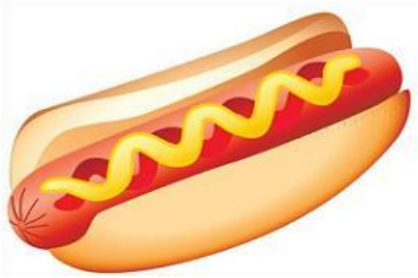
Sample MidMCM Problem
Hot Dog Concession Stand



During events at your school, students operate a ***concession stand*** to raise money in support of student activities. Your team is in charge of the concession stand for this year. Your team will sell food and other items at the stand. There are 10 monthly events this year.

Each year, the team operating the stand has the goal of raising as much money as possible for student activities. In order to do this, the team needs to avoid wasting money on items that don't sell, but also needs to have enough items to meet demand. In the past, teams have learned that at some events they purchased too many of an item, and at other events they ran out of an item.

Of most concern are ***perishable*** food items, like hot dogs. Because they are perishable, and to ensure freshness, hot dogs must be purchased only a few days before each event. Due to the school's concession stand rules, unsold hot dogs must be either given away or thrown away (discarded in the garbage) after each event. Your teacher has collected data on the number of hot dogs sold at each event over the past several years (see Table 1). You will notice that the number of hot dogs sold at each event changes. You have also learned that at two or three of the 10 events each year, the concession stand ran out of hot dogs.

Number Of Hot Dogs Sold At Each Event For The Past 5 Years					
EVENT #	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**
1	149	167	161	176	208
2	183	193	166	174	164
3	220	163	186	171	152
4	172	146	156	152	186
5	188	166	180	147	148
6	164	198	155	189	177
7	181	188	139	190	202
8	181	218	213	201	202
9	162	167	181	153	174
10	160	142	198	175	178

Table 1: Number of Hot Dogs Sold Over the Past 5 Years
Note: Year 5 is last year, year 1 was five years ago.

For this MidMCM, your team has the following options to purchase hot dogs from a local store. Table 2 shows the options for purchasing packages of hot dogs. You are planning to sell each hot dog for $2.00.

Hot Dogs in a Package	Cost (US Dollars)
8	$5.00
16	$8.00
24	$10.00

Table 2: Cost of Packages of Hot Dogs

Your task is to plan the purchases of hot dogs for the upcoming 10 events with the goal of raising the most money for student activities. Your team will purchase hot dogs for the concession stand using money from the student activities ***fund***. The fund currently has $75 dollars to purchase hot dogs for the first event. After each event, your team will deposit (put in) money raised from selling hot dogs into the fund. Prior to each event, you will withdraw (take out) money from the fund to purchase hot dogs.

1. Planning for Hot Dog Purchases.

a. Keeping in mind that your goal is to raise the most money for student activities, think about the questions you need to ask and decisions you need to make prior to planning your purchases of hot dogs. Make a list of these questions and decisions. To get you started, a few questions you might want to consider are:

- What do the data from the past years tell us about hot dog sales?
- What ***assumptions*** do we need to make to solve this problem?
- Given the changing demand for hot dogs, how do we decide how many hot dogs to purchase for each event?

b. Using the data provided and answering your questions from Part 1.a., develop a plan for purchasing hot dogs for the concession stand for the 10 events this year. Your plan might give the exact number of hot dogs to purchase each month for each event, or it might provide a ***procedure (or algorithm)*** to determine those amounts. Make sure you not only present your plan, but you also describe how you developed your plan.

c. Using your plan, and supporting your work with mathematics (like graphs, tables, calculations), look at the expected student activities fund deposits and withdrawals over the year.

- Are the required funds available prior to each event?
- Determine the total amount of money you expect to raise from the concession stand by the end of the year.
- Discuss what might impact this amount making it higher or lower than expected.

2. Plan for increased sales.

There are many ways that your team might try to increase the amount of money you make at the concession stand. One idea might be to decrease the price of a hot dog in order to sell more hot dogs. Develop your own idea to increase the money raised throughout the year and then write a paragraph about how your idea would help the concession stand make more money. Include any mathematics used (like graphs, tables, calculations) to support your idea.

