Next Generation Science Standards - OneCar

Product Description	NGSS	Elementary	Middle School	High School
OneCar	**K-PS2-1** **3-PS2-2** **4-PS3-4** **MS-PS2-2 MS-PS3-1** **MS-PS3-2** **MS-PS3-5 HS-PS2-1** **HS-PS2-2** **HS-PS3-3** **K-2-ETS1-1** **K-2-ETS1-2** **K-2-ETS1-3** **3-5-ETS1-1** **3-5-ETS1-2** **3-5-ETS1-3** **MS-ETS1-2** **MS-ETS1-3** **MS-ETS1-4** **HS-ETS1-2** **HS-ETS1-3** The Standards above apply to all of the OneCar configurations.	**K-PS2-1** Students can use the OneCar to plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. **3-PS2-2** Students can use the OneCar to make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. **4-PS3-4** Using the different OneCar, students can apply scientific ideas to design, test, and redefine a device that converts energy from one form to another. **K-2-ETS1-1** Students can use the OneCar in an	**MS-PS2-2** Students can use the OneCar to plan and conduct an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. **MS-PS3-1** Students can use the OneCar to construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. **MS-PS3-2** Students can use the OneCar to develop a model to describe that when an arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. **MS-PS3-5** Students can use the OneCar to plan and conduct an	**HS-PS2-1** Students can use the OneCar to investigate and analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass and its acceleration. **HS-PS2-2** Students can build and rebuild the OneCar in an investigation to understand the mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. **HS-PS3-3** Students can construct the different OneCars in an investigation that requires them to design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

		investigation that requires them to ask questions, make observations, and gather information about a simple problem that can be solved through the development of a new or improved object or tool. **K-2-ETS1-2** Students can test and develop a simple sketch, drawing or physical model of the OneCar to illustrate how the shape of an object helps it function as needed to solve a given problem. **K-2-ETS1-3** Students can use the OneCar in an investigation on design of the cars. Students can analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. **3-5-ETS1-1** **3-5-ETS1-2** **3-5-ETS1-3**	investigation that constructs, uses, and presents arguments to support a claim that when the motion energy of an object changes, energy is transferred to or from the object. **MS-ETS1-2** Students can engineer the OneCar to evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3** Students can design, construct and test the OneCar, then analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4** Students can develop a model to generate data for interactive testing and modification of a proposed object, tool, or	**HS-ETS1-2** Students can use OneCar to design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3** Students can use the different OneCars to test and evaluate a solution to a complex real-world problem based on prioritized criteria and trade-off the account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

		Students can use the OneCar to test design problems, compare multiple possible solutions and carry out fair tests in which variables are controlled and failure points considered.	process such that an optimal design can be achieved.	

OneCar Lesson Ideas

K-PS2-1
3-PS2-2
MS-PS2-2
HS-PS2-2
HS-PS3-3
Students can build and rebuild the OneCar in a variety of ways to better understand energy, force and momentum.
With the systematic use of variables in the trials, students evaluate each powered type of car and determine the forces (pushes and pulls) acting on the car.
Hand sketches of each car with the acting forces indicated by arrows will give a better visual indication of the net acting force.
3-5-ETS1-1
3-5-ETS1-2
3-5-ETS1-3
Students can investigate the OneCar with an assortment of test condition to evaluate scientific and engineering problems.
Students can run the OneCar on a variety of surfaces (rug, tile, concrete, etc) to see the effects of resistance.
MS-PS3-1
Students can investigate how changes in mass affect motion. When powered by a constant force such as the electric motor or wind propeller, the mass of the car can be altered (weights added) and the average speed determined between set markers (qualitatively or quantitatively).

MS-PS3-2
Students can investigate how changes in potential energy affect motion. The OneCar can be launched from an inclined plane, elevated to different heights. Or the car can simply be launched from different positions on the ramp. The increase in potential energy should be visible in the attained kinetic energy and speed of the car.

