and No. 2.

8) As soon as each of Newton Meter No. 1 and No. 2 displays around the target value, synchronously press the "Hold" button on each of the three meters. Fill the values displayed on

each of three meters in Table 2 after rounding them to the nearest whole numbers.

9) Repeat above procedure until collecting enough data to fill all the blank columns in Table 2.

*Learners in pairs have to press "HOLD" button of all three meters synchronously to read each measurement value because the values displayed on the screen are fluctuating throughout the experiment.

*Do not press the Newton Meter No. 3 against the block. Just make sure the Newton Meter No. 3 is firmly fixed on the table and kept still.

Table 2. Target values and Measured values of force displayed on Newton Meters (No. 1~3)

Newton Meter No. 1		Newton Meter No. 2		Newton Meter No. 3
Target	Measurement	Target	Measurement	Measurement
1 N	N	3 N	N	N
2 N	N	2 N	N	N
3 N	N	1 N	N	N

10) Summarize the motion and strength of the net force act on an object when pushed by two forces from the same side based on the result shown in Table 2.

Experiment 2

Motion and strength of the net force act on an object when pushed by two forces in opposite directions (see Fig. 6).

In this experiment, use a wooden block instead of the refrigerator. Measure the strength of force acts on the wooden block with Newton Meters.

With two Newton Meters facing each other (see No. 4 and No. 5 shown in Fig. 6), push on each side of the block while measuring the strength of the pushing force applied to the block. Therefore, two learners in a pair are needed to use two Newton Meters for this experiment.

1) At first remove the hook attached to each Newton Meter.

2) Place one meter on one side of the wooden block and the other meter on the opposite side as shown in Fig. 6.

3) Press the "ON/OFF" button of each meter for two seconds to turn the meter on. Check if numeral "0" is shown on each screen.

4) Put two meters on a desk and press zero-calibration button on each of them (keep the meters at a distance of around 1 mm from the block).

5) As shown in Fig. 6, one person controls one of the two Newton Meters (No. 4 or No. 5) and the other person controls the other Newton Meter.

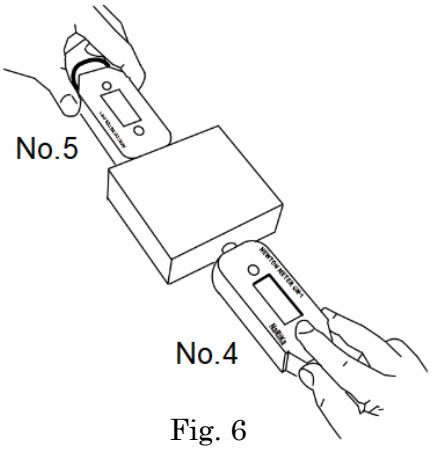

Fig. 6

6) Slowly and carefully press the two Newton Meters on the block synchronously.

7) Control the strength of the forces displayed on each of No. 4 and No. 5 Newton Meter until reaching the target values shown in Table 3.

8) As soon as each of the Newton Meters No. 4 and No. 5 displays around the target value, synchronously press the "Hold" button on each of the meter. Fill the values displayed on each of meter in Table 3 after rounding them to the nearest whole numbers.

9) Repeat above procedure until collecting enough data to fill all the blank columns in Table 3.

* Learners in pairs have to press "HOLD" button of the two meters synchronously to read each measurement value because the values displayed on the screen are fluctuating throughout the experiment.

Table 3. Target values and Measurement values of forces displayed on Newton Meters (No. 4~5)

Newton meter No. 4		Newton meter No. 5	
Target	Measurement	Target	Measurement
1 N	N	2 N	N
2 N	N	4 N	N
3 N	N	6 N	N

9) Summarize the motion and strength of the net force that acts on an object when pushed by two different strengths of forces from opposite directions based on the result shown in Table 3.

Experiment 3

Motion and strength of the net force act on an object when pushed by two strengths of the same forces in opposite directions (see Fig. 7).

In this experiment, use a wooden block instead of the refrigerator. Measure the strength of force acts on the wooden block with Newton Meters. With two Newton Meters facing each other (see No. 6 and No. 7 shown in Fig. 7), push on each side of the block while measuring the strength of the pushing force applied to the block. Therefore, two learners in a pair are needed to use two Newton Meters for this experiment.

1) At first remove the hook attached to each Newton Meter.

2) Place one meter on one side of the wooden block and the other meter on the opposite side as shown in Fig. 7.

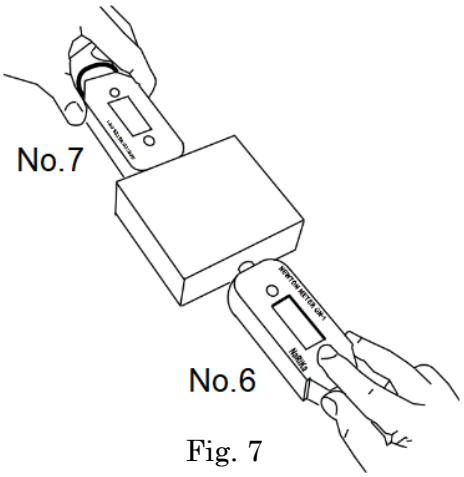

Fig. 7

3) Press the "ON/OFF" button of each meter for two seconds to turn the meter on. Check if numeral "0" is shown on each screen.

4) Put two meters on a desk and press zero-calibration button on each of them (keep the meters at a distance of around 1 mm from the block).

5) As shown in Fig. 7, one person controls one of the two Newton meters (No. 6 and No. 7) and the other person controls the other Newton Meter.

6) Slowly and carefully press the two Newton Meters on the block synchronously.

7) Control the strength of the forces displayed on each of No. 6 and No. 7 Newton Meter until reaching the target values shown in Table 4.

8) As soon as each of No. 6 and No. 7 Newton Meter displays around the target value, synchronously press the "Hold" button of each of the meter. Fill the values displayed on each of meter in Table 4 after rounding them to the nearest whole numbers.

9) Repeat above procedure until collecting enough data to fill all the blank column in Table 4.

*Learners in pair have to press "HOLD" button of the two meters synchronously to read each measurement value because the values displayed on the screen are fluctuating throughout the experiment.

Table 4. Target value and Measurement value of forces displayed on Newton Meters (No. 6~7)

Newton meter No. 6		Newton meter No. 7	
Target	Measurement	Target	Measurement
2 N	N	2 N	N
2 N	N	2 N	N
2 N	N	2 N	N

9) Summarize the motion and strength of the net force that acts on an object when pushed by two equal strengths of forces from opposite directions based on the result shown in Table 4.

4. Summary

Spring type Newton scales are generally designed to measure strength of pulling force only while measuring strength of pushing force falls outside of the scope of those scales. Furthermore, teachers/learners have to select the most suitable spring scale as appropriate according to experiment objectives and/or mass of the object to measure. Therefore, the science lab must be equipped with multiple types of spring scales with different measurement ranges.

On the other hand, the Newton Meter used in this experiment guide precisely measures strength of both pulling and pushing forces over the measurement range of ±19.99 N (with 0.01 N resolution), which is wider than the range of most types of spring scale. Furthermore, unlike spring scale, Newton Meter has the "HOLD" function that allows to retain measured value at any time.