Lab Framework

Text: CORD
Unit number and title: Unit 8 – Working with Shapes in Three Dimensions
Short Description: Students are given an aluminum soup can and material cost information. They are then asked why soup is packaged in a cylindrical shaped cans rather than cubes or spheres.
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Lab Title
Soup's On

LAB PLAN

TEACHER: Teacher Prep/ Lesson Plan

- **Lab Objective**
  Calculate and analyze the most cost-effective shape choice for an aluminum soup can based on volume, total area, and material cost.
- **Statement of pre-requisite skills needed**
  Basic math skills: adding/subtracting/multiplying/dividing/graphing
  Basic algebra skills: solving for one unknown
- **Vocabulary**
  Cylinder
  Cube
  Sphere
  Volume
  Total Surface Area
  Base Area
  Fluid Ounces
  Radius
  Diameter
  pi
- **Materials List**
  - Give each group:
    - Empty Standard Aluminum Soup Can
    - Measuring tape/ruler
    - Calculator
  - Give each student:
    - An information sheet with the following information
      - Formulas for Total Surface Area & Volume of Shapes
      - Cost per ounce for aluminum ($.50/ounce)
      - Empty cylinder can weight (.59 ounces)
      - 1 ounce to cubed inches conversion value (1 fluid oz = 1.805 in^3)
    - Information sheet with given values, conversion information, and formulas
    - Worksheet to record data, calculations, and results
    - Graphs for presentation of results
    - Memo template for recommendation paragraph with explanation

- **State Standards addressed**

  Math:
  - G.3.K: Analyze cross-sections of cubes, prisms, pyramids, and spheres and identify the resulting shapes.
  - G.6.C: Apply formulas for surface area and volume of three-dimensional figures to solve problems.
  - G.6.F: Solve problems involving measurement conversions within and between systems, including those involving derived units, and analyze solutions in terms of reasonableness of solutions and appropriate units.
  - G.7.A: Analyze a problem situation and represent it mathematically.
  - G.7.F: Summarize mathematical ideas with precision and efficiency for a given audience and purpose.
  - G.7.G: Synthesize information to draw conclusions and evaluate the arguments and conclusions of others.
  - G.7.H: Use inductive reasoning to make conjectures, and use deductive reasoning to prove or disprove conjectures.

  Reading:
  - EALR 2: The student understands the meaning of what is read.
  - EALR 3: The student reads different materials for a variety of purposes.

  Writing:
  - EALR 2: The student writes in a variety of forms for different audiences and purposes.

  Communication:
  - EALR 1: The student uses listening and observation skills and strategies to gain understanding.
  - EALR 3: The student uses communication skills and strategies to effectively present ideas and one's self in a variety of situations.
- **Leadership Skills**
  - 1.1 The student will analyze, refine, and apply decision-making skills through classroom, family, community, and business, and industry (work-related) experiences
  - 1.5 The student will be involved in activities that require applying theory, problem-solving, and using critical and creative thinking skills while understanding outcomes of related decisions
  - 2.1 The student will communicate, participate, and advocate effectively in pairs, small groups, teams, and large groups in order to reach common goals.
  - 2.8 The student will demonstrate the ability to incorporate and utilize the principles of group dynamics in a variety of settings
- **SCAN Skills/Workplace Skills**
  - 1.1 The student will demonstrate the ability to identify, organize, plan and allocate resources. This means that the student is able to demonstrate allocating time, money, materials, space and staff.
  - 1.2 The student will demonstrate the ability to acquire and use information in family, community, business and industry settings. This means that the students can acquire and evaluate data, organize and maintain files, interpret and communicate, and use computers to process information.
- **Set-up information**
  - Make copies of information sheet, worksheet, graphs, and memo
  - Set out cans, measuring tapes/rulers, and calculators

- **INTRODUCTION TO LAB GIVEN FIRST DAY**
  Inform the students that they are working for a soup company, and they are now in charge of the production of the standard aluminum soup can division. As an eager new division team, they want to save money for the company. With over 3 billion cans of soup sold per year in their company, every penny saved can result in massive profits. They are questioning if the cylinder shape of the aluminum soup can is really the most cost effective way to package the soup.

  Provide them with a standard aluminum soup can, and ask them to calculate the volume in ounces and the total surface area in inches. They must then calculate the total surface area in inches for both a cube and a sphere that would hold the same volume of soup.

  Given the price of aluminum per ounce and the weight of an empty can, they can then determine the material cost for each can shape. They should then determine the total volume of shelf/box space the object would use and the total footprint (or base area) it would take up.

