Promoting the Use of Educational Technology in Learning and Teaching in Science (S1-3) Learning and Teaching Resources

Action and Reaction

Part A: Background and Connections	
Topic	11.5 Action and Reaction
Relevant theme, topic and learning focus	Unit 11: Force and Motion
Prior knowledge	• Basic ideas of force • Measuring force, e.g., use a spring balance to measure force • The motion of an object

Previous and subsequent learning outcomes	Previous learning activity:
	• 11.2 Force
	  • Describe the effect of force on changing the speed and direction of motion of an object
	  • State that Newton (N) is a unit of force and use a spring balance to measure force
	
	Subsequent learning activity:
	• Space flight

Part B: Details of the learning activity	
Description	**Building prior knowledge** The concepts of motion and effect of motion as prior knowledge. An unbalanced force can change an object's speed and / or direction. **Strategies learning** This learning activity involves using a technological platform, *DragGame*, to support students' observation skill and investigative skill related to action and reaction pairs. Specifically, students are shown a Fan Cart and use the concepts of action and reaction to explain their observations. Students mark down their observations on the worksheet. Students understand the features of action and reaction pairs under different objects and in opposite directions.

	Modelling of learning strategies The teacher will demonstrate fan-powered cart, which supports students to understand the relationship between force and motion. **Scaffolding Learning Questions** The teacher provides the classroom activity and the experiment for students to understand the relationship between action and reaction. The teacher prepares different levels of questions for students to think about the related concepts, such as yes / no questions, guiding questions and open-ended questions. **Independent student learning** Students can re-work the *DragGame* activities after the lesson to consolidate their learning.
Learning objectives	*After the lessons, students should be able to:* Knowledge • Recognise that forces always work in action and reaction pairs. • Understand that action and reaction pairs are equal in magnitude and opposite direction and act on different objects. Skills • Identify some action and reaction pairs of forces in daily life.
Segment time	80 minutes
Materials	Student Worksheet Record the measurement of experiments (Spring balance) and observations of experiments (Fan Cart) *DragGame* activity, available after the experiments: https://draggame.e-learning.hk/en/templates/338/view/ (Fan Cart) https://draggame.e-learning.hk/en/templates/339/view/ (Fan Cart with cardboard)
Science model relevant to the topic	Newton's third law of motion

<table>
<tr><th colspan="2">Part C: Implementation</th></tr>
<tr><td>Engagement
(Whole Class)
7 minutes</td><td>
<u>Pre-lesson questions:</u>
1. Can an action-reaction pair act on a single object?
Answer: No. An action-reaction pair acts on two different objects.

2. The unit of measurement on Spring balance is:
a. Newton (Answer)
b. km h^{-1}
c. mm
d. h

3. Is the following statement correct? Forces are always working in action and reaction pairs.
Answer: For every action, there is an equal and opposite reaction. In other words, when one object exerts a force on another object, the second object exerts an equal and opposite force on the first object.

4. Action and reaction are (a) in direction and (b) in magnitude.
Answer: a) opposite
b) same

<u>Activating Prior Knowledge</u>

● The teacher introduces the following scenario to students to activate their understanding on the nature of force.
● The teacher asks students about the daily life example: how does the basketball bounce back?

<u>Introduction of the topic:</u>

● Teacher also asked students to join an activity, “pushing the wall”.

● Teacher instruct students to use scientific language to describe the action and reaction pair: "Force on you by the wall", "Force on the wall by you".

● To compare the magnitude of these two forces for introducing the idea of Action and Reaction.
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<tr><td>Exploration
(Group Work)
8 minutes</td><td>
<u>Group Work 1: Observing and measuring</u>
● Teacher asks students to measure the force by recording the reading of spring balance.
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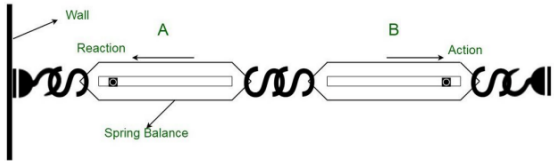
Students are comparing the size of the force acting on A by B and that on B by A.
Students observe and compare the results within the group.

Experiment


<table>
<tr><td>Reading on spring balance A (Newton)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Reading on spring balance B (Newton)</td><td></td><td></td><td></td><td></td><td></td></tr>
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Compare the size of the force acting on A by B, and that on B by A.

<u>Teacher reviews and summarises Group Work 1:</u>

Teacher recalls the objective of the Group Work: compare the size of the force acting on A by B, and that on B by A.
Teacher asks students for the measurement results based on the Newton scale (N). Same or different?
Teacher asks students why the result can be different between groups.