Your PDF solution document of no more than 25 total pages should include:

- One-page Summary Sheet.
- Table of Contents.
- Your complete solution.
- References list.

Glossary:

Concession Stand: A table or booth selling food, drinks, or other items at an event location.

Fund: A collection of a sum of money saved and made available for a specific purpose (for example, the Student Activities Fund).

Perishable: Likely to decay or go bad quickly.

Assumptions: A hypothesis or educated guess that takes the place of an unknown piece of information.

Procedure (or Algorithm): A way of doing something. A series of actions done in a certain order.

Guidance for our First Annual MidMCM.

As this is the first year of MidMCM, COMAP does not have example papers online. Therefore, we provide the following general guidance about submission organization.

Solutions must be in PDF format and submitted in one PDF document. This, however, does not preclude MidMCM teams from doing mathematics, graphs, tables, sketches, etc. by hand and including pictures of their work in the single PDF document submission. As students move to high school and the HiMCM, we expect that submissions will be typed. For the MidMCM, advisors may assist students in putting their solution components into one PDF format file for submission.

As with HiMCM, there is a 25-page limit for the submission document. This does not mean your solution must be 25 pages. All portions of your submission (text, graphs, tables, charts, pictures, etc.) must be within one PDF document that is 25 pages or less.

In general, a complete solution submission is organized as follows:

Executive Summary (Summary Sheet) – written last, this page summarizes your work.

Table of Contents – list the major items in your solution document to show the organization of your paper.

Introduction and Restatement of the Problem – orient the reader by introducing the problem and restating the problem in your own words.

Assumptions (with Justifications) – state any assumptions you made to simplify and solve the problem (and state why you made those assumptions).

Variable Definitions – define any variables you use in your model and equations.

Presentation of Model and Solution – ensure you address all requirements and describe what you are doing as you solve the problem. Show and explain all your work. Use representations that help you tell the reader how you solved the problem (equations, tables, graphs, etc.).

Analysis of Your Work – address any strengths (good points) and limitations (weaknesses) of your model and solution.

Conclusion – end your solution paper with a final concluding paragraph that summarizes your results and/or makes recommendations for future work.

Reference List – list any sources that you used to solve the problem (for example, website pages, newspaper or magazine articles, etc.).

TEACHER NOTES:

As this is our first MidMCM, we provide this pilot/sample problem for you to try out in your classroom in the file **2021_MidMCM_HotDogs.pdf**. The problem statement (pages 1-3 of this document) stands alone for students. All information is contained in these pages. Page 4 provides some guidance for teachers that they can share with students about solution submissions, organization, and formatting.

We have provided the hot dog sales data in the student data file **2021_MidMCMC_Student_HotDogData.xlsx** for students familiar with excel or spreadsheets. Students may use this file, but they do not have to.

We have provided the hot dog sales data, along with charts and some of the averages of hot dogs sold in the teacher data file **2021_MidMCM_Teacher_HotDogData.xlsx** for teachers to review for additional ideas and representations of these data.

We provide additional problem ideas we considered below. We did not include them as we felt our sample problem was long enough. You might use these as part of a follow-on class discussion or project extension of this sample MidMCM.

- Expand the problem to include other products (chips, drinks, etc.). Students could look at combination of sales of various items to raise the most money.
- Add the cost of hot dog rolls to the problem and note that many times packages of hot dog rolls come in different numbers than packages of hot dogs.
- Do not require hot dogs be thrown away. Perhaps have students think about whether they could freeze them for the next event or perhaps donate them.
- Include all additional sources of overhead (paper goods, condiments, cleaning supplies, gloves for servers, etc.) and discuss the "true" cost of each hot dog.

Please let us know what you think about the problem and how we might improve future MidMCM problems. Email us at info@comap.com.

The MidMCM Team
COMAP, Inc.
www.comap.com
@COMAPMath