Game lesson title	Exploring Newton's Laws of Motion with Osmos		
Brief intro	Help your students understand Newton's three laws of motion by exploring them in a video game. *Osmos* is a single-player computer/mobile game involving physics-based gameplay to solve puzzles. You are a mote, a blob of matter and your objective is to grow by absorbing other motes. To move around you need to eject matter behind you, propelling you forwards. However, you must balance ejecting matter (which causes you to shrink) and moving quickly. *Osmos* provides a physics sandbox for players to explore forces and motion in a frictionless space. The controls are simple and easy for players of all ability levels to learn.		
Lesson hook	Confused about reaction forces? Not sure what F=ma actually means? Play *Osmos* to experiment with forces and feel Newton's Laws of Motion in action.		
Suggested year level	**Year 7 - Year 10**	**Suggested age level**	12+ years old
Suggested duration	2x 50 min lessons (flexible)	**Costs involved?** (detail below)	No
Author	You are free to copy, communicate and adapt this lesson plan which was created by Megan Pusey and licensed under a Creative Commons Attribution 2.0		

Subject/s	
☒ **Science**	
Curriculum/Capabilities Alignment (VIC/AC) and Skills	
ACSSU117 (Year 7)	Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object.
ACSSU190 (Year 10)	The motion of objects can be described and predicted using the laws of physics.

VCSSU103 (Year 7-8)	Change to an object's motion is caused by unbalanced forces acting on the object; Earth's gravity pulls objects towards the centre of Earth.
VCSSU133 (Year 9-10)	The description and explanation of the motion of objects involves the interaction of forces and the exchange of energy and can be described and predicted using the laws of physics.

Game Used	**Osmos**		
Game play required?	**Yes. Play during class – approx. 30-40 mins.**		
CLASSIFICATION	**CONSOLE**	**INTERNET REQUIRED?**	**COST (RRP)**
G	*PC, Mac, Linux, Android, iPhone, iPad*	Not after initial download	*Demo is free* *US$5 for full game*

Important note about Game Classification

As classifications can change, teachers are responsible for checking the latest videogame classification and suitability for their class age group. Please visit https://www.classification.gov.au/ and https://www.commonsense.org/education/ to guide you.

How are games used by students in the lesson?

☐ **Watchers** – observing, analysing and evaluating. Learning about the world and ourselves through understanding the impact of games culture and industry.

☒ **Players** - learning by playing videogames - learning things applicable to life outside of (and in) the game e.g. flight simulators, esports, etc.

☐ **Makers** - learning through making games (coding, creative production, teamwork, leadership)

☐ **Explorers** (Minecraft) – imaginative, self-directed, exploratory/sandbox learning.

eSafety Considerations

None

Technical Notes
The game needs to be downloaded from the Osmos website prior to playing. The free demo is sufficient for this lesson. https://www.osmos-game.com/

Prior knowledge/skills (Required/Recommended/References)	
No prior knowledge or skills needed.	
Student outcomes	
Examples of student work	• Videos explaining forces or Newton's laws of motion
Learning goals	KNOW: **Forces (Year 7-8)** • When forces are balanced an object will keep doing what it's doing (e.g. moving at a constant velocity or remaining at rest). It won't speed up or slow down. • When forces are unbalanced an object will speed up (accelerate) or slow down (decelerate). **Newton's Laws (Year 9-10)** Newton's three laws of motion: 1. An object in motion will stay in motion unless acted upon by an external force 2. Net force is equal to mass multiplied by acceleration (F = ma) 3. For every action there's an equal and opposite reaction
	BE ABLE TO: **Forces (Year 7-8)** • Explain situations (in the game and real-life) using the ideas of balance/unbalanced forces • Identify when forces are balanced/unbalanced **Newton's Laws (Year 9-10)** • Explain situations (in the game and real-life) using Newton's three laws of motion

	• Choose which of Newton's three laws is most appropriate for explaining a given situation
	IMPROVE: **Year 7 - 10** • Ability to communicate scientific concepts using the correct terminology

LESSON SEQUENCE	
Prep & introduction activities	Have students download the free demo of the game (or paid version if using the full game). You can introduce the scientific ideas first and then play the game OR play the game first and then introduce the scientific ideas/terminology. Any good science textbook will contain information about forces/Newton's Laws. YouTube also has good introductory videos on the topics such as: • Bill Nye – Balanced/unbalanced forces (2:13) • Crash Course – Newton's Laws (11:03)

Main lesson activities	**Lesson 1**
	This first lesson is about allowing students time to explore the concepts.
	
	Playing through the levels of *Osmos* gives students experience with how objects move in a near frictionless environment. This is different from their everyday experiences with motion/forces.
	It's critical to developing their understanding of forces and Newton's Laws to allow them time to play and explore the different levels of *Osmos*. This is a single-player game, but students can take turns playing if there are limited devices.
	While students are playing, walk around the room and engage them in discussions. Ask students questions to encourage them to verbalise their understanding of what is happening on the screen such as:
	• What is happening here?
	• Why is it doing that?
	• How can you move in this game?
	  ○ How do you speed up?
	  ○ How do you slow down?
	• What are you trying to do?
	• How is this different from real-life?
	
	Lesson 2
	This second lesson is about getting students to communicate their understanding of the concepts. Students (or small groups of students) will

	create a short video explaining one concept (e.g. one of Newton's Laws or one situation of balanced/unbalanced forces). You may like to assign concepts to students/groups to avoid repetition. In the video students will need to include an example from *Osmos* and an example from real-life. • To capture footage from *Osmos* (by screencasting) I recommend the in-built tools on Mac (Quicktime) or Windows (Xbox Game Bar -Windows key + G). • For capturing footage from real-life students could use tablets, phones or laptop cameras. If this is not feasible they could use existing footage/photos found online. • There are multiple options for creating/editing videos, choose whichever is easiest for you. For example, iMovie (Mac only), Video Editor (Windows 10 Photos app), OpenShot. Students will then share their videos with the class.
Reflection activity	When viewing videos made by other students in the class, students can provide feedback with one positive comment and one constructive comment. Feedback can be anonymous if desired or use a tool like Poll Everywhere or Google/Microsoft Forms. Students/groups then receive their feedback and reflect on how they could improve their video and explanation.
Differentiation: modification, extension and inclusion notes	**Differentiation:** For students who have limited understanding, stay on the demo levels and replay levels if needed. If you purchase the full version of the game, there are many levels that increase in difficulty, further extending students. To extend students who have a good understanding of forces/Newton's Laws play the levels involving orbits. This will further their understanding of gravity and orbits which reappear in the Year 11/12 ATAR Physics courses. You can omit the video creation task if you want to just focus on the science understanding or if students will find it too technically challenging. **Inclusion:** This game uses simple controls and you should be able to find a version that will work for most students. On the PC, Mac, Linux version players can use a mouse or keyboard. The tablet/smartphone version uses the touch screen. For students who are Deaf or hard of hearing the game can be successfully played without sound.

Student Homework/Further Work
Continue playing more levels of *Osmos* to further develop understanding of forces/Newton's Laws.
Assessment
You can test student understanding with a quiz. Quizizz allows quizzes to be done live in class or set for homework (done in student's own time). Balanced/unbalanced forces quiz on Quizizz Newton's Laws quiz on Quizizz

ACMI Game Lessons acknowledges the support of the Department of Education Training, Victoria, through the Strategic Partnerships Program.