  They can then graph the different results for each of the shapes in order to determine which shape would make the most cost effective choice.

- **Lab organization**(-Grouping/leadership opportunities/cooperative learning expectations; -**Timeline required)**
  This lab can be broken into 3 segments that may take ¾ to a full week to complete
  - In the first segment, students will be collecting data on the cylindrical shaped aluminum can & making the calculations for volume, total surface area, and cost of material.
  - In the second segment, students will be making the same calculations for the cubic and spherical shaped cans based on the same volume
  - In the final segment, students will graph their findings, analyze their results, and come up with a rationale for a shape proposal for the aluminum cans

- **Teacher Assessment of student learning** (scoring guide, rubric)
  These items should be turned in for evaluation:
  - Worksheet – data collection & calculations
  - Graph of results
  - Memo with recommendation and reasoning

- **Summary of learning** (to be finished after student completes lab)
  - discuss real world application of learning from lab
  - opportunity for students to share/present learning

- **Optional activities**

You could have students create replica of the spherical (with a balloon) and cubic (with paper) shapes & provide them with a canned food box (from case of 24) to continue demonstrate the space used concept further.

- **Career Applications**
  Engineer
  Manufacturer
  Sales & Marketing
  Cost Controller

Lab Information Sheet

Unit: 8 Working with Shapes in Three Dimensions

Lab Title: Soup's On

Given Values:
Approximate empty can weight = .59 ounces
approximate price of aluminum per ounce = $0.50

Conversion Values:
1 fluid ounce = 1.805 in^3

Formulas:

Radius:
Half the Diameter (r=d/2)

Volume:
Cylinder ($v=\pi r^2 h$)

Cube ($v=e^3$)

Sphere ($v=\frac{4}{3}\pi r^3$)

Total Surface Area:
Cylinder ($a=2\pi rh + 2\pi r^2$)

Cube ($a=6 \times e^3$)

Sphere ($a=\pi 4r^2$)

LAB TITLE: Soup's On
STUDENT INSTRUCTIONS:

- **Statement of problem addressed by lab**
  What is the optimal cost-effective soup can shape?

- **Grouping instructions and roles**
  Students will work in groups of 3-4 and will be responsible for having their own work recorded. Each group will work together on data collection. Each individual will record the data and calculation results on their own data collection/calculation sheet.

- **Procedures** – steps to follow/instructions
  Students will collect data on an aluminum soup can, make calculations using the data collected, graph the data collected, and create a memo regarding their recommendations on the optimal soup can shape.

- **Outcome instructions**
  Students should be able to see that although a sphere or cube would take up the most optimal space, the cylinder is the most optimal shape once cost of material is considered.

- **Assessment instructions** (peer-teacher)
  Students will help each other within the group. Worksheets and memos are collected and graded for completeness and detail in documentation and reasoning.

Lab Data Collection & Calculations

Student: _____ **Date:** _____

Unit: 8 – Working with Shapes in Three Dimensions

Lab Title: Soup's On

Criteria: Write the problem/objective in statement form
What is the optimal cost-effective soup can shape?

Data Collection: Record the collected/given data
Calculations: Complete the given calculations to solve for an answer(s)

Collect & Calculate Data on the Following Aluminum Soup Can 3D Shape Options:

1. Cylinder
   a. Height (inches) - collect
   b. Diameter (inches) - collect
   c. Radius (inches) – calculate (r=d/2)
   d. Volume (fluid ounces) –
      i. Calculate ($v=\pi r^2 h$) in inches^3
      ii. Convert to fluid ounces (1 fluid ounce = 1.805 in^3)
      iii. Compare to volume information on the can – (How close is your calculation?)
   e. Total Surface Area (inches^2) – calculate ($a=2\pi rh+2\pi r^2$)
   f. Cost of Material (per can) – calculate
      (approximate empty can weight = .59 ounces)
      (approximate price of aluminum per ounce = $0.50)
      i. Surface area per ounce (inches^2)- calculate (a/weight)
      ii. Cost per inch^2 – calculate (price per ounce/surface area per ounce)
      iii. Cost per soup can cylinder– calculate (surface area x cost per inch^2)
   g. Total volume of shelf/box space used per can (inches^3) – calculate (v=d x d x h)
   h. Total footprint (base area) used per can (inches^2) – calculate (a=d x d)

