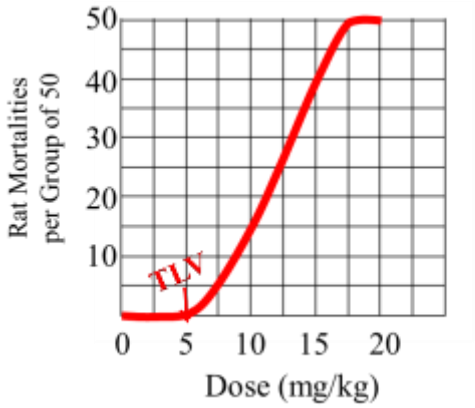
Acute Toxicity Study of an Experimental Chemical

Scientists performed an experiment to test the toxicity of a new chemical and used rats as a test organism. Different doses of the chemical are prepared and administered to nine groups of rats. The rats were observed for 2 weeks and the number of mortalities was recorded in each test group. The findings are indicated in the chart shown below.

Test Group	Number of Rats	Weight of Each Rat	Dose Given (mg/kg)	Number of Mortalities
1	50	0.5kg	0.0	0
2	50	0.5kg	2.5	0
3	50	0.5kg	5.0	0
4	50	0.5kg	7.5	5
5	50	0.5kg	10.0	15
6	50	0.5kg	12.5	25
7	50	0.5kg	15.0	40
8	50	0.5kg	17.5	50
9	50	0.5kg	20.0	50

1. Graph the dose given versus the number of mortalities in each 50-member test group. Make sure to label the graph axes.



2. What is the independent variable in this study? **dose (mg/kg)**

3. What is the dependent variable in this study? **number of rat mortalities (deaths)**

4. Which group served as the control group? **group 1 – was administered no treatment – used as a standard of comparison**

5. What are some other controlled variables that must be considered when conducting this experiment?

   weight of rat, number of rats in each test group, age, gender, and health of rat, type and amount of food fed to test subjects, same living conditions

6. What is the NOEL range? **0 – 5 mg/kg**

7. What is the LD_{50}? **12.5 mg/kg**

8. Indicate the TLV on the graph.
   What is the approximate value of the TLV? **5 mg/kg**

9. Assuming that a human being will respond to the chemical in the same way that a rat does, what is the dose in mg that would be lethal to a 70kg person? Show your work.

$$\frac{70\text{kg}}{1} \times \frac{12.5\text{ mg}}{1\text{kg}} = 875\text{mg}$$

Name _____ Date _____

APES Topic 9 – Toxicology Mr. Romano

Determining Toxicity AND Dimensional Analysis

PART I. Definition Check

1. What does LD_{50} mean and how do scientists determine the LD_{50} of a chemical?

LD_{50} means "lethal dose" is the amount of toxicant/chemical that kills 50% of a laboratory test population

2. In what units is the LD_{50} expressed? **mg/kg**

3. What are some of the ethical concerns regarding research for lethal doses?

animal testing / experimentation has always been debated topic between scientists and special interest groups

PART II. Determining Lethal Doses: Use dimensional analysis to complete the calculations in the data charts below

The LD_{50} for acetaminophen (Tylenol) = 2402 mg/kg (rat, administered orally)
The LD_{50} for ibuprofen (Advil) = 200mg/kg (rat, administered orally)

To use LD_{50}, you will need to convert measurements of body weight from pounds to kilograms
(1 kg = 2.2 lbs) do the following calculations:

1. How many kg does a 132-lb human weigh?	60 kg	$\frac{132\ \text{lb}}{1} \times \frac{1\ \text{kg}}{2.2\ \text{lb}} = 60\text{kg}$
2. How many kg does a 22-lb child weigh?	10 kg	$\frac{22\ \text{lb}}{1} \times \frac{1\ \text{kg}}{2.2\ \text{lb}} = 10\text{kg}$

ACETAMINOPHEN

	Calculations made	Answer
1. How many mg of Tylenol would be lethal to a 132-lb adult?	$\frac{60\ \text{kg}}{1} \times \frac{2402\text{mg}}{1\ \text{kg}}$	**144,120 mg**
2. How many 500mg tablets of Tylenol would be lethal for 132-lb adult?	$\frac{144{,}120\ \text{mg}}{1} \times \frac{1\ \text{tablet}}{500\ \text{mg}}$	**288 tablets**
3. How many mg of Tylenol would be lethal to a 22-lb child?	$\frac{10\ \text{kg}}{1} \times \frac{2402\text{mg}}{1\ \text{kg}}$	**24,020 mg**
4. How many 500mg tablets of Tylenol would be lethal for a 22-lb child?	$\frac{24{,}020\ \text{mg}}{1} \times \frac{1\ \text{tablet}}{500\ \text{mg}}$	**48 tablets**

IBUPROFEN

	Calculations made	Answer
1. How many mg of ibuprofen would be lethal to a 132-lb adult?	$\frac{60\ \text{kg}}{1} \times \frac{200\text{mg}}{1\ \text{kg}}$	**12,000 mg**
2. How many 500mg tablets of ibuprofen would be lethal for 132-lb adult?	$\frac{12{,}000\ \text{mg}}{1} \times \frac{1\ \text{tablet}}{500\ \text{mg}}$	**24 tablets**
3. How many mg of ibuprofen would be lethal to a 22-lb child?	$\frac{10\ \text{kg}}{1} \times \frac{200\text{mg}}{1\ \text{kg}}$	**2,000 mg**
4. How many 500mg tablets of ibuprofen would be lethal for a 22-lb child?	$\frac{2{,}000\ \text{mg}}{1} \times \frac{1\ \text{tablet}}{500\ \text{mg}}$	**4 tablets**

Part III: Summarizing

1. a. Which is more toxic, acetaminophen or ibuprofen? **ibuprofen**

   b. Mathematically, how great is the difference in their toxicities?

   ibuprofen is 12X more toxic than acetaminophen– a lower dosage has a greater response

   this can be determined 3 ways ….

   divide LD 50s - 2402 / 200 = 12 **divide 288 tablets / 24 tablets = 12** **divide 48 tablets / 4 tablets = 12**

2. Besides dosage, what other factors should be considered when determining the toxicity of a substance on a person?

   overall health, metabolic rate, age, gender, tolerance

3. How many Flintstone vitamin tablets would be a lethal dose of vitamin A for a 22-lb child?
   Each Flintstone vitamin tablet contains 0.9 mg of vitamin A and the LD_{50} of vitamin A = 2000 mg/kg.
   Show work in the area provided.

$$\frac{22\ \text{lb}}{1} \times \frac{1\ \text{kg}}{2.2\ \text{lb}} \times \frac{2000\ \text{mg}}{1\ \text{kg}} \times \frac{1\ \text{tablet}}{0.9\ \text{mg}} = \textbf{22,222 tablets}$$