Lesson 10.3 Newton’s second law of motion

Recommended teaching time for this lesson: 1 x 60 minute period

• 35 minutes of explicit teaching

• 25 minutes of suggested classroom activities

• 40 minutes homework

Getting started

Key ideas

* Newton’s second law of motion states that the acceleration of an object is in the direction of the net external force acting on it, proportional to the size of the force, and inversely proportional to its mass

Curriculum links

Science understanding

* Describe the three laws of motion of classical mechanics and give examples of each.
* Solve problems using of the laws of classical mechanics and .

Advice for teaching this lesson

Things to know before you start teaching

Newton’s second law of motion is a very simple equation that applies to nearly every scenario. Emphasis should be given to students that if there is an acceleration – of any sort – then Newton’s second law is applicable. This will become very relevant in Unit 3 – Gravity and Motion in future studies.

Common misconceptions

* Students often misunderstand that force applied equals the acceleration of the object. Students should be emphasised that the **net** force equals the acceleration of the object. The challenge level of Activity 2 will emphasise this to students who are capable.

Differentiation strategies

Provide a triangle equation for students to use for Newton’s second law. See Lesson 2.9 for an example of this.

Encourage students who are language focused to write Newton’s second law in three different formats focusing on each variable.

Starter activity: Physics in space!

Approximate time: 5 minutes

**Activity placement:** Place directly after Lesson overview

**Activity summary:** Video from the International Space Station demonstrating Newton’s second law of motion.

Notes for the teacher

Video link is: <https://www.youtube.com/watch?v=sPZ2bjW53c8>

Ensure students write evidence based sentences by referring to observations.

Instructions for students

Watch the following video.

STEMonstrations: Newton's second kaw of motion: <https://www.youtube.com/watch?v=sPZ2bjW53c8>

* 1. Write a summary sentence about how mass affects the final velocity of an object. Note that after the object leaves the string there is no more acceleration, so you are seeing velocity for most of the video.

Helpful hints

* The video talks about the acceleration, and what they say is true; however, you can’t observe the acceleration as easily as the velocity/speed of the object.

Answers

1. Student answers will vary. The following is a sample answer.
As mass increases the final velocity of the object gets less. This implies the acceleration is also less.

Classroom activity: Force doesn’t always equal movement

Approximate time: 10 minutes

**Activity placement:** Place directly above “Skill drill: Evaluating data related to Newton’s second law”

**Activity summary:** A small reflection activity.

Notes for the teacher

It is worthwhile getting students to share their constructed responses with the class/you in order to assess understanding.

Instructions for students

Step 1: Read the scenario below and answer the question following.
“You apply 10N of force to a stationary object, but it does not move.”

1. Explain how applying a force could not cause a change in motion.

Step 2: When asked by your teacher share your answers with the class.

Helpful hints

* Is an applied force the only force that may be acting on an object?

Answers

1. Student answers will vary. The following is a sample answer.
If the applied force is opposed by an equal force, then the net force will still be 0. As such there would be no change to the motion of a stationary object.

Classroom activity: Kinematics and the second law

Approximate time: 10 minutes

**Activity placement:** Place directly above “Check your learning 10.3”

**Activity summary:** A practice question linking the kinematic equations from the previous module to Newton’s second law.

Notes for the teacher

Students should recognise that data from one equation can be fed into another equation.

Higher skill students may prefer to substitute all equations together rather than solve one equation and then substitute this value into another equation. This is a good skill to develop for cancelling off values down the track. They will see this in Module 11 with kinetic energy to gravitational potential energy conversions.

Instructions for students

Solve the following question. You will need to use your skills from Module 9 as well as your learning from this lesson.

1. A car of 1100 kg accelerates to maximum speed over 40 metres in 5 seconds. Calculate the amount of force needed from the engine.

Helpful hints

* Remember your *suvat* equations from Lesson 9.7.

Support activity

Notes for the teacher

This will use the slightly simpler *v* = *u*+*at* equation but achieve the same final answer.

Instructions for students

Solve the following question. You will need to use your skills from Module 9 as well as your learning from this lesson.

1. Calculate the acceleration needed for a car to go from stationary to 16 m/s in 5 seconds.
2. Calculate the force needed if the car has a mass of 1100 kg.

Challenge activity

Notes for the teacher

This provides more information but requires students to work out a force net from the *suvat* equations and Newton’s second law.

Instructions for students

Solve the following question. You will need to use your skills from Module 9 as well as your learning from this lesson.

1. A 1100 kg car accelerates from stationary to 16 m/s in 80 m, while the engine applies 3200 N of force. Calculate the resistive force on the car.

Answers

Support activity

Challenge activity