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ABSTRACT

As part of Alberta Education's (Canada) broadened assessment initiatives, a sample of 693 Grade 3 students from across the province participated in the Mathematics Performance-based Assessment, 1994. This activity-based assessment, using picture books and manipulatives, was developed by Grade 3 teachers to assess a broad range of skills not easily measured using multiple-choice tests. The problem-solving and writing activities were designed to obtain valuable information about how students apply their knowledge in mathematics when solving real-life problems. The purpose of this document is to provide teachers, administrators, students, and parents with samples of students' performances that exemplify standards in relation to the assessment tasks. The samples of students' work selected for this booklet illustrate the quality of students' work at each of three levels: Does Not Meet Acceptable Standard; Meets the Acceptable Standard; and Meets the Standard of Excellence. The commentaries that accompany the samples highlight selected features of the students' responses and show how scoring criteria relate to students' work. Appendixes include science holistic scoring criteria, percentage of students at each level, and science descriptive coding criteria. (JRH)

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This document was written primarily for:

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Teachers	Grade 3 Teachers
Administrators	
Parents	
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Others (Specify)	

Distribution: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta School Boards Association • Alberta Education

Contents

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Confirming Standards for the Selection of Sample Papers:	Carol Lefebvre — Lakeland Public School District #5460
	Donna Richards — County of Grande Prairie #1
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Introduction

Purpose

The purpose of this document is to provide teachers, administrators, students, and parents with samples of students' performances that exemplify standards in relation to the 1994 Grade 3 Mathematics Performance-based Assessment (PBA) Tasks. The commentaries that accompany the samples highlight selected features of the students' responses and show how scoring criteria relate to students' work.

Mathematics Assessment in 1994

The Grade 3 Mathematics assessment in 1994 collected information and reported on a range of learning expectations. Three instruments were used to collect information: the achievement test, teacher and student questionnaires, and performance-based assessment tasks. The performance-based assessment component is the specific focus of this booklet.

Selection of Samples

The samples of students' work selected for this booklet were used for training markers during the July 1994 marking session of the performance-based assessment. As such, these examples generally illustrate the quality of students' work at each of three levels: Does Not Meet the Acceptable Standard, Meets the Acceptable Standard, and Meets the Standard of Excellence.

Confirming Standards

The initial work of confirming the standards that would govern the scoring of student performances was undertaken by a group of experienced Grade 3 Mathematics teachers on June 25 and 26, 1994. Their task was to read a large enough sample of student responses to select those that exemplified the different levels of performance. At the same time, these teachers prepared specific notes for use during the marking session. The Holistic Scoring Criteria are given in Appendix A.

These teachers later served as group leaders during the marking session. They used the selected examples to set the scoring guidelines and to train teachers for the marking session.

Marking

Teachers were selected for marking on the recommendation of their superintendents. All markers were teaching Grade 3 Mathematics in the same school year that the performance-based assessment was administered and had done so for at least two years.

Markers followed the agreed-upon standards when scoring student responses. The overall results are given in Appendix B.

General Description of the Performance-based Assessment

As part of Alberta Education's broadened assessment initiatives, a sample of 693 Grade 3 students from across the province participated in the Mathematics Performance-based Assessment, 1994. The activity-based assessment, using picture books and manipulatives, was developed by Grade 3 teachers to assess a broad range of skills not easily measured using multiple-choice tests. The problem-solving and writing activities were designed to obtain valuable information about how students apply their knowledge in mathematics when solving real-life problems.

Background

The PBA activities were designed to complement the multiple-choice component of the Grade 3 Mathematics Achievement Test, which identifies students' knowledge, skills, and problem-solving abilities but reveals nothing of the strategies students use. Because a single test score does not give a full

picture of what students know and are able to do, opportunity was given for them to respond in different settings and different ways using mathematical reasoning. Open-ended questions allow responses that provide evidence of different levels of achievement.

There are usually many approaches to solving problems. The open-endedness of the problems included in the PBA provided students with an opportunity to think for themselves and to express their mathematical ideas in a variety of ways. Each activity called for students to construct their own responses and to demonstrate the depth of their understanding of mathematical concepts. From an assessment point of view, open-ended questions enable teachers to see students' thinking.

According to the National Council of Teachers of Mathematics (1993), assessing mathematical power goes beyond measuring how much information children possess to include their willingness to use, apply, and communicate that information. The demand is that children not only know mathematics but that they be able to use math in the changeable world of their future. Math must be seen as more than a set of facts and skills to be memorized and applied. It must be seen as communication and reasoning.

Oral and written language plays an important role in developing mathematics. Children make sense of their world through communication with other people. Writing and talking about their thinking allows them an opportunity to rehearse and internalize their mathematical experiences. Written communication can be a valuable tool in helping children move beyond mere performance toward deeper understanding. Communication should not, however, be limited to that of a written nature. Communication may also be pictorial, spoken, or dramatic and may, as such, be equally useful for children to develop their mathematical thinking. For assessment purposes, communication can give teachers insight into what students know and are able to do.

Ultimately, the purpose of assessment is multi-faceted. Understanding students' mathematical thinking, diagnosing students' needs, and monitoring growth and achievement give teachers an opportunity to improve programs. Assessment can be a prime learning opportunity for both students and teachers.

Administration

The assessment was administered to whole class groups in regular classroom settings with both the classroom teacher and an assessment administrator from the Student Evaluation Branch present. Students were asked to read a book in a paired-reading situation and then independently solve three problems related to the context of the book. They were encouraged to use whichever manipulatives and other materials they needed to help them solve the problems. They were also asked to reflect on their strategies and answers in the test booklet. Students were given as much time as was needed to complete the assessment.