2. Cube
    a. Length of every width/height/depth (inches) for same volume – calculate ($v=e^3$)
    b. Total Surface Area (inches^2) – calculate ($a=6 \times e^3$)
    c. Cost per soup can cube – calculate (surface area x cost per inch^2)
    d. Total volume of shelf/box space used per can (inches^3) – calculate ($v=e^3$)
    e. Total footprint (base area) used per can (inches^2) – calculate ($a= e^2$)
3. Sphere
    a. Radius for same volume – calculate ($v=\frac{4}{3}\pi r^3$)
    b. Total Surface Area (inches^2) – calculate ($a=\pi 4r^2$)
    c. Cost per soup can cube – calculate (surface area x cost per inch^2)
    d. Total volume of shelf/box space used per can (inches^3) – calculate ($v=r^3$)
    e. Total footprint (base area) used per can (inches^2) – calculate ($a= r^2$)

Summary Statement:

Complete the following summary statement regarding your shape recommendation and reasoning using the memo template provided:

Our team has studied the current aluminum soup can shape and considered other shape options for the sake of cost effectiveness. We have determined that the following shape would be the most cost effective option for our company for the following reasons:

Other Assessment(s)

Graph your data collection/calculation results on the graph worksheets provided to include with your memo to use as supporting evidence for your recommendation and reasoning.

Lab Graph Worksheet 1 of 4

Student: _____ **Date:** _____

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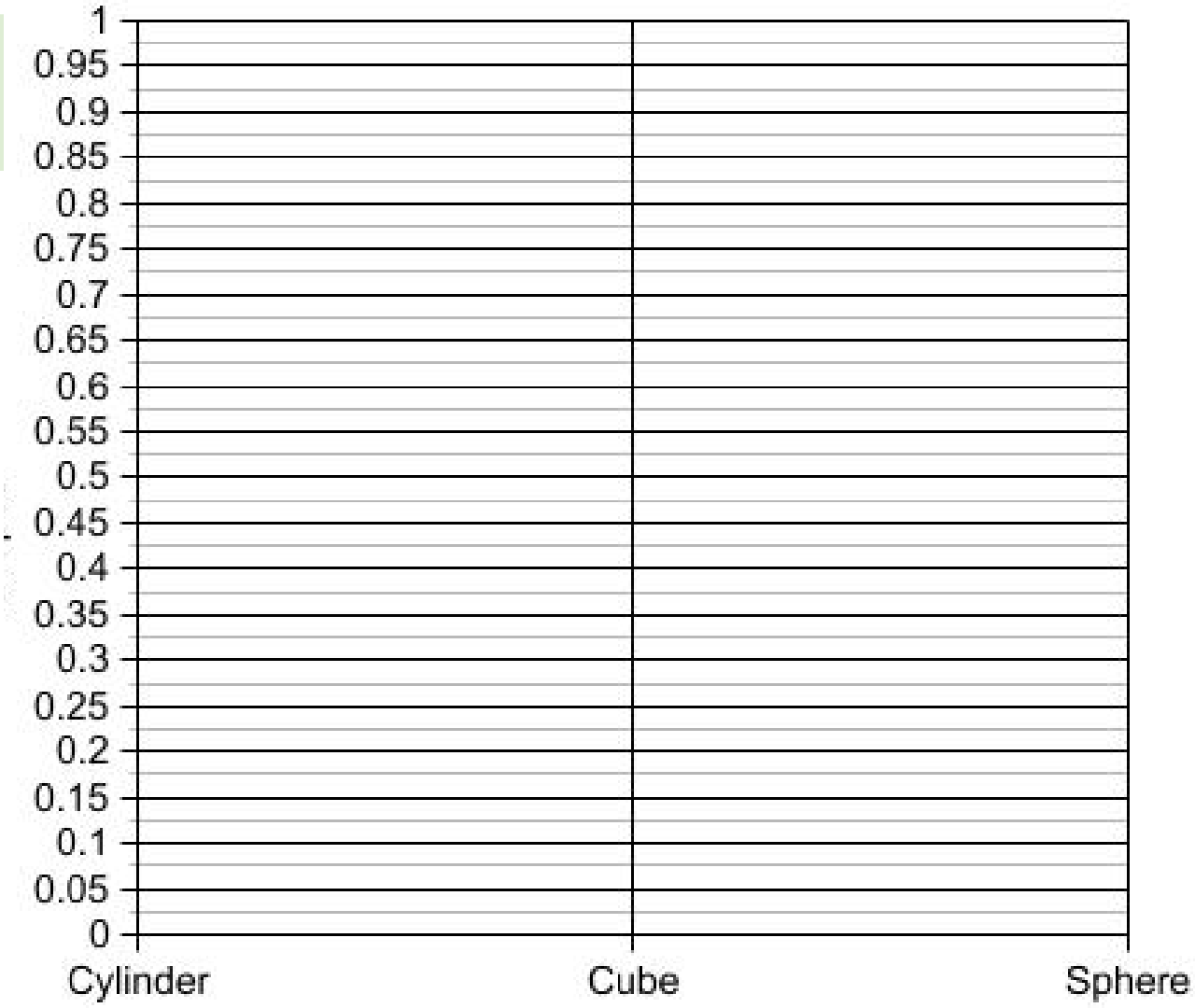
Graph your results for each shape:

