Lethal Dose Activity

Chemical reactions occur all around us and even inside of us. Some chemical reactions that occur in our bodies can be lethal. This activity is designed to introduce the topic of lethal dose and how to calculate the lethal dose of certain substances for humans.

**Part One: Lethal Dose and Weight Conversions**
Lethal dose is the concentration of a substance that kills 50% of the animals tested. It is represented by the symbol, \( \text{LD}_{50} \). The lethal dose of substances is different for people of different ages because lethal dose depends on body weight. In fact, the unit used to express lethal dose is \( \text{mg/kg} \), milligrams of substance per kilogram of body weight.

Because lethal dose is dependent on a person’s body weight, the first thing that must be done when calculating the lethal dose of a substance is to convert the person’s weight (usually measured in pounds) to kilograms. To do this you need to use dimensional analysis bridges as well as the conversion factor: \( 1.0 \text{ kg} = 2.2 \text{ lbs} \). Here are a few examples:

How many kg are in 150 lbs?

\[
\begin{array}{c|c|c}
150 \text{ lbs} & 1.0 \text{ kg} & = 68 \text{ kg} \\
2.2 \text{ lbs} & & \\
\end{array}
\]

How many pounds (lbs) would a 150 kg person weigh?

\[
\begin{array}{c|c|c}
150 \text{ kg} & 2.2 \text{ lbs} & = 330 \text{ lbs} \\
1.0 \text{ kg} & & \\
\end{array}
\]

Use the information above to calculate the following:
1. How many kg does a 132-lb human weigh?

2. How many kg does a 22-lb human child weigh?

**Part Two: Calculating Lethal Dose**

The \( \text{LD}_{50} \) for acetaminophen (aka Tylenol) is 2,404 \( \text{mg/kg} \) (rat, oral).

3. How many mg of acetaminophen would be lethal to a 132-lb adult?
   a. How many 500 mg tablets would that be?

4. How many mg of acetaminophen would be lethal to a 22-lb child?
   a. How many 500 mg tablets would that be?

The \( \text{LD}_{50} \) for aspirin is 200 \( \text{mg/kg} \) (rat, oral).

5. How many mg of aspirin would be lethal to a 132-lb adult?
   a. How many 500 mg tablets would that be?

6. How many mg of aspirin would be lethal to a 22-lb child?
   a. How many 500 mg tablets would that be?
Part Three: Comparing Lethal Doses
Examine the table of lethal doses for various substances.

7. What substance in the table is the most toxic when ingested? Explain.
8. Write the substances in order from most toxic to least toxic based on their lethal doses for ingestion only. (Ignore the substances that have lethal doses for “inhaled” or not available).
9. Calculate the lethal dose of the following substances for YOU (your body weight):
   a. Sugar  b. Caffeine  c. Alcohol  d. Aspirin
10. Are any substances in the table good for you? Explain.
11. Are there any substances in the world that are not toxic? Why or why not?

<table>
<thead>
<tr>
<th>Common name</th>
<th>Toxin</th>
<th>Lethal doses</th>
<th>Description</th>
<th>Toxic response</th>
</tr>
</thead>
<tbody>
<tr>
<td>aspirin</td>
<td>acetyl- salicylic acid</td>
<td>$LD_{50}$ 200 mg/kg (rat, oral)</td>
<td>odorless white crystal</td>
<td>gastric distress, confusion, psychosis, stupor, ringing in ears, drowsiness, hyperventilation</td>
</tr>
<tr>
<td>sodium chloride</td>
<td>NaCl</td>
<td>$LD_{50}$ 3 g/kg (rat, oral) 12357 mg/kg (human, oral)</td>
<td>white cubic crystal</td>
<td>eye irritant, elevated blood pressure</td>
</tr>
<tr>
<td>chlorine</td>
<td>Cl₂</td>
<td>$LD_{50}$ 850 mg/kg, (rat, inhaled)</td>
<td>greenish colored gas, amber liquid, pungent odor</td>
<td>corrosive to eyes, skin, respiratory tract, nausea, vomiting, pulmonary edema</td>
</tr>
<tr>
<td>helium</td>
<td>He</td>
<td>not established</td>
<td>odorless colorless gas</td>
<td>dizziness, nausea, simple asphyxiant</td>
</tr>
<tr>
<td>lorchel mushroom</td>
<td>C₄H₈N₂O</td>
<td>$LD_{50}$ 200 mg/kg (rat, oral)</td>
<td></td>
<td>nausea, vomiting, severe liver damage, coma, convulsions</td>
</tr>
<tr>
<td>arsenic</td>
<td>arsenic, arsenic trioxide</td>
<td>$LD_{50}$ 15 mg/kg (rat, oral)</td>
<td>grey, metallic crystals</td>
<td>acute - irritates eyes, skin, respiratory tract, nausea. Chronic - convulsions, tissue lesions, hemorrhage, kidney impairment,</td>
</tr>
<tr>
<td>sugar</td>
<td>glucose</td>
<td>$LD_{50}$ 30 g/kg (rat, oral)</td>
<td>sweet white powder</td>
<td>depressed activity, gastrointestinal disturbances. If diabetic – heart disease, blindness, nerve damage, kidney damage</td>
</tr>
<tr>
<td>iron tablets</td>
<td>iron sulfate</td>
<td>~ 5 adult tablets toxic for a 3 year old</td>
<td>greyish white powder</td>
<td>nausea, vomiting, diarrhea, black stool, liver damage, coma</td>
</tr>
<tr>
<td>iron tablets</td>
<td>FeSO₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lead</td>
<td>lead</td>
<td>Lowest published dose 450 mg/kg</td>
<td>bluish or silvery solid</td>
<td>acute - headache, insomnia, joint pain. Chronic-anemia, kidney disease, reproductive and developmental toxin.</td>
</tr>
<tr>
<td>snake venom</td>
<td>$\alpha$-bungarotoxin C₃₃₈H₅₂₉N₉₇O₁₅S₁₁</td>
<td>not available</td>
<td>large protein molecule</td>
<td>Paralysis, suffocation, loss of consciousness, seizures, hemorrhaging into tissues</td>
</tr>
<tr>
<td>Cola</td>
<td>caffeine</td>
<td>$LD_{50}$ 140 mg/kg (dog, oral)</td>
<td>white odorless powder or crystals</td>
<td>acute renal failure, nausea, psychosis, hemorrhage, increased pulse, convulsions</td>
</tr>
<tr>
<td>alcohol</td>
<td>ethanol</td>
<td>$LD_{50}$ 7060 mg/kg (rat, oral)</td>
<td>colorless liquid, pleasant odor</td>
<td>nausea, headache, vomiting, dizziness, nervous system depression, confusion, loss of consciousness</td>
</tr>
<tr>
<td>vitamin A</td>
<td>retinol</td>
<td>$LD_{50}$ 2000 mg/kg (rat, oral)</td>
<td>yellow crystals, orange solid</td>
<td>convulsions, unconsciousness, reproductive toxin</td>
</tr>
<tr>
<td>vitamin A</td>
<td>retinol</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>