Problems Used

Three problems were developed for use in the PBA, in addition to an initial warm-up question. A variety of picture books were available for student use. The test booklet accompanying each picture book contained the same basic problem format. The three problems allowed for students to operate in all three modes of learning (concrete, pictorial, and symbolic).

The first problem required students to estimate and then verify the estimate using standard and/or non-standard measuring instruments. This problem was primarily designed to evaluate learnings in the Measurement, and Operations and Properties components of Grade 3 Mathematics. The accuracy of the initial estimation was not specifically evaluated. A variety of manipulatives were made available to the students. Bingo chips the exact size of the object presented in the

problem were included as part of the materials.

A variety of problem-solving strategies was anticipated. These included check, interpreting a picture, using manipulatives, using a diagram, writing a number sentence, counting, and performing necessary operations. As part of the Looking Back stage of problem solving, students were expected to explain their solution. A basic framework was provided to give students a starting point in the communication of their problem-solving strategy. It was not expected that students fill the entire box made available nor was it required that they use every box provided. The use of diagrams or writing was considered an acceptable form of communication.

The second problem was designed to assess students' ability to recognize addition and multiplication situations and to determine a strategy to solve the problem presented. It was expected that students might look for and continue patterns, write and solve a number sentence, choose the appropriate operation and compute, or use numbers or words to describe a mathematical activity. They could use manipulatives, create mathematical symbols, or draw pictures to solve the problem. Students were asked to communicate what they had done to solve the problem.

The third problem was designed to allow students to demonstrate their ability to sort objects using self-generated criteria and to construct a pictograph. It was anticipated that students would use some or all of the following problem-solving strategies: interpret a picture, identify what was wanted and given, identify criteria for sorting, use manipulatives to show a solution, collect data, and use data to construct a graph. To assess the Looking Back stage of problem solving, students were asked to explain how they classified the objects. Communication in a variety of forms was considered acceptable provided it was able to be interpreted within the context of the problem.

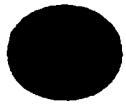
Samples of Students' Performance

Problem 1: Estimation

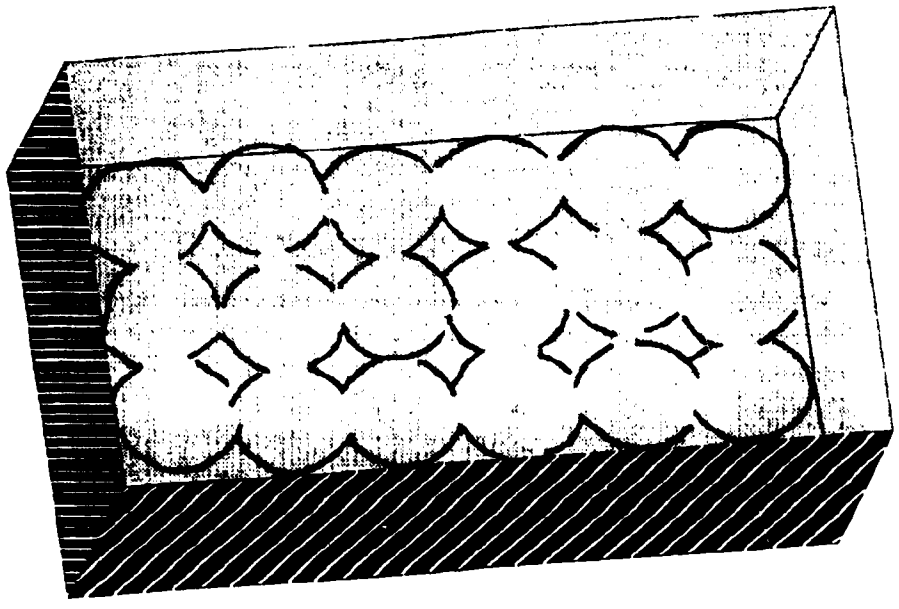
Sample A

Estimation problem from *Alexander, Who Used To Be Rich Last Sunday*.
This solution was scored as "**meets standard of excellence**."

This response shows an understanding of the need to use consistent and appropriately sized markers, and the need to cover the area indicated by the problem. The explanation is very clearly presented in a pictorial form indicating the use of an array to cover the rectangular base. Communication in the form of a diagram indicates an ability to apply the concept of multiplication to a problem situation.

I estimate that 15 gum balls this size  will cover the bottom of the box.

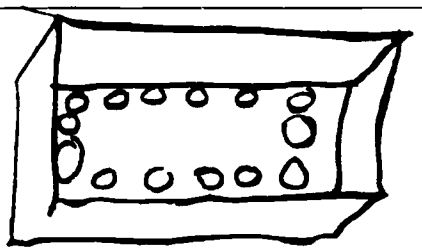
Check your estimate. **Show** your work.



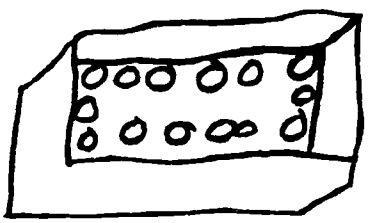
I found out that 18 gum balls will cover the bottom of the box.

What did you do to solve the gum ball problem? You may use words or pictures to explain.

