

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 5

Toxic Waste Remediation at the Kennedy Space Center!

Technological subject area of the LTA: Hazardous waste risk assessment. Risk assessment is the process of analyzing a potentially polluted area to determine if and how the site should be cleaned up.

Mathematics topics used in the LTA: Use of formulas, dimensional analysis, scientific notation, percentage.

Prerequisite knowledge: The LTA has two parts which are appropriate for the beginning or intermediate algebra level. Spinoff 5A requires knowledge of linear equations and functions and is just an extension of the LTA to a higher mathematical level.

Approximate class time for LTA: 3-4 hours.

Discussion of LTA and pedagogy:

The subject of the LTA is hazardous waste clean up. This is a highly technical field with many terms and techniques that are not known to the general public. Because of this we feel that anyone wanting to use the LTA in the classroom will need to use Part 1 which introduces students to the terminology and process of risk assessment. We have included a story in Part 1 to generate student interest. We suggest that it be given either as homework for students or as a class assignment with students working in a cooperative group setting. There are discussion questions at the end of Part 1, which are used primarily to help students understand the process and terms used in risk assessment. Each of these problems is open-ended and does not have only one answer.

The purpose of Part 2 is to lead students through the process of risk assessment. It should develop student skills such as use of formulas, dimensional analysis, organization of data in table format, and operations with scientific notation. Answers to the activities are included at the end of this discussion. The problems and discussion questions at the end of Part 2 are designed to reinforce these concepts and to ask students to synthesize their knowledge. Some of these questions are designed to encourage students to write about mathematics and connect what they are learning to other experiences. We feel that group work on this part would be very appropriate with students writing summary reports on an individual basis. Instructors planning to use this LTA might also consider inviting faculty from disciplines related to the topic of the LTA to collaborate in the project.

Note: It is worthwhile to note that the values used in the LTA and Spinoffs, such as Reference Dose, Reference Concentration, and Slope Factor, were current as of 7/97. These values may change as further research indicates. **Such changes would impact on the results of the calculations but not on the methodology.**

Spinoff 5A asks students to consider a more general case than Part 2. It requires students to produce, graph and analyze linear equations. Answers to Questions 1-8 are included after this discussion. There are more discussion questions at the end of Part 3. Each of these questions is open-ended and has no single correct answer. These discussion questions are designed, again, to encourage students to write about mathematics and connect what they are learning to other experiences. The use of group work on this part is recommended. We also encourage the use of a graphing calculator or other graphing utility on this Spinoff. It might be appropriate to have students present results of their work on any of the discussion questions in the LTA as oral presentations.

Spinoff 5B uses student skills in fitting linear equation to data, so a graphing calculator is a must. The topic of this Spinoff is permeability of rock surrounding a groundwater reservoir. It is conceivable that this Spinoff could be used as a stand-alone unit.

Spinoffs 5C and 5D are further explorations of the LTA material which extend students' knowledge of the risk assessment process. These Spinoffs should not be attempted unless students have completed the LTA. The level of mathematics needed in these Spinoffs is the same as the LTA and no more than a scientific calculator is necessary.

Answers to Part 2

Activity 1 Using equivalencies such as $1\text{ g} = 0.0353\text{ oz}$ and $16\text{ T} = 8\text{ oz}$ we find that 100 mg is approximately 1/4 teaspoon.

1.9 cubic meters is about the volume of a small refrigerator.

1 liter per day is about 1 quart per day in American units.

Activity 2 $6.250\text{E}+03$ liters

Activity 3 $9.500\text{E}+04\text{ m}^3$

Activity 4

Table 2

Exposure Assumption	Reference Variable	Units	Reasonable Maximum Exposure Value
Intake Rate <ul style="list-style-type: none"> • eating • breathing • drinking 	IR	mg/day	100
		m ³ /hr	1.9
		l/day	1
Exposure Time	ET	hr/day	8
Exposure Frequency	EF	days/yr	250
Exposure Duration	ED	years	25
Amount Ingested <ul style="list-style-type: none"> • eating • breathing • drinking 	AI	kg	6.250E-01
		m ³	9.500E+04
		l	6.250E+03

Activity 5

Table 3

Intake Factor	Reference Variable	Units	Value
Carcinogenic Intake Factor <ul style="list-style-type: none"> • eating • drinking • breathing 	CIF	kg/kg-day	3.495E-07
		l/kg-day	3.495E-03
		m ³ /kg-day	5.312E-02
Non-carcinogenic Intake Factor <ul style="list-style-type: none"> • eating • drinking • breathing 	NIF	kg/kg-day	9.785E-07
		l/kg-day	9.785E-03
		m ³ /kg-day	1.487E-01

Activity 6 and 7

Table 4 Pathway Sums for Ingesting Soil

Metal	Cancer Risk	Hazard Quotient
Beryllium	3.246E-07	4.227E-05
Thallium		9.967E-02
Pathway Sums	3.246E-07	9.971E-02

Activity 8 and 9

Table 6 Pathway Sums for Inhaling Airborne Soil

Hazardous Substance	Cancer Risk	Hazard Quotient
Beryllium	9.977E-11	6.650E-09
Cadmium	6.259E-11	
Chromium	7.565E-09	
4-Methyl-2-Pentanone		5.332E-07
Pathway Sums	7.727E-09	5.399E-07

Activity 10 and 11

Table 8 Pathway Sums for Ingesting Water

Hazardous Material	Cancer Risk	Hazard Quotient
Arsenic	2.055E-04	1.279E+00
Barium		8.4815E-03
Nickel		3.567E-03
Pathway Sums	2.055E-04	1.291E+00

Activity 12

Since the Cancer Risk for drinking the water is greater than 10^{-6} and the Hazard Quotient for drinking the water is greater than 1, we should assume that drinking the water at the site would pose a risk to an industrial worker at this site. The values for Cancer Risk and Hazard Quotient do not indicate a risk from ingesting the soil and breathing the contaminated air.