TOTAL SURFACE AREA IN INCHES^3:
(Remember to label your points with the values)

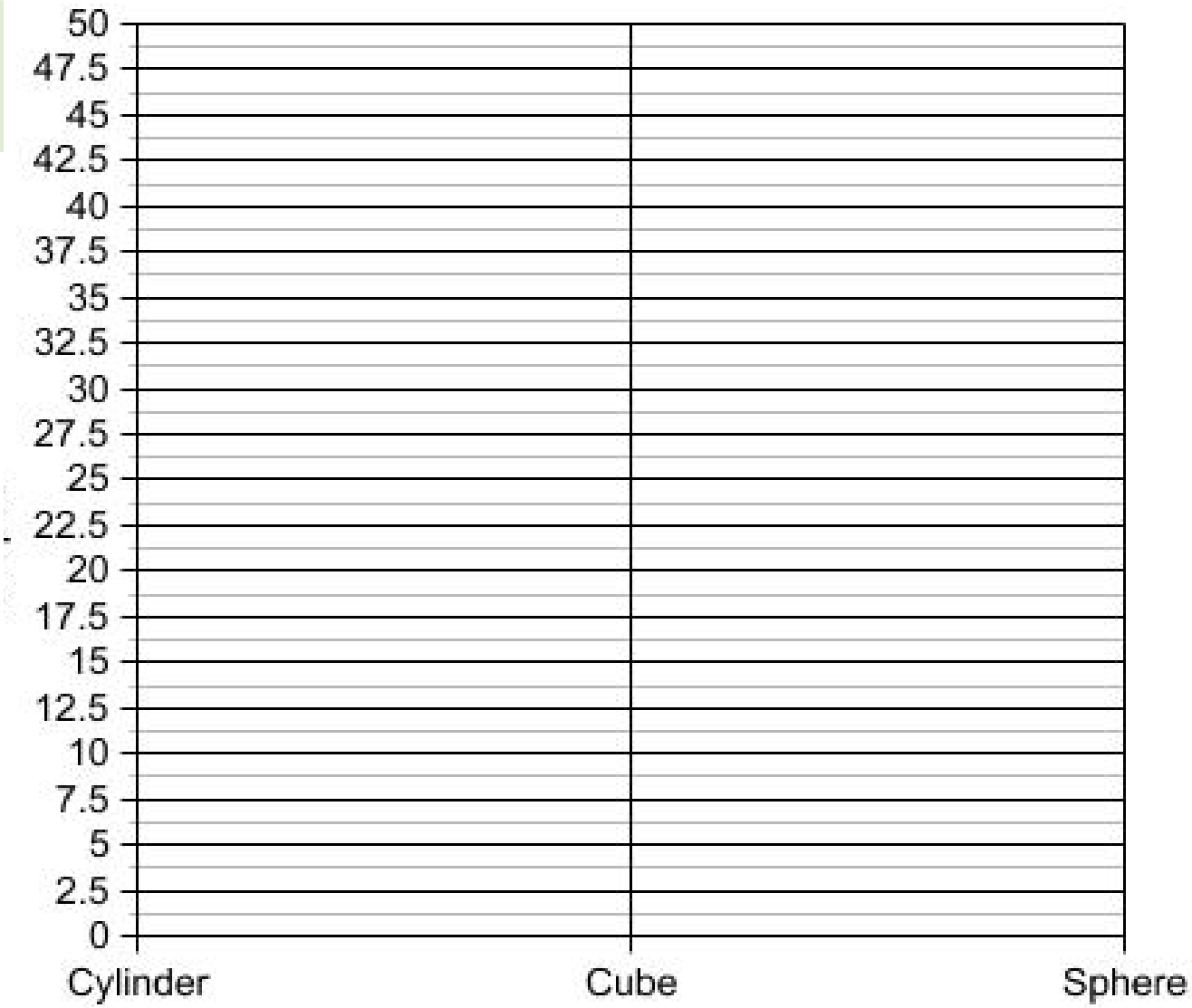
Lab Graph Worksheet 2 of 4

TOTAL COST PER CAN IN DOLLARS:
(Remember to label your points with the values)