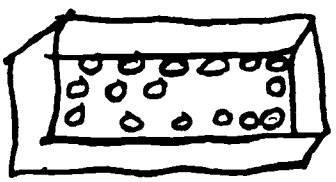
1. **First**



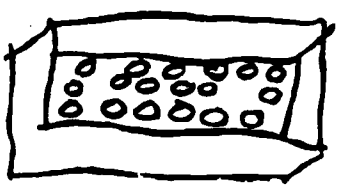
2. **Then**



3. **Next**



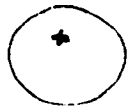
4. **Finally**



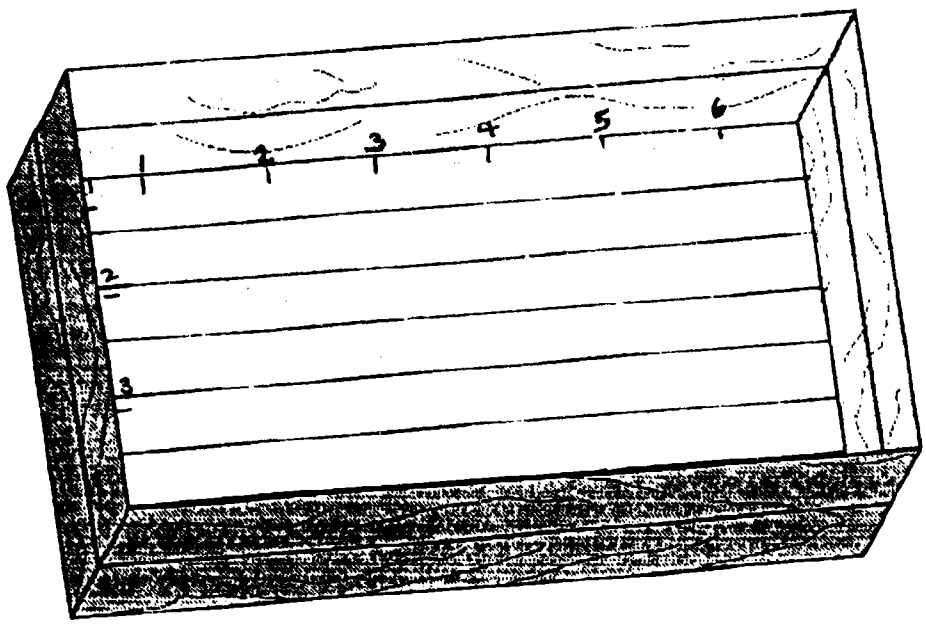
Sample B

Estimation problem from *Each Orange Had 8 Slices*.
This solution was scored as "**meets standard of excellence**."

A clear understanding of the need to cover the rectangular base with a consistently-sized marker is shown. The strategy used results in an array, without drawing each and every bingo chip onto the base. The ability to mark a row of chips along the top and a row of chips along the side and to develop a multiplication sentence demonstrates an advanced level of mathematical thinking. The strategy used to make the estimate and then verify it is described in concise, mathematical language, leaving no unanswered questions as to what the plan was or how it was carried out. The answer is plausible and falls within the acceptable range for this problem.

I estimate that 19 oranges this size  will cover the bottom of the box.

Check your estimate. **Show** your work.



I found out that 18 oranges will cover the bottom of the box.

What did you do to solve the orange problem? You may use words or pictures to explain.

1. First I estimated how many oranges would fit into the box by using two finger and puting them side by side and two lines were one orange.

2. Then I timesedthe across by the two line down and I got my estimate.

3. Next I put the chip side by side and put ticks where one was, I did the same going down.

4. Finally I timesed the across by the down and I got my answer.

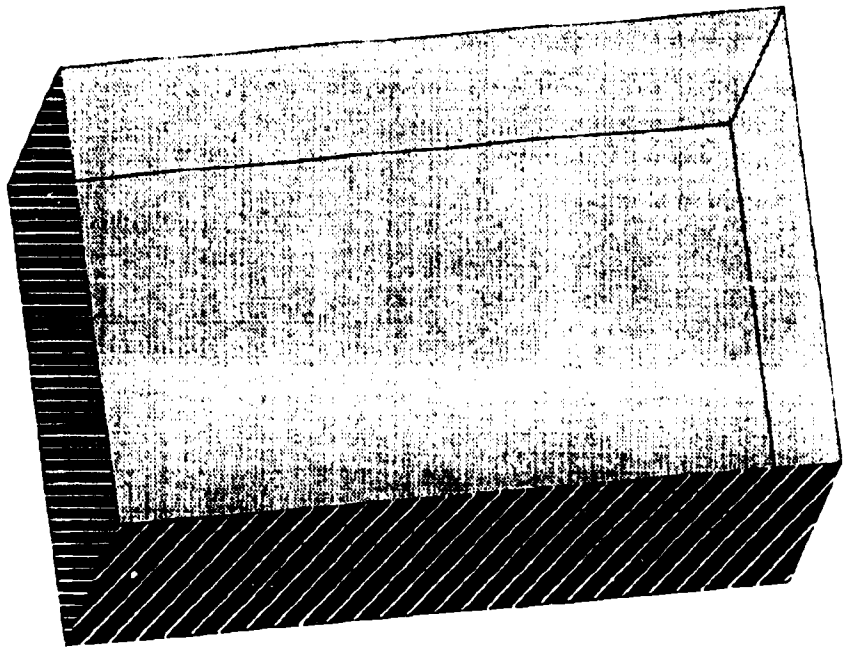
Sample C

Estimation problem from *Alexander, Who Used To Be Rich Last Sunday*.
This solution was scored as "**meets acceptable standard**."

There is evidence that the need to cover the rectangular base with consistently sized markers was understood. Although a diagram is not used, the explanation is clear enough to make the inference that the entire base was covered with markers the size of the gum balls. It is likely that counting was used to determine the number of gum balls required to cover the bottom of the box. The answer falls within an acceptable range consistent given the procedure described. The explanation is acceptable and clearly describes the actions taken.

I estimate that 19 gum balls this size  will cover the bottom of the box.

Check your estimate. **Show** your work.



I found out that 18 gum balls will cover the bottom of the box.

