Lesson Plan

Grade/Class	Grade 6 Science	Date/Time	NA
Topic/Unit Title	Understanding Mass and Weight of Planets	Time	60 minutes

Lesson Outcomes / Purpose

Curriculum: Outcomes, Essential Questions, Targeted Learning and Experiences

Utilizing Manitoba curricula list all outcomes, essential questions, descriptions of targeted learning or experiences that will be presented/explored in this lesson.

6-4-11: Recognize that mass is the amount of matter in an object, that weight is the force of gravity on the mass of an object, and that the force of gravity varies from planet to planet. GLO: D3

6-0-6A: Construct graphs to display data and interpret and evaluate these and other graphs. GLO: C2, C6

Essential Questions:

1. What is the difference between mass and weight?
2. How does gravitational acceleration change with altitude?
3. How does gravitational acceleration change with planet mass?
4. How does gravitational acceleration change with planet radius?

Targeted Learning and Experiences:
Students will use DESMOS to visualize gravitational acceleration when changing altitude, planet mass, and planet radius.

Specific Learning Outcomes and Evidence of Learning

Expand on the targeted learning and curricular outcomes noted above. Consider referring to the supplemental resource attached to the Unit Planning Template, "*Appendices of Verbs"* and making use of sentence leads, ("The student(s) will be able…"(TSWBA) and "I can…" statements) to describe what observable evidence of learning students will engage in, and on which they may be assessed. For example:

1. Students will categorize… (Cognitive Domain, Analyze)
2. Students will design…(Affective Domain)
3. I can draw and label the parts of a tree. (Cognitive & Psychomotor Domain, Remember & Simple)
4. I can create coding to move my sphero to a 3 – 4 beat (Psychomotor Domain, Complex)

SLO:

- Students will be able to explain the differences between mass and weight.
- Students will use a graphing tool to determine differences in gravitational acceleration, fill in a table, and explain what is occurring.

Evidence:

- Students will be able to describe the differences between mass and weight.
- Students will accurately determine what is occurring with gravitational acceleration based on the table they fill in.

Cross-Curricular/Real World Connections

Note any relevant cross-curricular outcomes, essential questions or experiences or authentic learning present in this lesson.

Mathematics:
6.N.2 Solve problems involving large numbers, using technology. [ME, PS, T]
6.PR.1 Demonstrate an understanding of the relationships within tables of values to solve problems. [C, CN, PS, R]
6.PR.2 Represent and describe patterns and relationships using graphs and tables. [C, CN, ME, PS, R, V]
6.PR.3 Represent generalizations arising from number relationships using equations with letter variables. [C, CN, PS, R, V]

Assessment Evidence

Description (conversation, observation or product)	FOR	AS	OF
Initial inquiry discussion period (first three questions)	x	x	
Working with DESMOS (graphing calculator)	x	x	
Filling in the tables provided to the students		x	x
Answering questions based on the tables		x	x
Concluding remarks and student agreement	x		

Materials (ICT considered)

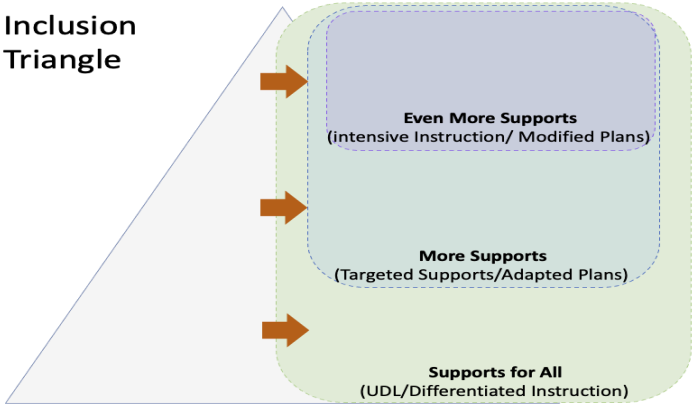
Resources (referenced), handouts, ICT, equipment, etc. Include exemplars / samples

- computer/internet
- DESMOS
- printable worksheets to fill

Key Words / Vocabulary

- Mass (M)
- Force (F)
- Weight (W)
- Gravitational acceleration (g)
- Altitude (z)
- Radius (R)

Differentiated Instruction & Student Specific Planning



Adapted from Shelley Moore, 2015

Considering students' readiness, interests, and learning profile, how will learning tasks for this lesson be differentiated?

