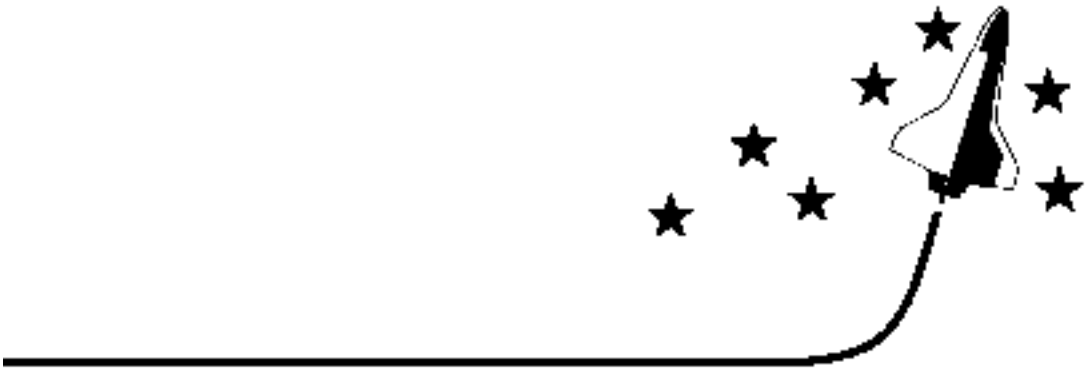
FACULTY NOTES

The LTAs and Spinoffs are designed so that each professor can implement them in a way that is consistent with his/her teaching style and course objectives. This may range from using the materials as out-of-class projects with minimal in-class guidance to doing most of the work in class. The LTAs and Spinoffs are amenable to small group cooperative work and typically benefit from the use of some learning technology. Since the objective of the LTAs and Spinoffs is to support the specific academic goals you have set for your students, the Faculty Notes are not intended to be prescriptive. The purpose of the Faculty Notes is to provide information that assists you to take full advantage of the LTAs and Spinoffs. This includes suggestions for instruction as well as answers for the exercises.



FACULTY NOTES

LTA 2

NASA Aquatics Lab

Background Information

This LTA is written so that in Part III Exercise 2, students will develop a function for the load of the form $L(x) = \frac{a}{x^2}$, where x^2 is the radius of the pallet. In Part III Exercise 3, the students should get a linear function of the height.

Mathematical topics covered include:

Relations involving Measurement and Geometry
Basic Level Rational Equations
Basic Level Graphs, Geometry
Rational Functions and
Limits (intuitively).

Timeline: This Laboratory Technical Activity (LTA) is intended as a two hour laboratory activity where students interact with peers and instructors. It is suggested that students begin work on this project during one class period and take it home for further work either individually or collaboratively. They can then finish the project either outside of class or during the following class period.

Required Technology: Any graphing calculator or computer algebra system may be employed. The LTA assumes students have a basic knowledge of how to graph functions and perform elementary operations with the technology the instructor uses in class.

Level: Precalculus or College Algebra

Instructional Methodology: This LTA is intended for group activity either in class or take home or both. Instructors are better able to meet individual needs in this learning environment because the capable students may be able to proceed with little or no assistance.

Possible Modifications: The LTA could be easily modified to provide a more difficult exercise for students when constructing their initial load function. The first two sections could be replaced by a single paragraph which instructs the students to identify appropriate variables, constants, and units needed to solve the load problem.

> One variation of this would be to have the students start the identification in small groups, share their results with a larger group, and successively larger groups until the entire class has discussed appropriate variables, and so forth. It might be possible to have the class split into two competitive groups to come up with the "best" list with more points awarded to those with the best list.
>
> Another variation would be to have the students start on the identification of variables, etc., and then hand out Parts I and II after the students have worked on the problem for a while.

The first problem in Part III could be rewritten so that students would be allowed (or even encouraged) to choose the area of the pallet as the independent variable. The remaining questions would not need to be changed.

Part V Exercise 1, could be omitted without losing the value of the LTA as a learning tool. The question is intended to help put the mathematics into context.

Part VI could be eliminated also if time is a problem. It would make the LTA shorter, and the instructor may have writing activities in another part of the course which are sufficient.

Assessment**:** Specific learning objectives are listed in Part VI.