What did you do to solve the gum ball problem? You may use words or pictures to explain.

1. **First** I estimated how much Gum balls would cover the bottom of the box.

2. **Then** I used The chips to find out what it was

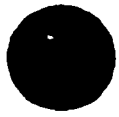
3. **Next** I found out what The answer was and I put it Down on the paper.

4. **Finally** Then I put the answer down I found out it was 18.

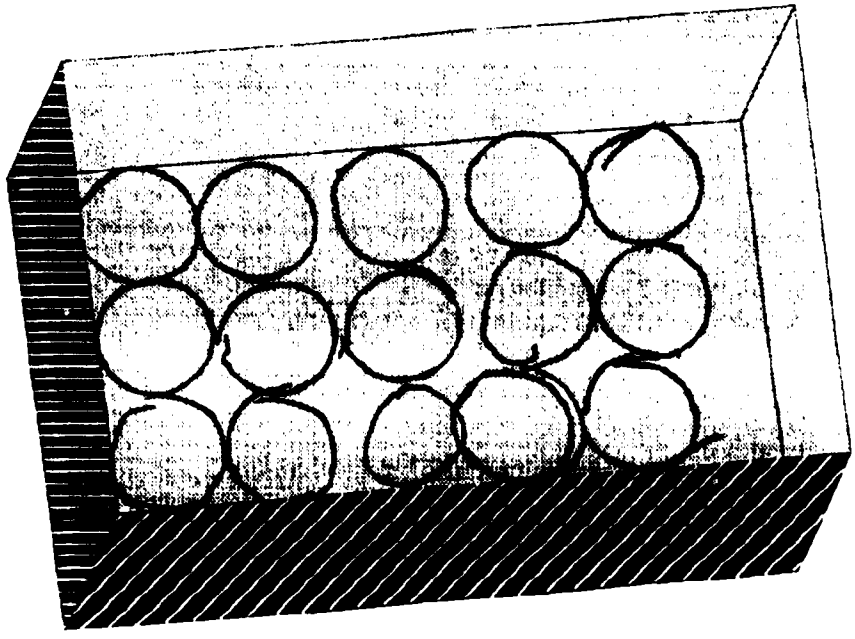
Sample D

Estimation problem from *Alexander, Who Used To Be Rich Last Sunday*.
This solution was scored as "**meets acceptable standard**."

The response shows an understanding of the need to cover the base with consistently sized markers, as can be seen in the diagram. Visible markings were used, and the size of the shape is consistent. It is likely that the provided bingo chips were used, judging from the consistency of the drawing. Markers were placed on the rectangular base in an array. The markers were counted to arrive at the answer. The answer falls within the acceptable range. Presentation of the diagram clearly shows evidence of a plan. The explanation lacks detail and is very basic, relating to the external actions taken to solve the problem.

I estimate that __14__ gum balls this size  will cover the bottom of the box.

Check your estimate. **Show** your work.



I found out that __15__ gum balls will cover the bottom of the box.

What did you do to solve the gum ball problem? You may use words or pictures to explain.

1. **First** I estimated how many.

2. **Then** I drew balls in the box.

3. **Next** I counted them.

4. **Finally** I wrote down the answers

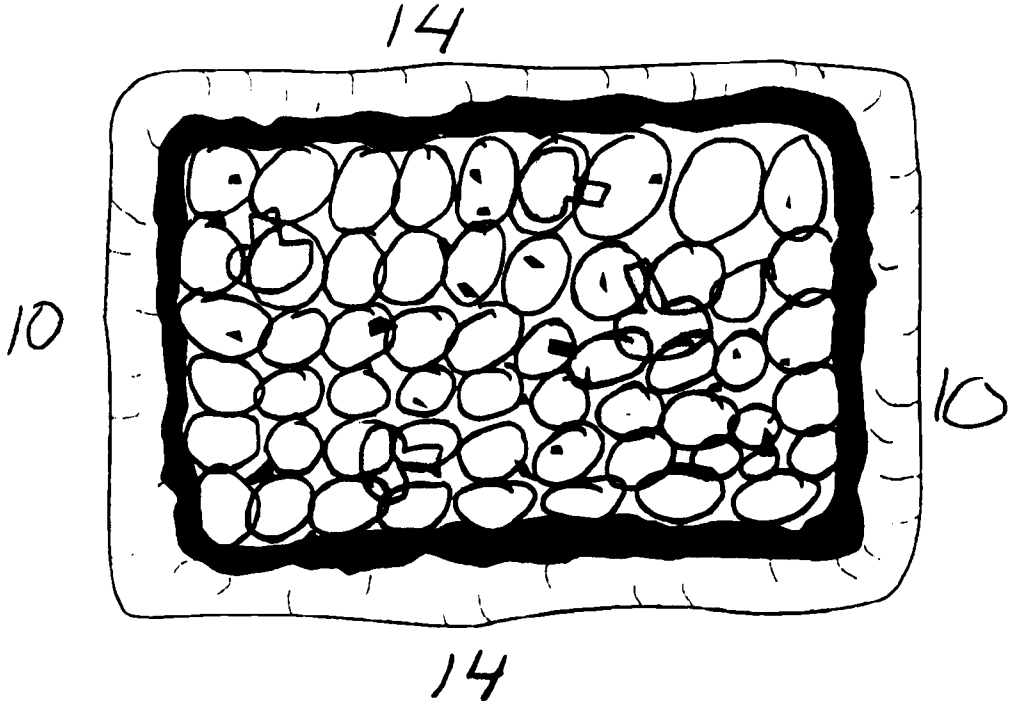
Sample E

Estimation problem from *Moira's Birthday*.
This solution was scored as "**does not meet acceptable standard**."