MS-PS3-2
Students can investigate how changes in forces and/or direction affect motion. The OneCar can be launched from an inclined plane or powered using any of the energy sources to create a collision with another stationary car. Or two cars traveling in same direction at different speeds colliding with each other. All in one dimension.
MS-ETS1-2
MS-ETS1-3
HS-ETS1-2
HS-ETS1-3
Students can engineer the OneCar in a variety of ways to evaluate and design an optimal solution based on criteria for the constraints of the problem.
For example, students can

- modify the wheels with different textured tapes or rubber bands to increase the grip
- reduce the weight of the car by introducing new materials
- increase or decrease the length of the car by cutting or adding chassis boards

MS-ETS1-4
HS-ETS1-2
HS-ETS1-3
Students can run trials with the OneCar, and then develop computer models to guide possible modifications or variables to the OneCar. A test track can be developed with OneCar running with one set of wheels along a track (data cable channel). A motion app can be used or a set distance between posts to determine the average speed. A standardized track will produce more reliable data.

A Note from the Designer of OneCar:
Each powered method contributes to a higher kinetic energy of the car, but the type of force (constant or not) and the duration of the exertion of force determine the change in the motion of the car. Therefore for evaluation purposes students should only use one type of powered method when evaluating the effect of a changed variable. In the battery, solar, capacitor and wind (propeller) cars the electric motor transfers a fixed torque to the axle or propeller so the force can be seen as constant and this accelerates the car (Newton's 2nd Law of Motion); For school applications we can assume that the elastics and mousetrap cars exert a constant force too. In the compressed air and chemical cars, the initial high force is reduced as the internal pressure in the reservoir drops (non-constant forces).

Battery Car	**4-PS3-2** **HS-PS3-2** NGSS	**4-PS3-2** Using the Battery OneCar, students can		**HS-PS3-2** Students can use the Battery Car in an investigation to develop and use models

	Standards that apply to the Battery Car ONLY.	make observations to provide evidence that an electric current can transfer energy from place to place.		to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.
Battery Car Lesson Ideas				
4-PS3-2 **HS-PS3-2** Students can experiment with “used” batteries that may have less stored energy Students can evaluate: Are all battery brands equal? Test the power of “new” batteries from different manufacturers.				
Air Car	No Additional Standards apply to this configuration of the OneCar			
Air Car Lesson Ideas				
Students can use different sized bottles while keeping the pressure constant. Students can investigate how the size of the hole in the bottle cap affects performance. Students can turn the car into a rocket by powering it along a line. Students can vary the amounts of air pumped into the bottle. When students conduct the investigations, keep in mind that with the compressed air, the high initial force is reduced as the internal pressure in the reservoir drops (non-constant forces). Calculating an average speed over a fixed distance will provide more accurate data.				
Chemical Car	**K-PS2-2** **3-PS2-2** **MS-PS1-2** **HS-PS1-2** **HS-PS1-4** NGSS Standards that	**K-PS2-2** The Chemical Car can be loaded with recommended chemicals and water to investigate movement. Students can analyze	**MS-PS1-2** Using the Chemical OneCar, students can analyze and interpret data on the properties of substances before and after the substances interact to	**HS-PS1-2** Using the Chemical OneCar, students can construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of

	apply to the Chemical Car ONLY.	data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. **3-PS2-2** The Chemical Car can be loaded with recommended chemicals and water to investigate motion. Students can make observation and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	determine if a chemical reaction has occurred.	chemical properties. **HS-PS1-4** Using the Chemical OneCar, students can develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Chemical Car Lesson Ideas

K-PS2-2
3-PS2-2
Allow younger learners to experiment with the amount of water added, to investigate the speed and duration of the Chemical Car. Use a scale to quantify the mass of the Chemical Car.
MS-PS1-2
HS-PS1-2
Students can research and look up the chemical formulas and properties of the chemicals used in the Chemical Car, to evaluate the chemical reaction. They should also be able to describe the chemical reaction in words.
MS-PS1-2

HS-PS1-2
HS-PS1-4
Students can calculate the chemical ratios for the neutralization reaction using the balanced chemical reaction.
Students can research and develop other possible safe chemical reactions that convert chemical energy into kinetic energy.
When students conduct the investigations, keep in mind that with the chemical reaction, the high initial force is reduced as the internal pressure in the reservoir drops (non-constant forces). Calculating an average speed over a fixed distance will provide accurate data.