Students will have various amounts of contact time with the teacher to assist in guiding them to collecting data. The teacher can prompt the students with questions to guide students towards the answer.

Learning Plan

		Time
Hook Activate	An application of predict, explain, observation, and explain (PEOE) model used by Dial (2009) will be used to reinforce the concept of mass vs weight. Students will be broken into pairs to talk about the following series of questions to identify whether they have a misconception about mass and weight: 1. Is there a difference between mass and weight? If so, explain why? 2. What is the standard unit to measure mass? Is it the same as weight? 3. If you were walking on the moon, would your mass change? Would your weight change?	**5 minutes**
Acquire	Mass is the amount of matter that makes up an entity. For example, a human's mass is the amount of matter that is in their body. *Weight* (W) essentially constitutes the force (F_g) exerted on matter by the gravitational attraction (Britannica, 2025). In this case, weight is the force that your body experiences from gravitational attraction to the Earth. The gravitational force that your body experience is given by the following formula: $$W = F_g = mg$$ An exception to this occurring at high altitudes, where there is a reduced gravitational force acting on the plane. In this case, the mass of the plane does not change but their weight will decrease. Weight is calculated based on the object's mass and gravitational force. Gravitational acceleration is dependent on the altitude above sea level, given by the following formula (Deng, 2008):	**10 minutes**

	$$g = \frac{GM_e}{(R_e + Z)^2}$$ A simplified version of the equation will be used to calculate gravitational acceleration of planets based on their physical characteristics. $$g = \frac{GM_e}{R_e^2}$$	
Apply	Students will work in groups to explore the effects of altitude, planetary mass, and planetary radius on gravitational acceleration while using DESMOS. Students will be provided a table to fill in and a set of questions to answer based on their findings to guide their exploration.	**40 minutes**
Closure	Bring the class together for a group discussion about what they had discovered using the DESMOS software. The teacher will ask groups of students to share an observation that they had uncovered about the relationships between gravitational acceleration and each of the variables. *Does the answer to the questions at the start of the class change?*	**5 minutes**
Reflections about the lesson:		

Rationale:
This lesson plan develops students' understanding for the conceptual difference between mass and weight. Using a PEOE model, the teacher provides a guided inquiry to identify misconceptions that can be formatively assessed during the activated portion of the lesson plan. An inquiry-based approach was used to enhance students' learning by exploring the conceptual difference using the DESMOS software. By using a graphing software, students are able to visualize the differences in mass and weight by looking through the lens of gravitational acceleration. Students use collaborative learning and discussion to build a foundation to support the differences between mass and weight. Additionally, mathematical competencies are used within this lesson plan to develop the conceptual difference between mass and weight. This lesson plan supports scientific inquiry and students' critical thinking skills while developing students' technological abilities.

gravitational acceleration (g)	altitude (Z)
	0 m
	1,000 m
	1,000,000 m
	1,000,000,000 m

1. What is the gravitational acceleration (g) when your altitude (Z) is 0?

2. What happens to the gravitational acceleration (g) when your altitude (Z) increases? Does it increase or decrease?

gravitational acceleration (g)	Planet Mass (M_x)
	0.1 M_e
	1 M_e
	10 M_e
	100 M_e

3. What happens to the gravitational acceleration (g) when your planet mass (M_x) increases? Does it increase or decrease?

4. What happens to the gravitational acceleration (g) when your planet mass (M_x) decreases? Does it increase or decrease?

gravitational acceleration (g)	Planet Radius (R_x)
	0.1 R_e
	1 R_e
	10 R_e
	100 R_e

5. What happens to the gravitational acceleration (g) when your planet radius (R_x) increases? Does it increase or decrease?

6. What happens to the gravitational acceleration (g) when your planet radius (R_x) decreases? Does it increase or decrease?