In this example, an attempt was made to solve the problem and the word "cover" appears to be understood. However, the meaning of "this size" marker was not understood, because the size of the covering shape is inconsistent. It appears that the circles were drawn freehand, without using any kind of marker. A second attempt at an appropriate strategy was made (by using a ruler to measure the sides), as indicated in the explanation. Evidence of this strategy appears around the perimeter of the rectangular base. Neither the work shown nor the explanation provide a connection between the use of the ruler and the use of the drawn circles, further indicating only partial understanding of the task. Finally, an answer is arrived at by counting, but it is not plausible given the demands of the problem.

I estimate that 29 slices of pepperoni this size  will cover the pizza.

Check your estimate. **Show** your work.



I found out that 56 slices of pepperoni will cover the pizza.

What did you do to solve the pepperoni problem? You may use words or pictures to explain.

1. **First** I took my ruler

2. **Then** I measured the sides

3. **Next** Than I drue pepronie

4. **Finally** I counted my cercles

Problem 2: Recipe

Sample A

Recipe problem from *Moira's Birthday*.
This solution was scored as "**meets standard of excellence.**"

The problem was understood and a workable strategy was selected. The plan was successfully carried out, with accurate doubling of the ingredients and all the ingredients listed. The use of multiplication is communicated in the final statement. The ability to explain how the solution was arrived at indicates a clear and logical approach to the solution of the problem.

Best Chocolate Cake

2 flour
2 baking soda
3 butter
1 sugar
3 chocolate
2 eggs
1 milk

Makes 1 cake

The baker needs to make two birthday cakes. How would he do it?

4 flour
4 baking soda
6 butter
2 sugar
6 chocolate
4 eggs
2 milk

I x everything by two and it came out like this.

Sample B

Recipe problem from *Each Orange Had 8 Slices.*
This solution was scored as "**meets acceptable standard**."

Clearly, understanding of the need to double the recipe is evident. The plan was obviously to double the recipe, but it is limited to the statement and does not indicate the mathematical computation of that procedure. The answer is acceptable, but the communication offered does not provide specific information about whether or not the student was actually able to perform the operation necessary to carry out the plan.

Orange Drink

3 cups orange juice
2 cups milk
2 cups water
1 cup sugar
2 teaspoons vanilla
2 trays ice cubes

Makes 6 drinks

You are having a party and you need to make 12 orange drinks.
How would you do it?

dabbal the amawati

Sample C

Recipe problem from *Moira's Birthday*.
This solution was scored as "**meets acceptable standard**."

An understanding of the need to increase the amount of the recipe is clear. The recipe is re-written, showing each ingredient correctly doubled. No ingredients are left out and no computational errors are made. The communication is limited to a rewriting of the recipe with doubled ingredients and does not include any information about the strategy used.

Best Chocolate Cake

2 cups flour
2 tsp baking soda
3 sticks butter
1 cup sugar
3 squares chocolate
2 eggs
1 cup milk

Makes 1 cake

The baker needs to make two birthday cakes. How would he do it?

4 flour
4 bakingsoda
6 butter
2 sugar
6 chocolate
4 eggs
2 milk

Sample D

Recipe problem from *Pancakes for Breakfast*.
This solution was scored as "**does not meet acceptable standard**."

An understanding of the need to increase the amount of the ingredients in the recipe is shown. The number "2" is circled in an attempt to identify given information. However, understanding the need to double the recipe is not evident. The numerical values in the recipe have been increased consistently by one, indicating evidence of some kind of plan. The solution, although related to the recipe and consistent with the plan, would not result in a doubling of the recipe.

Pancake Batter

2 cup flour
2 tsp baking powder
3 tbsp butter
3 tbsp sugar
1 tsp salt
3 eggs
2 cup milk

Makes 1 dozen pancakes

You need to make (2) dozen pancakes. How would you do it?

3 cups of flour
3 teaspoons baking powder
4 tea spoons butter
4 teaspoons sugar
2 teaspoonss salt
4 eggs

3 cups milk

Problem 3: Pictograph

Sample A

Graph problem from *Alexander, Who Used To Be Rich Last Sunday*.
This solution was scored as "**meets standard of excellence**."

The problem was analyzed and readily understood by the student. The graph and written explanation provide evidence of the completeness of the student's understanding of the task. The student used all pictures and sorted them into mutually exclusive categories (that is, items from one group could not also be placed in another group). The explanation given shows clear, logical thought regarding the sorting of the items by their common attributes, and is detailed, leaving little doubt as to what the student was thinking. The student carried out the plan by placing all pictures on the graph from bottom to top, leaving no spaces and providing general category titles.

- Cut out **all** of the things that Alexander wanted. Cut along the lines.

- Sort them into **3 GROUPS** on your desk.

- Explain how you sorted the things Alexander wanted.

I put the cupcakes and chocolate bars together because there junk food.

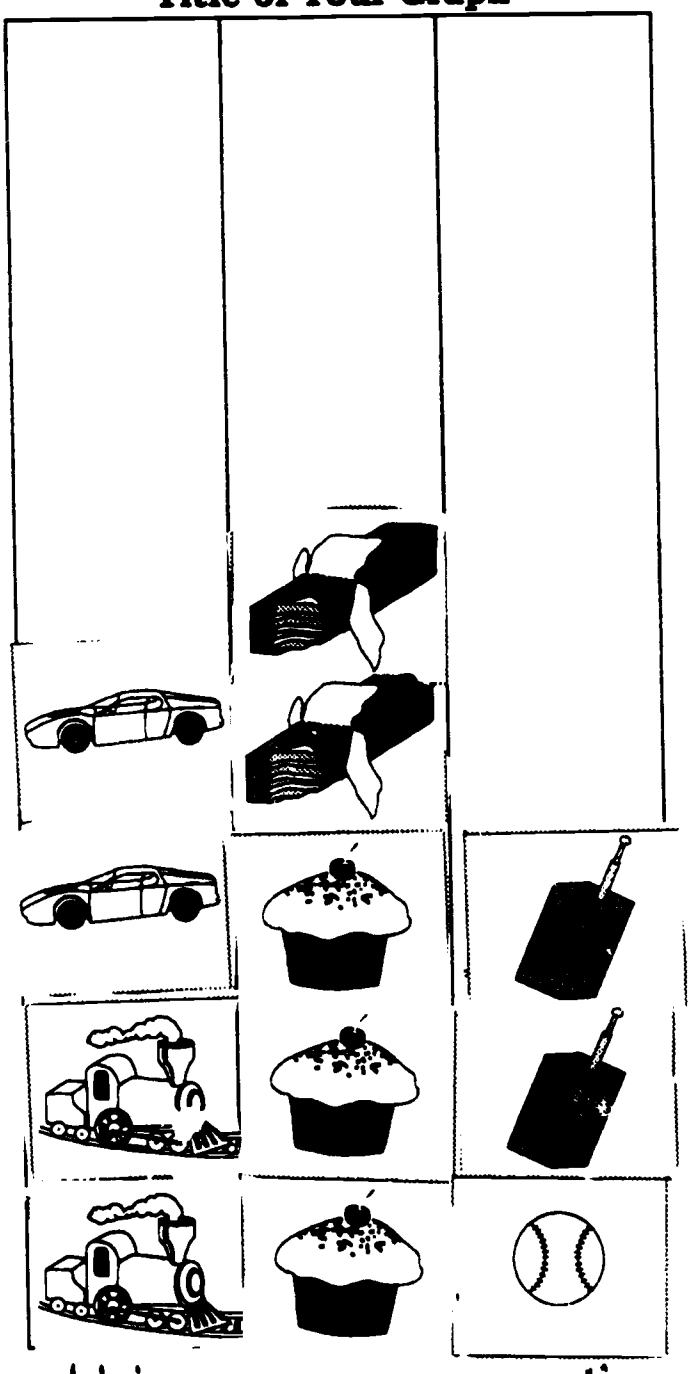
I put the trains and cars together because they can drive.

I put the walkie Talkies and the ball. together because you can take them on a vacatiotion.

- Glue your groups to make a pictograph.
- Label and title the pictograph.

My Picture graph

Title of Your Graph



driving things | junk food **Labels** | vacation toys

Sample B

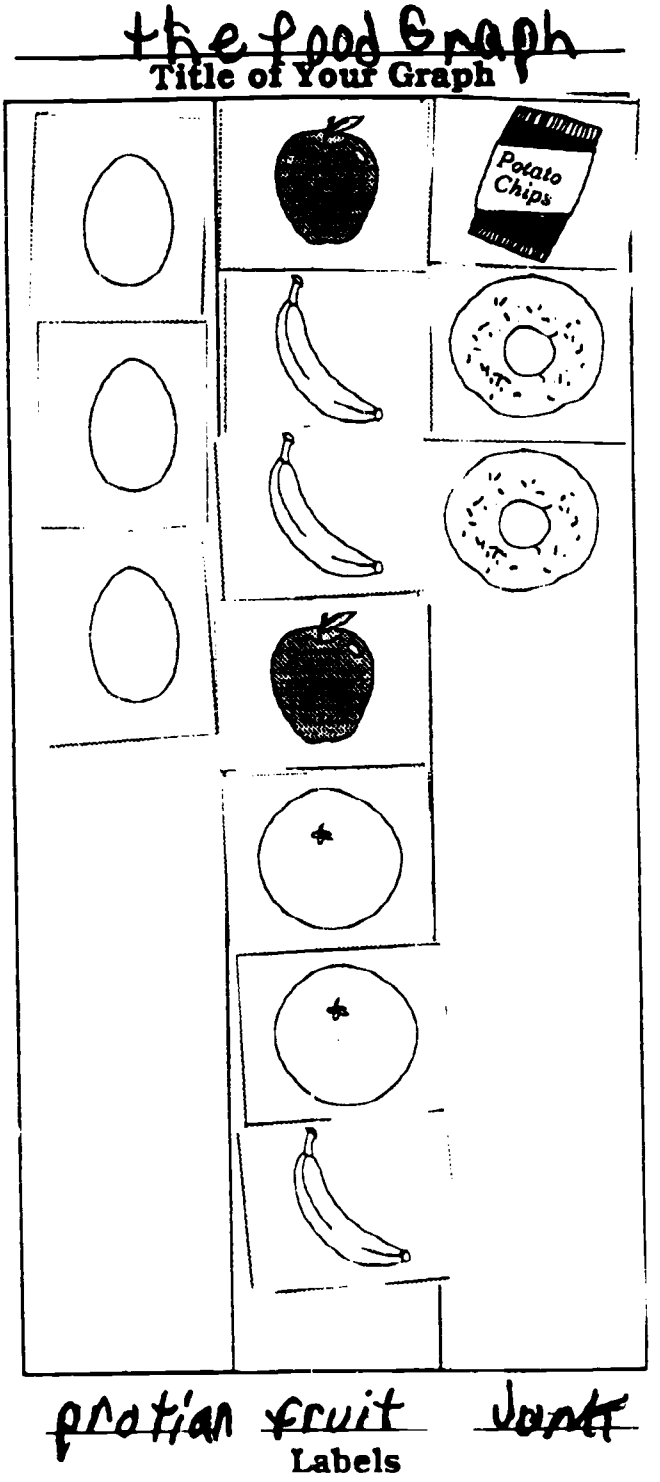
Graph problem : *The Shopping Basket.*
This solution was s ed as "m ts **standard of excellence**."