Elastic Car	No additional Standards apply to this configuration of the OneCar			

Elastic Car Lesson Ideas

Students can vary the number or size of elastic bands added to the car
Students can vary the number of wraps of the elastic band.

Propeller Car	No additional Standards apply to this configuration of the OneCar			

Propeller Car Lesson Ideas

Students can design and create a new shape for the propeller.
Students can Investigate how the material of the propeller affects motion.
Students can redesign the propeller position or angle.
Students can design and 3D print a new propeller.

Solar Car	**1-PS4-3** **4-PS3-2** **MS-PS4-1** **MS-PS4-2** **HS-PS4-5**	**1-PS4-3** Using the Solar OneCar, students can plan and conduct an investigation to determine the effect of	**MS-PS4-1** Students can conduct investigations showing evidence that the amplitude of a wave is related to the	**HS-PS4-5** Students can use Solar OneCar to conduct investigations and gather data about how technological devices use the principles of wave behavior and wave

	NGSS Standards that apply to the Solar Car ONLY.	placing objects made with different materials in the path of a beam of light. **4-PS3-2** Using the Solar OneCar, students can make observations to provide evidence that energy can be transferred from place to place by light.	energy in a wave is related to solar energy gathered with the Solar Cell on the Solar OneCar. **MS-PS4-2** Students can use the Solar OneCar to develop and use a model to describe how waves are reflected, absorbed, or transmitted through various materials.	interactions with matter to transmit and capture energy.
Solar Car Lesson Ideas **1-PS4-3** **4-PS3-2** **MS-PS4-2** Students can use different sunny conditions to evaluate optimum driving conditions for the OneCar. **MS-PS4-1** Students plan and investigate to cover the solar panel with different colored transparent gel screens (light filters). OneCar is monitored for average speed or distance that it moves a stationary object. **MS-PS4-2** **HS-PS3-3** **HS-PS4-5** Students can investigate solar power and describe with data, diagrams or descriptions how various materials affect the waves. The Solar Car is set up on a smooth surface and is powered by the reflection of sun onto its solar panel by a hand mirror. Here are a few options: • one mirror; • one mirror through a glass window; • one mirror through a red gelled screen (light filter) • two mirrors taking the reflective angles in consideration Students can change the angle of the solar panel.				
Capacitor Car	**4-PS3-2** **MS-PS4-1**	**4-PS3-2** Using the Capacitor		**HS-PS3-2** Students can use the Capacitor Car in

	HS-PS3-2 NGSS Standards apply to the Capacitor Car ONLY.	OneCar, students can make observations to provide evidence that electric current can transfer energy from place to place.		an investigation to develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.

Capacitor Car Lesson Ideas

4-PS3-2
HS-PS3-2
This may be students' first exposure to a capacitor:

- Demonstrate the uses of a capacitor with other applications

Students can vary the amount of time the capacitor is charged before a test run
Students research, plan and produce a simple capacitor made from plastic film and aluminum foil

Mousetrap Car	No additional Standards apply to this configuration of the OneCar			

Mousetrap Car Lesson Ideas

Mousetrap car performance is often evaluated by the distance a car travels. To achieve the best distance, the pull force should engage with the axle over the longest possible period. Students can design, test, and redefine their mousetrap powered cars tweaking the following parameters:

- Size and mass distribution of the wheels powering the car
- The length of the car body and the mousetrap lever arm
- The weight distribution of the car
- Friction points in the car