Acceleration

Introduction

The difference between velocity (in metres per second) and acceleration (in metres per second squared) is key in science. Yet students meeting these terms for the first time in secondary school are often unable to discriminate between these ideas, or the terminology and the units used. Using a Micro:bit to detect acceleration rather than velocity gives students an opportunity to get first hand experience of the difference between these aspects of motion.

Space context

Figure 1 ESA/CNES/ARIANESPACE-Optique Video du CSG, S. Martin

The last weather satellite in Europe's highly successful Meteosat Second Generation (MTG) series lifted off on an Ariane 5 launcher at 21:42 GMT on 15 July 2015 from Europe's Spaceport in Kourou, French Guiana.

Introduction

Students will be familiar with pictures of spacecraft, including ISS, travelling through space at high velocity with no rockets firing, and without needing fuel. They will also be familiar with seeing the launch of space vehicles, where large amounts of fuel are needed to escape from Earth's gravitational field. This activity will help explain that during acceleration fuel is required but fuel is not required when travelling at constant velocity, providing there are no resistant forces acting. Interplanetary travel will require a huge fuel payload compared to orbiting flights around a planet.

Prior Knowledge

When objects are in motion the distance they travel over a certain time is called 'velocity'.

If they speed up or slow down their velocity changes. The rate at which it changes is called 'acceleration'. Acceleration can have a positive or negative value depending on whether the object speeds up or slows down.

If acceleration is zero, the object will continue to move at the same velocity or remain stationary.

Learning intentions

Show that an object travelling at constant velocity has zero acceleration. Maintaining acceleration requires the continuous input of increasing amounts of effort.

To overcome the acceleration due to Earth's gravity, space vehicles need to carry and use significant amounts of fuel.

By adjusting inputs in the code, students will be able to change the orientation of the accelerometer used as input to the device. (This may be useful if they choose to attach the Micro:bit to a vehicle for part of this lesson.)

Resources

- Micro:bit and connecting lead to computer
- Battery pack
- Computer with access to Micro:bit web site to download code

Preparation

The code for this activity is available **here**

Once the code has been downloaded it needs to be compiled and flashed to the Micro:bit. Additional help is available **here**

To start the procedure, press the reset button on the rear of the device.

Lesson activity

When the procedure is first run on the Micro:bit device, none of the LEDs are illuminated. Moving the device will cause the LEDs to light up when the device accelerates, but then will turn off again when motion stops or the device moves at constant motion. Challenge the students to move the device whilst keeping the LEDs off. Explain that constant motion does not involve acceleration, and that constant motion does not mean either fast or slow – it is independent of velocity.

Next, challenge the students to keep the LEDs illuminated for as long as possible.

Possible results table

Attempt number	Velocity at start (low/medium/high)	Velocity at finish (low/medium/high)	Estimated duration of acceleration /s	What did you do?

Many will move the device as fast as possible, but be unable to maintain acceleration for long. Students who move the device very slowly and accelerate at a slow rate are likely to be most successful in this challenge. Students should be able to explain that they need to exert considerable amounts of effort to maintain acceleration. Relate this to the fuel payload of spacecraft at launch.

The activity could be completed using a hand held Micro:bit device, or students could manufacture a vehicle to use in their investigation.

Assessment opportunities

- Ask students to sketch distance time graphs for the device when it was travelling at constant velocity and at constant acceleration. This could be completed as a group or individual activity.
- Ask students to describe, and then explain, the difference between acceleration and velocity.
- Ask students to link their developing understanding to fuel consumption of cars at different stages in a short journey. Present students with an image of a space craft at launch, with fuel tanks labeled. Ask them to explain why the fuel tanks are so much larger than those of a passenger aircraft.

Taking it further

Introduce the idea of circular rather than linear acceleration. Some students may discover that moving the Micro:bit in a circular path results in constant acceleration – this can be linked to the use of centrifuges for astronaut training.

Explore how weightlessness is imitated in astronaut training, using a 'commercial' airliner. See ESA video here

Micro:bit contains a three axis accelerometer. When stationary, two will give a zero reading, and the third will indicate gravity. How can the Micro:bit be used to simulate conditions of weightlessness?

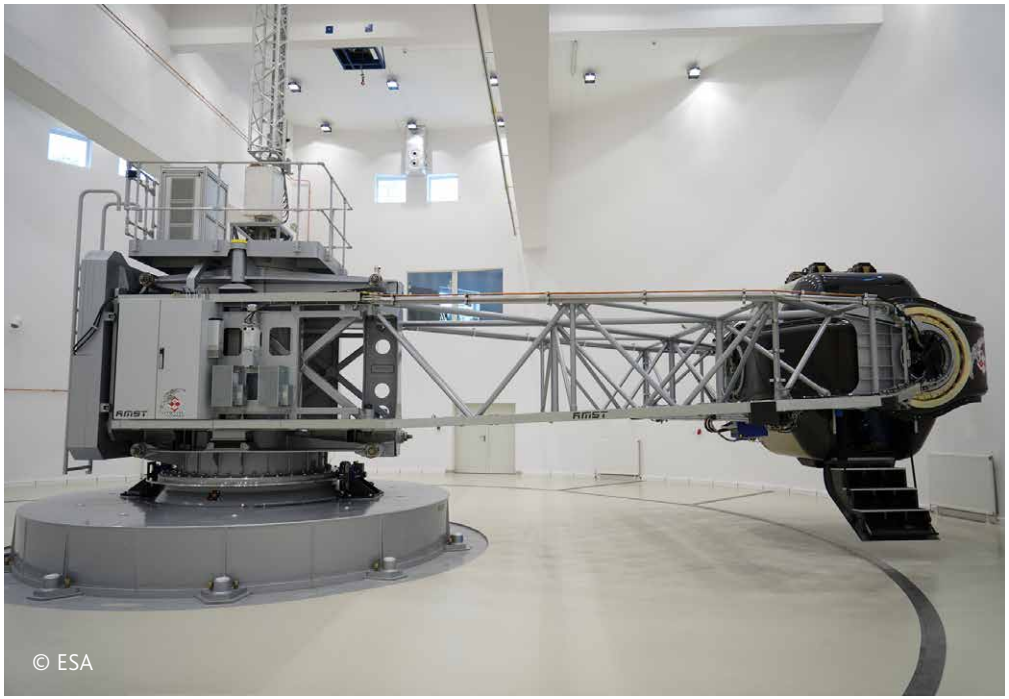

Figure 2

Links

Teacher support on Micro:bit site

NASA site describing space shuttle launch facts and figures