T response demonstrates a clear understanding of the task. Foods are sorted into categories th are mutually exclusive. The plan is carried out using all pictures and placing them on the graph with consistent spacing. Labels given to the categories are general and appropriate accor ng to food groups. The sorting proc dure is broad and reflects more than a personal prefere e sorting rule. The explanation is basic but clear, stating the plan to sort the foods into food groups.

- Cut out **all** the foods shown below. Cut along the lines.
- Sort them into **3 GROUPS** on your desk.
- Explain how you sorted the food.

I sorted them by food groups

- Glue your groups to make a pictograph.
- Label and title the pictograph.



Sample C

Graph problem from *One Watermelon Seed*.
This solution was scored as "**meets acceptable standard**."

Understanding of the task was demonstrated in this response by sorting the items into three groups and providing labels for each group. The sorting is based on personal food preferences—an appropriate sorting method. However, the categories are not mutually exclusive: for example, the peppers could have gone into either the "vegetables" group or the "don't eat" group. All pictures have been used and were attached to the graph from the top down as the plan was carried out. Although a top-down layout is not conventional graphing, it is considered acceptable for this level. The communication of the procedures used includes a simple explanation of how the foods were sorted, almost a restatement of the category names.

- Cut out **all** the garden foods shown below. Cut along the lines.
- Sort them into **3 GROUPS** on your desk.

- Explain how you sorted the garden foods.

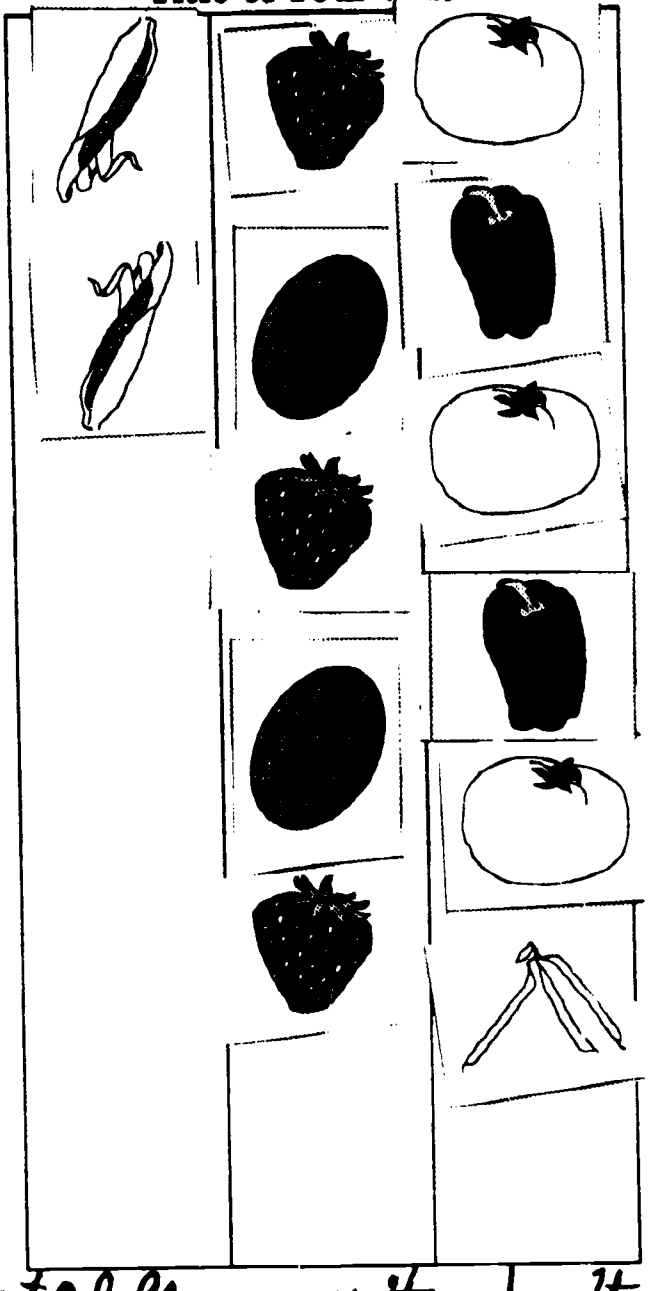
I put the things that I eat and don't eat and the fruit and vegetables.

27

- Glue your groups to make a pictograph.
- Label and title the pictograph.

The fruits and vegtables

Title of Your Graph



vegtables fruit don't eat

Labels

Sample D

Graph problem from *Alexander, Who Used To Be Rich Last Sunday*.
This solution was scored as "**meets acceptable standard**."

The graph is clearly and accurately constructed. The groups are given general and mutually exclusive category labels, providing evidence of the student's understanding of the task. The categories are based on a wider classification system than personal preferences. All pictures have been used and were attached to the graph from bottom to top, with consistent spacing as the plan was carried out. The communication of the procedures used to solve the problem is a restatement of the graph categories.

- Cut out **all** of the things that Alexander wanted. Cut along the lines.
- Sort them into **3 GROUPS** on your desk.
- Explain how you sorted the things Alexander wanted.

