Year 10

Conceptual narrative Science: Forces and motion

In the physical sciences sub-strand, there are two main conceptual threads being developed from Foundation through to Year 10, energy and forces and motion.

Big ideas

A variety of physics laws emphasising Newton's Laws, explain why objects move as they do.

What concepts do I want my students to understand?

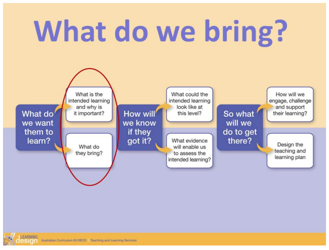
- Newton's first law of motion states that an object at rest will remain this way unless it is acted upon by a force.
- An object that is moving will continue to move at the same speed and in the same direction, unless an unbalanced force acts upon it.
- Newton's second law of motion, states that an object will accelerate in the direction of an unbalanced force acting upon it. The size of this acceleration depends upon the mass the object and the size of the force acting upon it.
- Newton's third law states that for every action force there is an equal (in size) and opposite (in direction) reaction force.

Appendix 1 shows how the three interwoven strands, Science Understanding, Science as a Human Endeavour and Science Inquiry Skills, work together to build the sophistication and complexity of the science concepts from Foundation to Year 10.

This conceptual narrative illustrates one of the nine science concepts from the Australian Curriculum: Science Content structure. It tells the story of the concept in isolation of the eight others. However, there are situations when it is advisable to teach both concepts (energy and forces and motion) together, because they complement each other.

Note: Not all concepts are specifically addressed in each year level.

Introduction



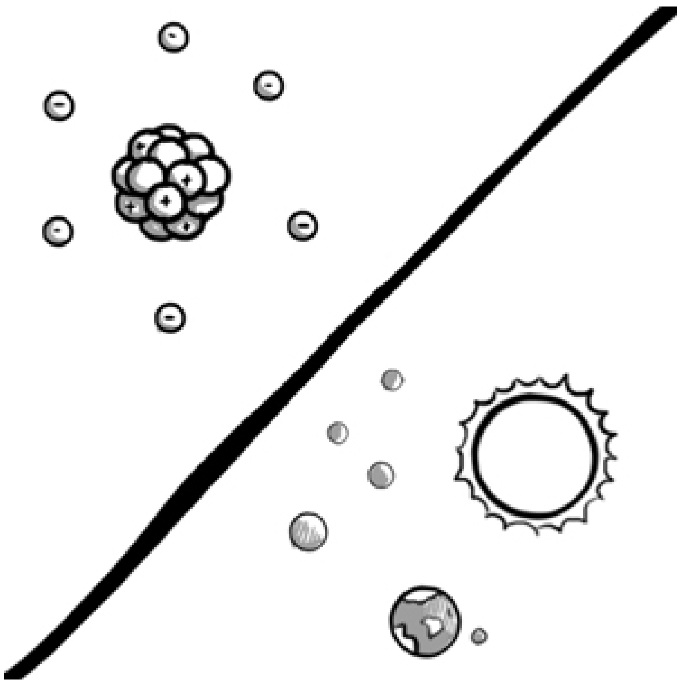
What might my students already know about this concept?

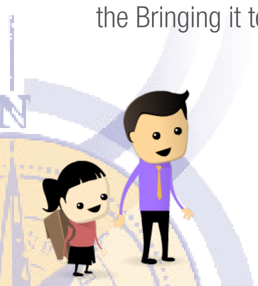
Students are likely to be aware that an object at rest stays at rest, and an object in motion stays in motion with the same speed and in the same direction, unless acted upon by an unbalanced force. Students may know contact and non-contact forces.

What content could I use to explore this concept?

There are many contexts to investigate these laws to predict the motion of objects. We could learn the concept of action and reaction forces though baseball, balloons, bowling, and the concept of inertia through riding skateboards, or the concept of f=ma by making and letting off rockets.

Now to bring the essence of scientific understanding to life, let's think about this concept through the six questions from the Bringing it to Life tool (BitL).





In Year 10, we want our students to understand Newton's laws and use these to describe and predict the motion of objects.

Year 10 example

In this example, we will investigate how Newton's Laws of motion can be used to improve the performance in throwing a basketball through a ring, from the free throw line. I will take my students outside to throw a basketball into the basketball ring from the free throw line and video their throw, using a SloPro app.

What do you observe?

How can I help my students make observations?

Using the BitL questions, I could ask:

- *What do you observe?*

In Year 10, we want students to make observations and be aware that they may change over time and/or geographically. Students also need to be able to make observations from secondary sources when necessary. I want students to observe the forces acting on themselves and others, when throwing the basketball. I want them to decide on what features, actions or properties they will observe and measure, and what equipment they need to help them. I could ask:

- *Does everyone who gets the shot in, have the same techniques?*
- *Does it matter how you hold the ball?*
- *Does it matter if you hold it in one hand or two hands?*

What patterns and relationships can you see?

How can I help students to see patterns and relationships? What questions might my students ask?

Student's curiosity leads them to ask questions. These questions help students to order their findings into a pattern to be able to make comparisons or find relationships. These questions support students to be more precise and foster analysis and classification of the observations.

Using the BitL questions, I could ask:

- *What patterns and relationships can you see?*

In Year 10, I want my students to explore Newton's theories by gathering evidence and then applying the physical laws. I want them to notice the relationship between technique of the person and their success. I could ask:

- *What comparisons would be useful to observe when you watch the video?*
- *What is different about the technique of a successful shooter and an unsuccessful shooter? Why do these differences impact on the success of the shot?*
- *Are there any anomalies in what you observe?*

I want my students to ask their own questions from what they notice and formulate an investigable question.