Teacher guides students to think of possible reasons from the error of measurement. Meanwhile, teacher can also discuss the concept and features of action-reaction pairs with students.
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Explanation
(Whole Class)
10 minutes

(Group Work)
15 minutes
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Based on the Group Work 1, teacher starts the concepts of Action-Reaction pairs and clarify features using science inquiry skills:

Teacher uses the result of an experiment to explain what equal in magnitude is, i.e., same size
The direction is opposite, i.e. if A pushes B forward, B is also pushed backward by A.
The two forces are between two objects.
Based on these three features, force on A by B and force on B by A are a pair of action and reaction.
The action-reaction pair will not act on the same object

<u>Group Work 2: Fan Cart Experiment (Part 1)</u>

Teacher introduces the setting and materials of the Fan Cart Experiment
Before the group work starts, the teacher asks students to predict the cart's motion.
Teacher asks students to carry out two investigations under different settings and make observations.

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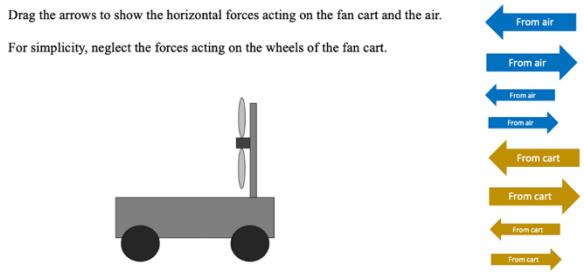
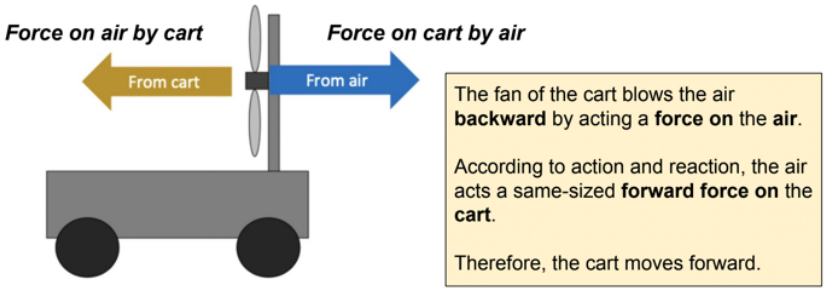
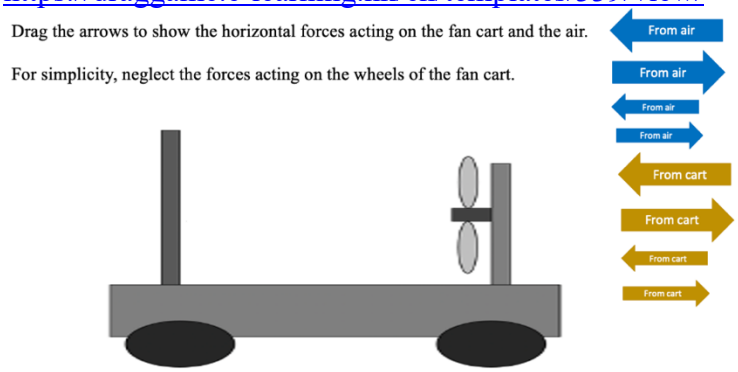
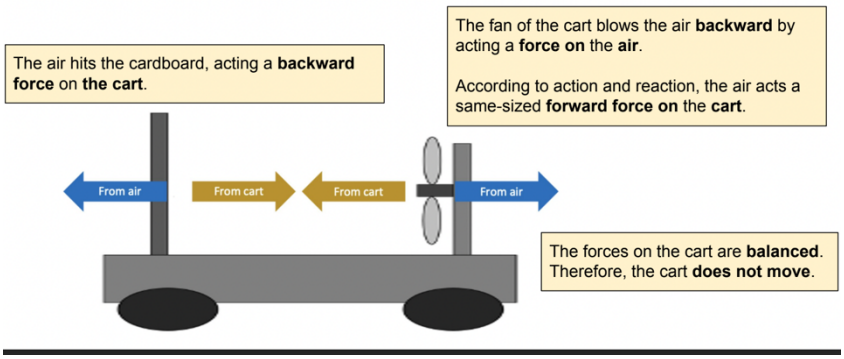
	1. Fix the fan onto the cart and turn it on 2. Fix the cardboard onto the back of the cart and hold the fan in hand, then blow air toward the cardboard ● Teacher asks students to **explain** their observation from the group, can the cart move successfully?
(Whole Class) 10 minutes	Teacher assigns the **DragGame Activity 1** to conclude the findings from the Fan Cart https://draggame.e-learning.hk/en/templates/338/view/  <u>Questions from DragGame Activity 1</u> - What is the difference between big and small arrows? - How did students choose the particular arrows and place the arrows in a suitable position? - Think of the direction of the force on the cart and the object which gives the force acting on the cart? - Force by the cart, which is acting on which object? (Answer: on the air) - Observing the position of arrows on the cart and in the air. The teacher provides the answers to support students in understanding the position and sizes of arrows. 
Elaboration	In the review of Group Work 2, the teacher consolidated ideas of force and worked on Fan Cart Experiment with Cardboard