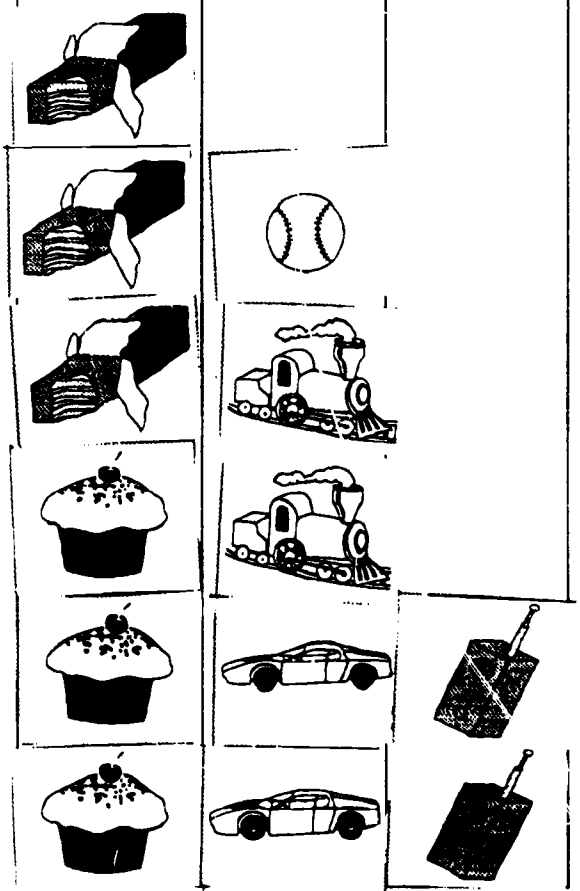
Something to eat

something that moves

Something you can talk through

- Glue your groups to make a pictograph.
- Label and title the pictograph.

Title of Your Graph



Something to eat | something that flies | something that you can talk into

Labels

Sample E

Graph problem from *The Shopping Basket*.
This solution was scored as "**does not meet acceptable standard**."

This response does not show an understanding of the task, nor an ability to sort the food into three distinct groups with commonalities. The items are sorted into pairs or groups of similar foods distributed equally among the three columns. The titles appear to be a count of items in each group rather than a graph-appropriate descriptive label, further indicating a lack of understanding of the problem. The explanation accompanying the problem does not help to indicate an understanding of the task.

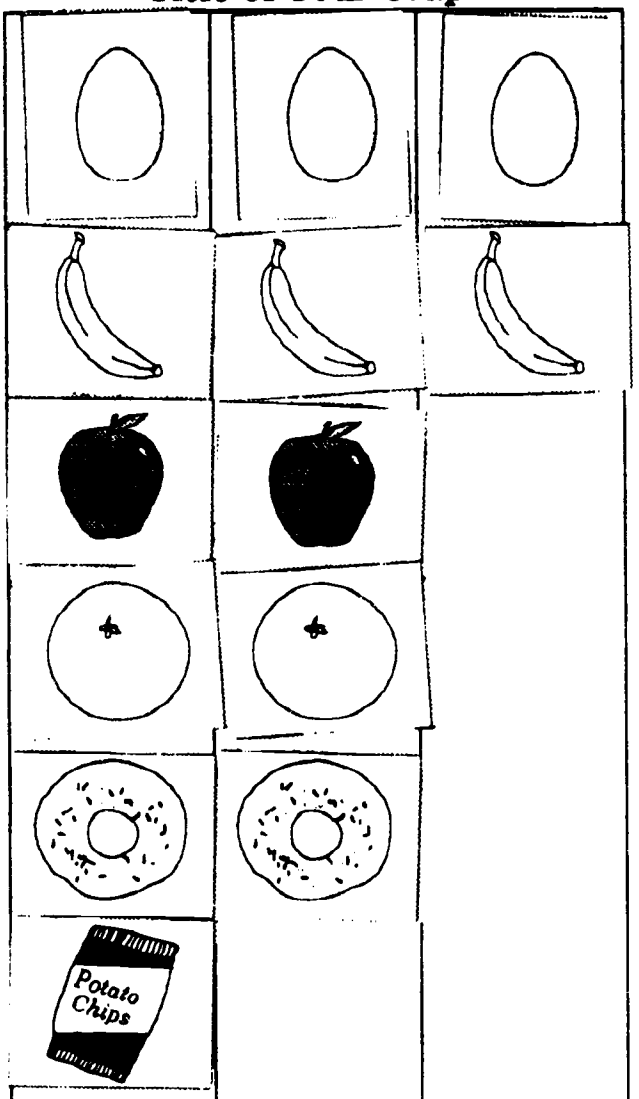
- Cut out **all** the foods shown below. Cut along the lines.
- Sort them into **3 GROUPS** on your desk.
- Explain how you sorted the food.

I took the food and layed them out and paired them.

- Glue your groups to make a pictograph.
- Label and title the pictograph.

The food graph

Title of Your Graph



group 6 group 5 group 2

Labels

Appendices

Appendix A

Grade 3 Mathematics Holistic Scoring Criteria

	3	2	1	0
Understanding the Problem	Analyzed and readily understood the task	Understood the task	Partially understood the task	Totally misunderstood the task
Developing a Plan	Showed explicit evidence of a plan	Showed some evidence of a plan	Showed little evidence of a plan	Showed no evidence of a plan
Carrying Out the Plan	Used an efficient and workable strategy	Used a workable strategy	Used an appropriate strategy some of the time	Used an inappropriate, unworkable strategy
Looking Back	Communicated the processes needed to solve the problem in a clear and logical manner	Communicated basic procedures used to solve the problem	Communicated an answer that was unclear or had little or no connection to the problem	Did not communicate an answer to the problem

Appendix B

Percentage of Students at Each Level

These provincial results show the percentage of students demonstrating the different levels of performance on the total assessment.

Student Achievement	Percentage
Students Achieving the Standard of Excellence	4.6
Students Achieving Acceptable Standard But Not the Standard of Excellence	67.1
Students Not Yet Achieving Acceptable Standard	28.3