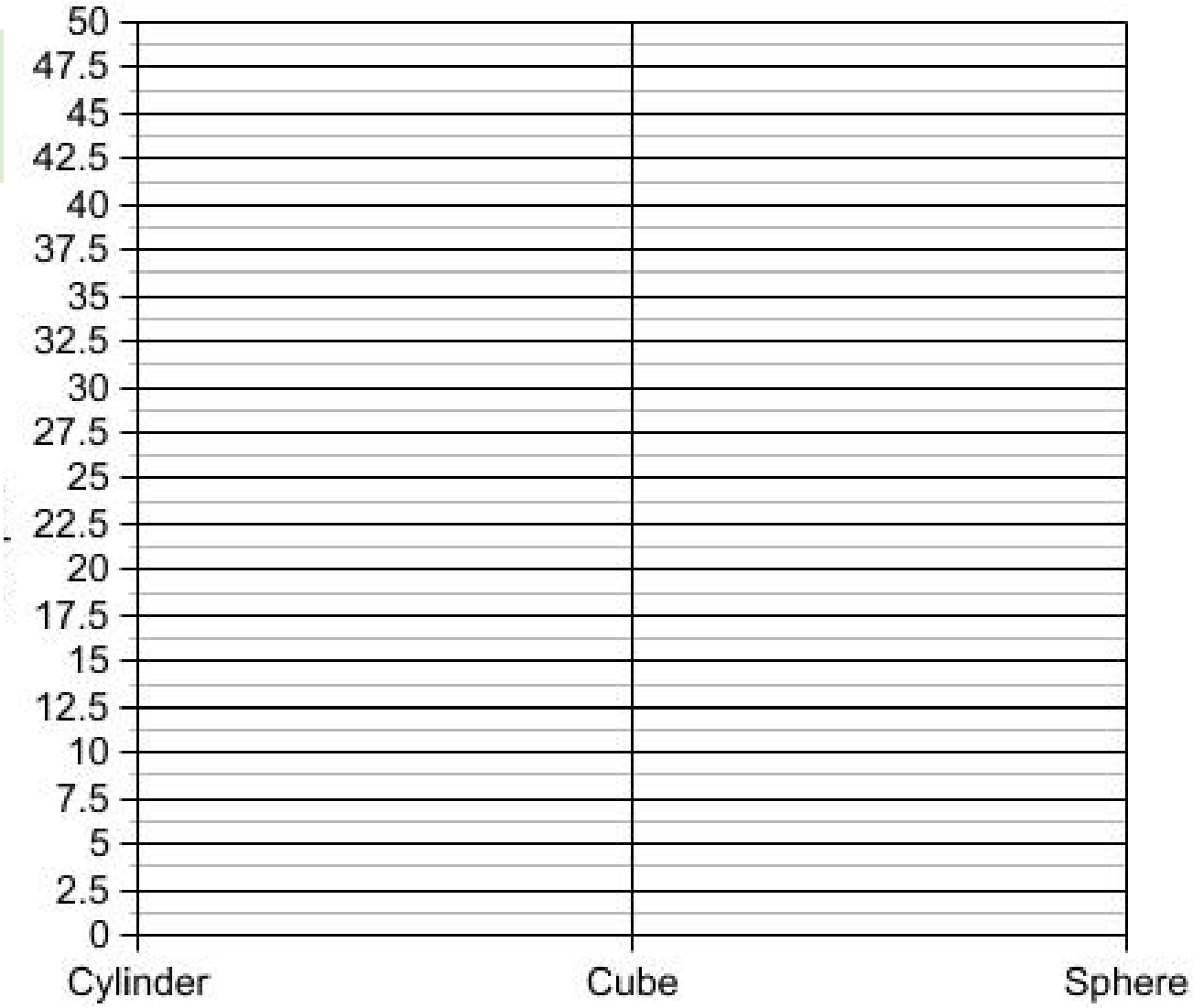
Lab Graph Worksheet 3 of 4

TOTAL FOOTPRINT (BASE AREA) REQUIRED PER CAN IN INCHES^2:
(Remember to label your points with the values)



Lab Graph Worksheet 4 of 4

TOTAL VOLUME OF SPACE REQUIRED PER CAN IN INCHES^3:
(Remember to label your points with the values)



Soup's On

Memo

To: Soup's On Board of Directors
From:
Date:
Re: Most cost effective aluminum soup can shape

Shape Recommendation & Reasoning

Our team has studied the current aluminum soup can shape and considered other shape options for the sake of cost effectiveness. We have determined that the following shape would be the most cost effective option for our company for the following reasons: