Name: …………………………………… Date: ………………..

Thinking with Models _ Gradient of a line

Investigation Task: Designing a Wheelchair Ramp Assessment Criterion: D and C

Key concept : Relationships, Logic & Form	Related Concept : Pattern, Model & Representation	Global context: Scientific and Technical Innovation

Inquiry Question

How can mathematical relationships, such as the gradient of a line, be used to design safe and functional structures in real-life situations?

Objective: Students will apply their understanding of gradient (slope) to solve a real-life design problem, clearly communicating mathematical reasoning and justifying the accuracy and sense of their solution.

Context: A community center wants to add a **wheelchair ramp** to make the building accessible. According to safety guidelines, the **maximum safe gradient** of a ramp must not be **steeper than 1:12** (for every 1 meter of height, ramp length must be at least 12 meters).

The center's entrance is **1.2 meters above ground level**, and there is **limited space** to build the ramp.

Tasks:

Calculate → Identify → Frame a rule → Verify → Justify & Explain

ATL Skills:

Thinking Skills: Critical thinking: Identify patterns, frame rules, justify reasoning.

Communication Skills: Organize and express mathematical steps clearly using appropriate notation

Self-Management Skills: Evaluate whether solutions are reasonable and meet real-life safety requirements.

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Context: A community center wants to add a **wheelchair ramp** to make the building accessible. According to safety guidelines, the **maximum safe gradient** of a ramp must not be **steeper than 1:12** (for every 1 meter of height, ramp length must be at least 12 meters).

The center's entrance is **1.2 meters above ground level**, and there is **limited space** to build the ramp.

a) **Calculate** the **maximum gradient** a wheelchair ramp can have according to safety guidelines.

Safety guideline: $Gradient = \frac{Rise}{Run} = \frac{1}{12}$

b) **Determine** the **minimum length** of the ramp needed if the platform height is **1.2 meters**.

$$Rise = 1.2m \text{ and } Run =?$$

$$\frac{Rise}{Run} = \frac{1.2}{run} = \frac{1}{12}$$

Run=1.2×12=14.4m

Minimum ramp length = 14.4 meters

c) If the available construction space is only **10 meters**, **find** the **actual gradient** if the ramp is built within that space.

$$Gradient = \frac{Rise}{Run} = \frac{1.2}{10} = 0.12$$

$$Gradient = 1{:}\frac{10}{1.2} = 1{:}8.33$$

Actual ramp gradient = 1:8.33

d) **Justify** whether this **design makes sense** and **meets safety standards** in the **context** of wheelchair safety.

Compare:

- Safe gradient: 1:12
- Actual gradient: 1:8.33

Since 1:8.33 is steeper than 1:12, It does NOT meet safety guidelines and would be unsafe for wheelchair users.

e) **Justify the degree of accuracy** of your calculations (rounding, measurement, assumptions, etc.)

- Values rounded to **2 decimal places** where needed.
- Measurement of ramp space assumed to be exact.
- Ratio simplified for **clarity and communication**.
- The level of accuracy is **reasonable for construction planning**.

Conceptual Understanding Framework

Key Concepts

Key Concept	Definition
Relationships	Shows how mathematical ideas connect to each other and to the real world, such as gradient showing a relationship between vertical change and horizontal distance.
Logic	The use of clear reasoning and steps to reach valid solutions through justified arguments.
Form	The structure and representation of mathematical ideas, such as representing gradient as a ratio, equation, or graph.

Related Concepts

Related Concept	Definition
Model	A mathematical representation of a real situation, like using gradient to model the design of a ramp.
Measurement	Using units to quantify physical dimensions like height, distance, and slope.
System	Components that interact to perform a function, such as ramp length, safety rules, and gradient working together.

Global Contexts

Global Context	Definition
Scientific and Technical Innovation	Exploring how engineering and math help solve human challenges like accessibility.
Fairness and Development	Ensures equal access for all people, such as wheelchair users needing ramps.
Identities and Relationships	How people connect and interact within a community, including ensuring inclusion for all.

Statements of Inquiry (SOI) Based on Global Context

Global Context	Statement of Inquiry (SOI)
Scientific and Technical Innovation	Logical mathematical models help design safe and functional structures that improve real-life accessibility.
Fairness and Development	Measuring gradients supports fairness by ensuring equal access through inclusive design.
Identities and Relationships	Relationships in mathematics help communities build connections by meeting the needs of all members.

ATL Skills

ATL Skill Category	ATL Skill	Description
Thinking Skills	Critical Thinking	Apply logic and reasoning to solve real-life mathematical problems.
Communication Skills	Mathematical Communication	Organize and express mathematical steps clearly using appropriate notation.
Self-Management Skills	Reflection	Evaluate whether solutions are reasonable and meet real-life safety requirements.

GRASPS Task Design

GRASPS Component	Definition According to This Task
G – Goal	Design a safe wheelchair ramp by applying knowledge of gradient to meet real safety standards.
R – Role	You are a student consultant helping a community center ensure accessibility.
A – Audience	Community center project team (non-math professionals who need clear reasoning).
S – Situation	The community center entrance is 1.2 meters high and needs a ramp that follows safety rules.
P – Product/Performance	A written mathematical report showing calculations, justification, and a design recommendation.
S – Standards for Success	Use mathematical accuracy (Criterion D) and clear communication (Criterion C) with correct gradient calculations and safety justification.