Problem #	Point Value	Objectives
Part I	10 (1/2 point each)	Mathematical Modeling, Unit Analysis
Part II	8 (2 points each; one for constant/variable)	Mathematical Modeling, Unit Analysis
Part III	20 (4 points for #1; 8 each for #2 & #3)	Mathematical Modeling, Critical Thinking, Communicating Mathematics
Part IV	36 (4 points for #5; 8 each for #1-#4)	Interpreting Graphs, Unit Analysis, Communicating Mathematics, Function Values, Critical Thinking
Part V	10 (5 points each)	Communicating Mathematics, Critical Thinking, Interpreting Graphs
Part VI	16	Communicating Mathematics, Critical Thinking
Total:	100	

Learning Objectives: As a result of doing this LTA, students should improve their skills in the following areas.

1. Mathematical Modeling: understand connections between a technical application and an algebraic representation
2. Interpreting Graphs: find points of intersection, interpret practical meaning of the coordinates, and recognize asymptotic behavior
3. Unit Analysis: convert units and determine the units of each variable involved
4. Communication: communicate mathematics to others, both written and verbal
5. Critical Thinking: deduce conclusions and explain the practical meaning of mathematical results
6. Function Values: evaluate rational functions at various points in the domain, find a value in the domain corresponding to a given value in the range

Solutions

Note: Answers for LTA 2 have been rounded to the three most significant digits to be consistent with the accuracy of the data provided.

Part I - Relevant Quantities

Table 1

Quantity	Constant or Variable	Constant Value or Variable Symbol	Appropriate Units
number of gallons per cubic foot	constant	7.48 (i)	gallons/cubic foot
volume of entire tank in cubic feet	constant	75.4 (ii)	cubic feet
volume of entire tank in gallons	constant	564 (iii)	gallons
radius of the tank	constant	2	feet
radius of the pallet	variable	r	feet
height of the tank	constant	6	feet
water level in the tank	variable	h	feet

(i) Number of gallons per cubic foot = $\dfrac{62.4\dfrac{lbs}{ft^3}}{8.34\dfrac{lbs}{gal}} = 7.48201\dfrac{lbs}{ft^3}\dfrac{gal}{lbs} = 7.48201\dfrac{gal}{ft^3}$

(ii) Volume of tank (in cubic feet) = $V = \pi\ (2\,ft)^2(6\,ft) = 75.3982\ ft^3$

(iii) Volume of tank (in gallons) = V = $(7.48201\dfrac{gal}{ft^3})(75.3982\ ft^3) = 564.13\,gal$

Part II - Relationships

1. a) A
   b) $A = \pi r^2$

2. a) V
   b) $V = 4\pi h$

3. a) W
   b) $W = 784h$

4) Weight of full tank of water = $8.34\dfrac{lbs}{gal}(564.13\,gal)$ = 4700 lbs (rounded to 3 signifiant digits)

Part III - Modeling

1) Distributed load of full tank = $\dfrac{4700\,lbs}{\pi\,(2\,ft)^2} = 374\,\dfrac{lbs}{ft^2}$

2) Independent variable: r (in feet)
Dependent variable: L (in pounds per square foot)
Function: $L = \dfrac{4700}{\pi r^2}$

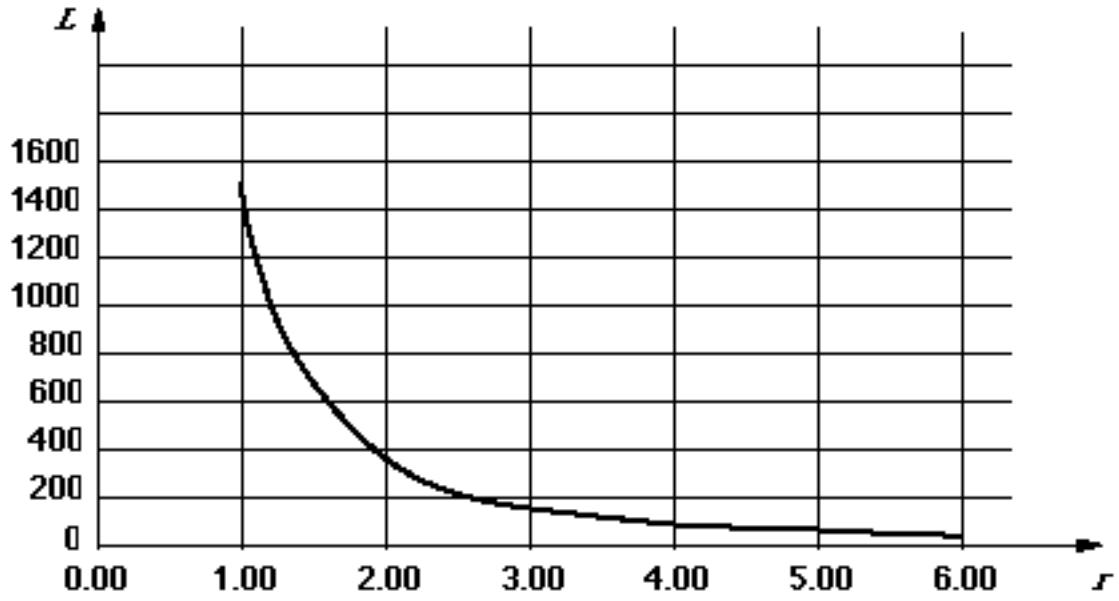
3) Independent variable: h (in feet)
Dependent variable: L (in pounds per square foot)
Function: $L = \dfrac{62.4\,(4\,\pi\,h)}{4\pi} = 62.4\,h$

Part IV - Analysis

1) The radius of the pallet can be no more than 6 feet because the distance from the center of Tank A to the nearest obstruction is $\frac{3}{4}$ inch on the floor plan.

$\frac{3}{4}$ inch $\div$ $\frac{1}{8}$ inch per foot = $\frac{3}{4}$ 8 feet = 6 feet

2) Notice that in the following graph we have taken the domain to be the interval (0,6]. This will allow us to study the effect of making the radius of the pallet any number greater than 0 feet but less than or equal 6 feet.



3) Algebraic Solution

$\frac{4700}{\pi r^2} = 200 \qquad r^2 = \frac{23.5}{\pi} \qquad r = 2.74$

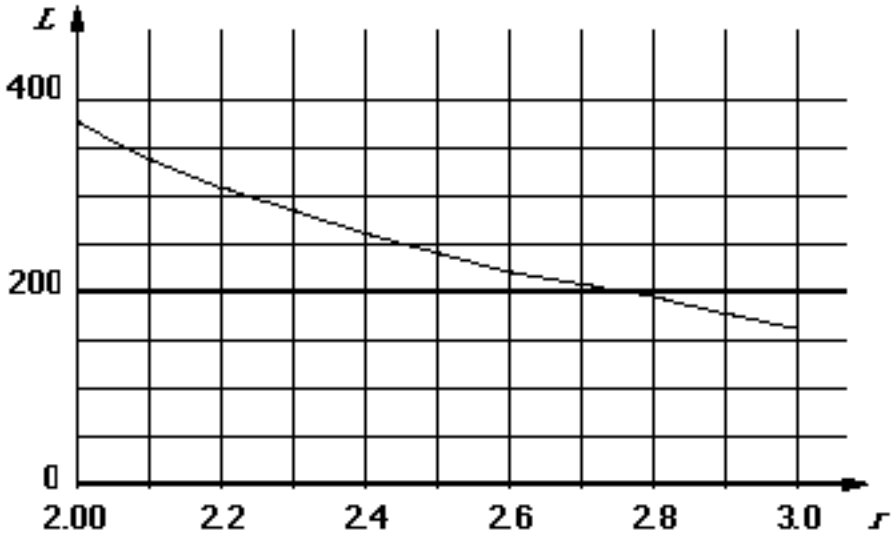
Numerical Solution

r	L
1	1500
2	374
3	166
4	93.5

r	L
2.5	239
2.6	221
2.7	205
2.8	191

r	L
2.72	202
2.73	201
2.74	199
2.75	198

Graphical Solution



4) $62.4h = 200 \qquad h = 3.21$
The height of the water in the tank must be under 3.21 feet in order to keep the load under 200 lb per sq ft.

5) $7.48(\pi\ 2^2)(3.21) = 301.728$
The number of gallons that can be safely stored in the tank cannot exceed 301 gallons.

Part V - Other Considerations

1) Various written responses are possible.

2) The load decreases and eventually gets close to zero as the radius of the pallet is allowed to increase without bound.

Part VI - Conclusions

A written report