Two hinged arches problem with answer Document

Two Hinged Arches Problem with Answer: A Comprehensive Guide

Introduction to the Two Hinged Arches Problem

The analysis of arches is a fundamental topic in structural engineering, especially when designing bridges, gateways, and other load-bearing structures. Among various types of arches, two hinged arches are particularly significant due to their unique load distribution characteristics and ease of analysis.

The two hinged arch is a symmetrical or asymmetrical structure hinged at both ends, allowing rotation but not translation at the supports. This feature simplifies the calculation of reactions and internal forces, making it a popular subject in civil engineering education and practical design scenarios.

In this article, we will explore the two hinged arches problem with answer?a common problem encountered in structural analysis courses and engineering practice. We will detail the problem setup, assumptions, step-by-step solution process, and conclude with insights to enhance your understanding.

Understanding the Two Hinged Arch Structure

What is a Two Hinged Arch?

A two hinged arch is a curved structure supported at its ends with hinges, which allows the arch to rotate but not translate. The key features include:

- Hinged supports at both ends
- The ability to carry vertical loads
- The structure?s ability to transfer loads primarily through compression along the curve
- Symmetry in many cases, simplifying analysis

Common Applications

- Bridges
- Roof structures
- Architectural arches
- Domes

Understanding how these structures respond under various loads helps in designing safe and economical structures.

Formulating the Two Hinged Arch Problem

Typical Problem Statement

Consider a two hinged arch of span L, rise h, and uniform thickness subjected to a specific load distribution. The problem involves calculating:

- Reactions at supports
- Internal axial forces
- Bending moments (if any)
- Deflections (if required)

For simplicity, most problems assume:

- The arch is perfectly rigid
- Loads are static and uniformly distributed or point loads
- Material behavior is elastic
- Supports are ideal hinges with no moment transfer

Sample Problem Setup

Suppose an arch with:

- Span $L = 30\, \text{m}$
- Rise $h = 6\, \text{m}$
- Uniformly distributed load $w = 10\, \text{kN/m}$
- Supports hinged at both ends

The goal is to determine the reactions at supports and the internal axial force at the crown.

Step-by-Step Solution to the Two Hinged Arch Problem

Step 1: Establish the Geometry and Coordinates

- The arch is symmetric about the centerline.
- Coordinates are set with the origin at the center of the span.
- The supports are at $x = -L/2$ and $x = L/2$.

The equation of the parabola (commonly used for such arches) is:

$$
y = \frac{4h}{L^2} x^2
$$

for a parabola passing through the supports and the crown.

Step 2: Calculate the Total Load and Its Effects

- Total load:

$$
W = w \times L = 10\, \text{kN/m} \times 30\, \text{m} = 300\, \text{kN}
$$

- Since the load is symmetric, reactions at supports are equal:

$$
R_A = R_B = \frac{W}{2} = 150\, \text{kN}
$$

Step 3: Determine Horizontal Thrust (H)

The horizontal thrust is crucial for stability.

Using static equilibrium:

$$
\text{Sum of vertical forces}:
$$

$$
R_A + R_B = W
$$

which is satisfied by the reactions.

To find the horizontal thrust H, analyze the moment about one support.

For a uniformly distributed load, the moment at support A:

$$
M_A = -\frac{w L^2}{8} = -\frac{10 \times 30^2}{8} = -\frac{10 \times 900}{8} = -1125\, \text{kNm}
$$

Using the relation between internal forces and reactions for a parabola:

$$
H = \frac{w L^2}{8h} = \frac{10 \times 900}{8 \times 6} = \frac{9000}{48} \approx 187.5\, \text{kN}
$$

This horizontal thrust acts inward at the supports, counteracting the bending moments.

Step 4: Calculate Internal Axial Force at the Crown

At the crown (highest point), the internal force is primarily axial.

Using the equilibrium:

\[

N = H

\]

since at the crown, the internal axial force equals the horizontal thrust.

The bending moment at the crown is zero (for a symmetrical parabola under uniform load), so the internal force is purely axial:

\[

N_{crown} = H \approx 187.5\, \text{kN}

\]

Step 5: Check for Structural Stability and Deflections

- Ensure that the axial forces and reactions are within material limits.
- For detailed deflection analysis, use methods like the conjugate beam or energy methods.

Summary of the Key Results

| Parameter | Value |

|---|---|

| Support reactions \(R_A, R_B \) | 150 kN each |

| Horizontal thrust \(H \) | approximately 187.5 kN |

| Axial force at the crown | approximately 187.5 kN |

| Maximum bending moment at supports | \(-1125\, \text{kNm}\) |

| Load type | Uniform distributed load |

These results provide vital information for designing the arch, verifying material strength, and ensuring safety.

Additional Considerations and Variations

Non-Uniform Loads

If the load is not uniform, integration of load distribution will be necessary to determine reactions and internal forces.

Asymmetrical Arches

For asymmetrical arches, equilibrium equations become more complex, requiring methods like the method of sections or finite element analysis.

Different Support Conditions

If supports are fixed or roller supports, the analysis adjusts accordingly, affecting internal moment distributions and reactions.

Material and Geometric Nonlinearities

In real-world applications, material nonlinearities, large deflections, and imperfections should be considered for more accurate analysis.

Conclusion

The two hinged arches problem with answer demonstrates the fundamental principles of structural analysis, including equilibrium, load distribution, and internal force calculation. By understanding the geometry, applying equilibrium equations, and deriving the horizontal thrust, engineers can ensure the stability and safety of arch structures.

This comprehensive approach not only helps in academic settings but also serves as a foundation for practical design and analysis of complex arch structures. Mastery of such problems enhances problem-solving skills essential for any civil or structural engineer.

References and Further Reading

- Structural Analysis by R.C. Hibbeler
- Structural Analysis by Aslam Kassimali

- Formulas and Theories for Structural Analysis by Devdas Menon
- Relevant standards and codes for arch design (e.g., Eurocode, AASHTO)

Note: Always adapt the analysis based on specific problem parameters and consult structural design codes for safety and compliance.

Two Hinged Arches Problem with Answer: A Comprehensive Review

Understanding the mechanics and analysis of two hinged arches is a fundamental component of structural engineering, especially when dealing with arch bridges, roof structures, or aqueducts. The two hinged arches problem is a classic topic in structural analysis, offering insight into how arches respond under various loads while providing an elegant solution framework through statics principles. This article aims to thoroughly examine the problem, its solution methodology, key concepts involved, and the implications for structural design, offering both theoretical and practical perspectives.

Introduction to Two Hinged Arches

Hinged arches are structures with hinges at the supports, allowing rotation but preventing translation at these points. When analyzing two such arches, the primary goal is to determine internal forces, moments, and support reactions under specific loading conditions. These structures are statically determinate, making them easier to analyze compared to fixed arches or continuous systems.

The two hinged arches problem typically involves calculating the reactions at supports, internal bending moments, and axial forces when subjected to various loads such as uniform loads, point loads, or thermal effects. Understanding the problem's solution provides foundational knowledge applicable in designing stable, efficient, and safe arch structures.

Fundamental Concepts and Assumptions

Before delving into the problem's solution, it?s essential to understand the key assumptions and concepts:

- Statics-Based Approach: The analysis relies on the principles of equilibrium: sum of forces and moments must be zero.
- Two Hinges: The supports at the base are hinges, allowing rotation but no translation, simplifying the analysis.
- Uniform or Point Loads: Loads are often idealized as either uniformly distributed or concentrated points for ease of calculation.
- Arch Geometry: The shape of the arch (parabolic, circular, or other) influences internal force

distribution but often simplified in analysis.

- Material Behavior: The material is assumed to be elastic and linear, obeying Hooke's law.
- Small Deformations: Deformations are considered small enough that their effect on the structure's geometry is negligible.

Problem Statement and Typical Scenario

A common example of the two hinged arches problem involves a symmetrical arch with supports at the same level, subjected to a uniform load or a point load at the crown or span. The goal is to determine:

- Support reactions (horizontal and vertical)
- Internal bending moments along the span
- Axial forces within the arch

Sample problem statement:

Given a symmetrical two-hinged arch of span L, with a uniform load w per unit length, find the reactions at supports and the bending moment distribution along the arch.

Methodology to Solve the Two Hinged Arches Problem

The analysis involves several steps, combining static equilibrium equations with geometric considerations.

Step 1: Free Body Diagram (FBD)

Draw the FBD of the entire arch, indicating supports, loads, and internal forces.

Step 2: Equilibrium Equations

Apply the fundamental equations:

- Sum of vertical forces: $\sum F_y = 0$
- Sum of horizontal forces: $\sum F_x = 0$
- Sum of moments about a point: $\sum M = 0$

Step 3: Support Reactions

Due to symmetry (for symmetrical loading), support reactions are often equal:

- Vertical reactions at supports: R_A and R_B
- Horizontal reaction: H

Using equilibrium equations, calculate R_A, R_B, and H.

Step 4: Internal Force Calculation

Divide the arch into segments and apply the method of sections or calculus-based approaches to find internal axial forces and moments at any point.

Step 5: Moment Distribution

Use the bending moment equations derived from equilibrium conditions or differential equations of the elastic curve (for more advanced analysis).

Analytical Solutions with Examples

Let's consider a specific example to illustrate the process:

Example:

- Span $L = 30\, \text{m}$
- Uniform load $w = 5\, \text{kN/m}$
- Supports at points A and B, hinged and at the same level
- Symmetrical loading and geometry

Solution:

- Calculate Total Load:

$$
W_{total} = w \times L = 5 \times 30 = 150\, \text{kN}
$$

- Support Reactions:

By symmetry,

$$
R_A = R_B = \frac{W_{total}}{2} = 75\, \text{kN}
$$

- Horizontal Reaction:

Using the method of moments about support A:

$$
H = \frac{w L^2}{8 h}
$$

where h is the height of the arch. For a parabolic arch, expressions relate the horizontal thrust H to the load and geometry.

- Internal Moment at Mid-span:

The maximum bending moment typically occurs at the crown and can be calculated based on load distribution and support reactions.

Features, Pros, and Cons of the Two Hinged Arches Problem Approach

Features:

- Simplified Analysis: The use of statics makes the problem straightforward for symmetrical loads and geometries.
- Design Insights: Helps in understanding how loads are transferred through the arch.
- Foundation for Advanced Analysis: Serves as a basis for more complex, non-linear, or dynamic analysis.

Pros:

- Determinacy: The structure is statically determinate, simplifying calculations.
- Clear Physical Interpretation: Reactions and internal forces can be directly related to applied loads.
- Efficiency: Suitable for initial design and feasibility studies.

Cons:

- Idealizations: Assumptions like small deformations and perfect hinges may not hold in real structures.
- Limited to Certain Conditions: Not suitable for fixed arches or those with more complex boundary conditions.
- Ignores Material and Geometric Nonlinearities: Does not account for effects like load-induced deformations significantly affecting the geometry.

Applications and Practical Implications

The two hinged arches problem is fundamental in bridge design, especially for structures requiring large spans. It informs decisions about material selection, cross-sectional geometry, and load distribution. Engineers also use this analysis to optimize the arch shape for minimal material use while ensuring safety.

In practice, the solution must be verified with more advanced methods like finite element analysis, considering real-world complexities such as wind loads, temperature variations, and material imperfections.

Conclusion

The two hinged arches problem exemplifies a classical yet vital aspect of structural analysis, blending static equilibrium principles with geometric considerations. Its straightforward approach makes it an essential tool for civil engineers during the preliminary design phases, providing insight into force distributions and stability. While the basic problem offers clear solutions, real-world applications often require considerations beyond the ideal assumptions, necessitating more advanced analysis techniques.

Understanding this problem equips engineers with a solid foundation to tackle more complex structural challenges, ensuring safety, efficiency, and innovation in their designs. Whether for educational purposes or practical applications, mastering the two hinged arches problem remains a

cornerstone of structural engineering expertise.

QuestionAnswer What is the two hinged arches problem in structural engineering? The two hinged arches problem involves analyzing the stability and load distribution of an arch with hinges at both ends, focusing on how forces are transmitted and how the structure maintains equilibrium under various loads. How do you determine the support reactions in a two hinged arch problem? Support reactions are determined by applying equilibrium equations?sum of vertical forces, horizontal forces, and moments?considering the load distribution and the geometry of the arch, often using methods like the method of sections or moment distribution. What assumptions are typically made in solving the two hinged arches problem? Common assumptions include that the arches are perfectly flexible, the loads are distributed or point loads as specified, the material is elastic, and the hinges are frictionless, allowing for simplified analysis using elastic theory. What is the significance of the 'funicular shape' in the two hinged arches problem? The funicular shape represents the ideal load-carrying form of the arch under a given load, where the compression forces follow a curve that minimizes bending moments, which is crucial for designing efficient two-hinged arches. Can the two hinged arches problem be solved using the method of moments? Yes, the method of moments is often used to analyze two hinged arches by setting up equilibrium equations for moments around supports or hinges, enabling calculation of internal forces and reactions. What are common challenges faced when solving the two hinged arches problem? Challenges include accurately modeling load distribution, accounting for geometric nonlinearities, ensuring stability under asymmetrical loads, and solving complex equations that may require numerical methods or iterative techniques.

Related keywords: two hinged arches, structural analysis, statics problem, arch stability, load distribution, equilibrium equations, engineering solution, arch design, mechanical analysis, civil engineering problem

Problem and solution short passages 6th grade

problem and solution short passages 6th grade are essential tools for young students to develop their reading comprehension, critical thinking, and writing skills. These passages help students identify issues within a story or real-life scenario and think creatively about how to resolve them. In the 6th grade, students are at a crucial stage where they can begin to understand more complex texts and practice summarizing information concisely. This article explores the importance of problem and solution short passages for 6th graders, provides strategies for teaching and learning these skills, and offers example passages to enhance understanding.

Understanding Problem and Solution Short Passages for 6th Graders

What Are Problem and Solution Passages?

Problem and solution passages are a type of reading comprehension text that presents a specific issue or challenge (the problem) and then discusses one or more ways to resolve or address the issue (the solution). These passages are designed to help students practice identifying key elements within a story or informational text.

Key features of problem and solution passages include:

- Clear presentation of a problem or challenge.
- Multiple potential or actual solutions.
- Explanation of how solutions work or why they are effective.
- Contextual clues to help identify parts of the passage.

Why Are They Important for 6th Grade Students?

For 6th graders, mastering problem and solution passages supports several academic and cognitive skills:

- Enhances reading comprehension by focusing on main ideas and details.
- Develops critical thinking by analyzing how problems are addressed.
- Prepares students for more complex texts in later grades.
- Builds writing skills through summarizing and explaining solutions.
- Encourages problem-solving attitudes applicable in real life.

Strategies for Teaching Problem and Solution Passages to 6th Graders

Teaching 6th graders how to effectively understand and write problem and solution passages involves engaging activities, guided practice, and scaffolded instruction. Here are some effective strategies:

1. Use Visual Aids and Graphic Organizers

Graphic organizers help students visually map the problem and solutions within a passage. Examples include:

- T-charts labeled "Problem" and "Solution."

- Cause-and-effect diagrams.
- Story maps highlighting the problem and resolution.

2. Practice Guided Reading

Read passages aloud as a class, pausing to discuss:

- What the problem is.
- Possible or actual solutions.
- How the solution addresses the problem.

3. Encourage Questioning

Ask students targeted questions:

- What is the main problem in this passage?
- How do the characters try to solve the problem?
- Why do you think the solution worked or didn?t work?

4. Have Students Write Their Own Passages

Students can practice creating their own problem and solution passages by:

- Writing about personal experiences.
- Creating stories with clear problems and resolutions.
- Summarizing existing stories or articles.

5. Incorporate Real-Life Scenarios

Use real-world problems relevant to students? lives to make learning meaningful, such as:

- Bullying at school.
- Environmental issues.
- Family conflicts.

Examples of Problem and Solution Short Passages for 6th Grade

Below are sample passages suitable for 6th-grade learners to practice identifying problems and solutions.

Example 1: School Lunch Issue

Problem:

Many students at Lincoln Middle School didn?t enjoy the new lunch menu. The food was cold, and students felt it didn?t taste good.

Solution:

The school cafeteria staff asked students for feedback and started offering a variety of popular dishes. They also improved food storage to keep meals warm.

Discussion:

Students can identify the problem as dissatisfaction with school lunches and the solution as gathering feedback and improving food quality.

Example 2: Lost Pet

Problem:

Emma?s family?s dog, Max, ran away during a walk in the park. Emma was worried because Max was not used to being outside alone.

Solution:

Emma and her family put up flyers around the neighborhood and checked local shelters. Soon, someone recognized Max and called them.

Discussion:

In this passage, the problem is Max running away, and the solution involves community help and searching efforts.

Example 3: Road Construction Delay

Problem:

The main road to the town was closed for construction, making it difficult for residents to get to work and school.

Solution:

The city authorities set up a detour route and shared updates through local radio and signs to help drivers find alternative paths.

Discussion:

The problem is the road closure, and the solution is providing detours and communication to minimize inconvenience.

Tips for Creating Effective Problem and Solution Passages

When designing your own passages or helping students write them, keep these tips in mind:

Key points for effective passages:

- Clearly state the problem at the beginning.
- Use descriptive details to make the problem relatable.
- Offer logical and feasible solutions.
- Include transitional words like ?because,? ?so,? ?therefore,? to connect ideas.
- End with a summary or a reflection on the effectiveness of the solution.

Practice Activities to Reinforce Learning

To help 6th graders master problem and solution short passages, consider incorporating these activities:

- Story Mapping: Students read a passage and fill out a story map highlighting the problem and solutions.
- Group Discussions: Small groups analyze passages and discuss possible alternative solutions.
- Writing Exercises: Students write their own problem and solution stories based on prompts.
- Quiz Games: Use quizzes to identify problems and solutions in various texts.

Conclusion

Problem and solution short passages are powerful educational tools for 6th grade students. They

not only improve reading comprehension but also foster critical thinking and problem-solving skills. By understanding how to recognize problems and think about effective solutions, students become better prepared for academic challenges and real-life situations. Teachers and parents can support this learning by providing engaging activities, clear examples, and opportunities for creative writing. With consistent practice, 6th graders will develop confidence in analyzing texts and expressing their ideas clearly and effectively.

Remember: The key to mastering problem and solution passages is practice, discussion, and application. Encourage students to look for problems and solutions everywhere?from stories and articles to everyday life?and watch their skills grow!

Problem and Solution Short Passages 6th Grade: A Guide to Developing Critical Reading Skills

Introduction

Problem and solution short passages 6th grade is a fundamental component of reading comprehension education at this level. As students transition into middle school, they encounter more complex texts that require not only understanding the main idea but also analyzing the structure of the passage. One common format that educators emphasize is the problem and solution passage. These passages help students develop critical thinking by identifying challenges and understanding how they are addressed. This article explores what problem and solution passages are, why they are important for 6th-grade learners, and practical strategies to improve skills in reading and analyzing these types of texts.

What Are Problem and Solution Short Passages?

Defining the Structure

Problem and solution passages are a specific type of informational text that presents a challenge and then offers one or more ways to resolve it. They are designed to help students recognize how authors organize information and to develop their ability to identify key ideas quickly.

Key Characteristics:

- Introduction of a Problem: The passage begins by describing an issue or challenge that needs attention.
- Explanation of the Problem: Details about why the problem exists and its impact.
- Proposed Solutions: The text then discusses possible ways to solve or address the problem.
- Resolution or Conclusion: Often, the passage ends with the most effective solution or a summary of how the problem is resolved.

Example:

Imagine a paragraph about a neighborhood with a lot of litter. It explains how trash affects wildlife and the community?s health. Then, it discusses solutions such as organizing cleanup events and installing trash bins. The passage ends by emphasizing the importance of community effort.

Why Are Problem and Solution Passages Important for 6th Graders?

Developing Critical Thinking

At the 6th-grade level, students are expanding their vocabulary and comprehension skills. Recognizing the problem-solution structure helps them:

- Understand Cause and Effect: See how problems lead to certain consequences and how solutions can prevent or fix issues.
- Enhance Analytical Skills: Identify the main ideas and supporting details.
- Improve Writing Skills: Learn how to structure their own writing logically.

Real-World Relevance

These passages mirror real-life situations, such as solving community issues, personal challenges, or environmental problems. By mastering this reading skill, students become better equipped to analyze situations critically and contribute thoughtfully to discussions.

Challenges Students Face with Problem and Solution Passages

While these passages are valuable, students often encounter difficulties such as:

- Identifying the Problem: Sometimes, the problem is implied rather than explicitly stated.
- Distinguishing Between Multiple Solutions: Recognizing which solution is most effective or emphasized.
- Understanding Vocabulary: Complex words or technical terms can hinder comprehension.
- Connecting Ideas: Linking the problem with its solution requires careful reading and analysis.

Recognizing these challenges is the first step toward developing effective strategies to overcome them.

Strategies to Improve Reading and Comprehension of Problem and Solution Passages

- Teach Signal Words and Phrases

Signal words help students identify parts of the passage. Examples include:

- Problem indicators: "The issue is," "The challenge," "A common problem."
- Solution indicators: "To solve this," "One way to fix it," "The solution is."

- Use Graphic Organizers

Visual tools aid in breaking down the passage:

- Problem-Solution Charts: Students can record the problem and note each proposed solution.
- Flowcharts: Show the progression from identifying a problem to implementing a solution.
- Mind Maps: Connect related ideas and solutions visually.

- Practice Summarization

Encourage students to paraphrase each section:

- Restate the problem in their own words.
- Summarize the proposed solutions.
- Conclude with the overall resolution.

This deepens understanding and retention.

- Ask Guided Questions

Use targeted questions to activate critical thinking:

- What is the main problem discussed?
- Why is this problem important?
- What solutions are suggested?
- Which solution do you think is the best? Why?
- How does this passage relate to real life?

- Build Vocabulary Skills

Introduce new words within context and practice using them in sentences. Understanding key terms makes comprehension smoother.

Classroom Activities to Reinforce Skills

Interactive Read-Alouds

Read problem and solution passages aloud, pausing to discuss key points and signal words.

Identify and Highlight

Provide students with texts where they highlight problem and solution phrases, fostering close reading.

Group Discussions

Small groups analyze a passage together, identifying problems and solutions, then share findings with the class.

Writing Practice

Have students write their own problem-solution paragraphs about issues they care about, reinforcing structure and comprehension.

Examples of Problem and Solution Passages for 6th Grade

Sample Passage 1:

Problem: Many students in the school cafeteria waste food because they don?t finish their meals.

Solution: The school can implement a "finish your plate" campaign and donate leftovers to local shelters.

Outcome: These actions help reduce waste and support community members in need.

Sample Passage 2:

Problem: The local park is overrun with litter, making it unpleasant for visitors.

Solution: Organizing monthly cleanup days and installing more trash bins encourage visitors to keep the park clean.

Outcome: A cleaner park becomes more inviting and safe for everyone.

Conclusion

Mastering problem and solution short passages is a vital skill for 6th-grade students. It enhances their ability to analyze texts critically, understand cause-and-effect relationships, and develop logical thinking. By learning to identify key signal words, using graphic organizers, practicing summarization, and engaging in interactive activities, students can become confident readers capable of tackling complex informational texts. These skills not only support academic success but also prepare them to navigate real-world challenges with insight and problem-solving abilities. As educators and parents, fostering these skills early lays the foundation for lifelong critical thinking and effective communication.

QuestionAnswer What is a problem and solution short passage? A problem and solution short passage is a short text that explains a problem and then describes how it can be solved. Why is it important to understand problem and solution passages? Understanding these passages helps you improve reading comprehension and learn how problems can be fixed in real life. How can I identify the problem in a passage? Look for sentences that describe an issue or something that is going wrong; these often start with words like 'problem,' 'issue,' or 'difficulty.' What clues indicate the solution in a problem and solution passage? Solutions are usually described after the problem, often starting with words like 'to fix,' 'solution,' 'so,' or 'therefore.' Can you give an example of a problem and solution short passage? Yes. Example: 'Many students forget their homework. To solve this, students can use a planner or remind themselves before leaving school.' How can I practice identifying problems and solutions in passages? Practice by reading short stories or articles and underlining the problem and solution parts. Then, check if you identified them correctly. What are some common words used in problem and solution passages? Common words include 'problem,' 'issue,' 'difficulty,' 'solution,' 'fix,' 'answer,' and 'therefore.' Why are problem and solution passages useful in everyday life? They help you understand how to think about problems and find ways to solve them in situations like school, home, or with friends. What should I do if I can't find the solution in a passage? Try reading the passage carefully again and look for sentences that suggest how the problem can be fixed or improved. How can teachers help students understand problem and solution passages better? Teachers can provide examples, ask questions about the passages, and have students practice identifying problems and solutions regularly.

Related keywords: problem-solving, short passages, 6th grade reading, comprehension, solutions, reading skills, text analysis, critical thinking, practice passages, educational resources

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