What do you predict will happen?

How can I help students to identify and formulate investigable questions?

Students ask testable questions that help them to narrow the focus of the inquiry. These questions provide opportunities for students to make predictions.

Using the BitL questions, I could ask:

- *What do you predict will happen?*

I want my students to predict what they think will happen with the question they formulate. I want them to hypothesise and check that their hypothesis is scientifically testable. I could prompt them with questions like:

- *Scientists currently think that unbalanced forces cause a change in an objects motion. How does this relate to your idea?*
- *Could you ask a question about the direction of a force?*

What investigations could you design?

These questions support students to develop science inquiry skills and problem solve.

Using the BitL questions, I could ask:

- *What investigations could you design?*

At Year 10 level, I want my students to not only know how to use an inquiry approach to answer scientific questions, but to design their own investigations. I would ask the students:

- *How might you test your predictions?*
- *Which variables will you keep constant?*
- *How will you consider fairness?*
- *Do you need to use two hands?*
- *Does it matter how you stand?*
- *How could you measure your results?*
- *What equipment could you use that will improve the accuracy of your data?*

How can you review and communicate?

How can I help students share their observations and questions?

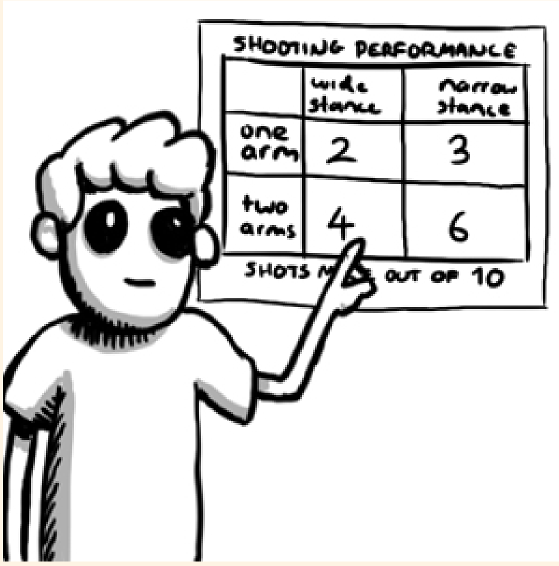
These questions stimulate student's reasoning and help them analyse, draw conclusions and make generalisations about the concepts.

Using the BitL questions, I could ask:

- *How can you review and communicate?*

At Year 10, I want my students to analyse and communicate any patterns they discover, and evaluate their results. I also want them to consider the source of uncertainty in their results and ways to improve the quality of the data. I would ask my students:

- *How might someone else explain this same phenomenon?*
- *What new questions might you ask to find out more about forces and motion?*



So what? What next?

How can I help students apply the concepts in a range of authentic contexts?

These questions support student's reasoning, to expand or change their ideas from their experience and evidence and generalise to new contexts.

Using the BitL questions, I could ask:

- *Finally, So what? What next?*
- *Who might be interested in the use of Newton's laws to improve sporting technique? How might they use this?*
- *How might understanding this phenomena help to improve sports training and safety in sport?*

Concluding comments

What concepts might students develop through working with the BitL questions in this way?

By exploring this science understanding through these questions, we can help our students to be able to think, work and process scientifically. Students can connect science to their world and consider why they need to learn about forces and how they connect in terms of Newton's laws of motion.

Appendix 1

Appendix 1 shows how the three interwoven strands, Science Understanding, Science as a Human Endeavour and Science Inquiry Skills, work together to build the sophistication and complexity of the science concepts from Foundation to Year 10.

This conceptual narrative illustrates one of the nine science concepts from the Australian Curriculum: Science Content structure. These concepts develop in depth and breadth of understanding from Foundation to Year 10. This conceptual narrative tells the story of the concept in isolation of the eight others. However, there are situations when it is advisable to teach both concepts (energy and forces and motion) together, because they complement each other.

Note: Not all concepts are specifically addressed in each year level.

Physical sciences

In the physical sciences sub-strand, there are two main conceptual threads being developed from Foundation through to Year 10. They are the concepts energy and forces and motion. Let's look at the concept forces and motion.

Foundation

In the Foundation year, students look at the way objects move, and how they move depends on their size and shape. For example, different balls like footballs, tennis balls and table tennis balls roll differently depending on their size and shape.

Year 2

In Year 2, students learn that movement is caused by either a push or a pull, and that it takes a bigger push to move a brick than a lunch box. They also learn that you can change the shape of some objects when a push or pull force is applied.

Year 4

In Year 4, students group forces as contact forces and non-contact forces. Examples of forces acting on contact are, a bat striking a ball or friction, where one object rubs against another object, like when you get a carpet burn. An example of a non-contact force is the pull of a magnet on paperclips.

Year 7

Year 7 is when students look at common situations where a balanced or unbalanced force cause changes to an object's motion. An example of a balanced force is a tug-of-war where the force exerted by the two teams is equal and it is clear that neither team will win. We say the forces on the rope are balanced, when the rope stays still. However, if the forces on the rope are unbalanced we can see a different effect. If in the tug-o-war and one side exerts greater force than the other, then the forces on the rope are unbalanced and the rope starts to move in the direction of the greatest force.

Year 10

At Year 10, students use Newton's laws to describe and predict motion and use mathematics to quantify this. Force is equal to, the mass times the acceleration, and speed is equal to distance divided by time. These are equations that students use to describe the effects of interactions between objects. They extend the application of force to other scales, including forces between atoms and between stars and planets.

So from Foundation to Year 10, students broaden and deepen their understanding by building on from their learning about forces and the motion of familiar objects, to consider a wider range of forces and then use laws and mathematical models to describe, predict and generalise.