(Whole Class and Work in Pair) 15 minutes	<u>Group Work 3: Fan Cart Experiment with Cardboard</u> Before the experiment started, the teacher asks students to predict the result of the Fan Cart Experiment with the Cardboard once turn on the fan: - Cart moves to left; - Cart moves to right OR - Cart does not move After the experiment, the teacher asked for the result from each group. - Teacher asks students to interpret the result of the experiment. Why are the results different? - Comparing Experiment 1 and Experiment 2, the teacher asks students for their findings. ▪ At rest? ▪ Moving right? ▪ Moving left? The teacher introduces **DragGame Activity 2** for the arrows arrangement when the cardboard is added to the cart. https://draggame.e-learning.hk/en/templates/339/view/  The teacher asks students about the observation of DragGame Activity 2 ● Which side of the fan is the cart at? ● Can you explain why the car is at rest? ● Does the cart push itself? ● Why are the arrows arranged in this way? ● The force by the cart? The force by the air? ● Are the forces on the cart balanced? The teacher provides the suggested answer from *DragGame Activity* 2, to demonstrate the forces when cardboard adds in the Fan Cart:

	- *Fix the fan onto the cart again. Turn on the fan so that it blows air toward the cardboard.* 
Summary (Whole Class and Work in Pair) 10 minutes	Based on the class activities, DragGame and experiments ***Fan Cart,*** the teacher will conclude the learning outcomes: ● From Experiment 2, the two horizontal forces acting on the Fan Cart are balanced. ● The forces on the Fan Cart are represented by the arrows. ● Using the concept of action-reaction pair to explain why the Fan Cart is at rest in the experiment. ● Introduction of the topic from raft example. Teacher uses the daily example, i.e. the video demonstrates why the raft moves forward. ● Conclude the action-reaction pair with the example at the beginning of the lesson.

Part D: Extensions	
Possible adaptations / extensions / modifications	Depending on the progress of the lesson and student's responses, the teacher can decide to use both or one of the following sets of the *DragGame*: https://draggame.e-learning.hk/en/templates/338/view/ https://draggame.e-learning.hk/en/templates/339/view/
Assessments	Formative assessment using the drawings in two DragGame activities, in which students will receive feedback on the following: • Position of Arrows • Direction of Arrows • Size of Arrows Students also can share their ideas from DragGame and Oral presentations during the class, which will include:

<table>
<tr><td></td><td>- <u>Knowledge</u>
* Action-Reaction in pairs
* The action and reaction act on different objects and in opposite directions
* Action-Reaction pairs are equal in magnitude

- <u>Skills</u>
* Measurement of Force (N) from Spring balance
* Identify the interaction between forces
* Use proper linking words to distinguish and sequence the critical findings from Fan Cart experiments. For example, "Firstly", "Secondly", etc.
* Use of proper linking words to explain the causal effect. For example, adding the Cardboard to Fan Cart, then the Cart is at rest.
* Use of proper sentences and starting phrases to refer to the DragGame diagrams. For example, "One can see that there is an arrow on the Fan Cart, which represents the force on the Fan Cart by the air?"
* Spelling and grammatical accuracy
* Identify some action and reaction pairs of forces in the daily example</td></tr>
<tr><td>Words List</td><td><table>
<tr><td>Action</td><td>Reaction</td><td>Equal in magnitude</td></tr>
<tr><td>Opposite in direction</td><td>Act on different objects</td><td></td></tr>
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Notes to teachers for effective implementation

- The teacher should create an open and warm classroom environment for students to expose their ideas and share their thoughts publicly. The teacher can demonstrate features of DragGame before students work on it.
- The teacher can ask students to clarify their *DragGame* drawings, and elaborate on their thought and reasoning using dialogic moves (e.g., *Say more*, *Press for reasoning*).
- The teacher can repeat, acknowledge and revoice students' ideas and invite other students to comment on their ideas using dialogic moves (e.g., *Revoice*, *Agree/disagree*, *Add on*).
- The teacher can try to make use of and refer to student ideas when guiding the class to build a class consensus when building explanations so that students think that their ideas are valued by the teacher.
- The teacher can provide the suggested answer to the DragGame activity after discussion time, which supports students to link up the activity, the experiment and application of scientific concepts.

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