



Lethal Dose Activity

CLASS SET!

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, LD₅₀. 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 **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 kg = 2.2 lbs**. Here are a few examples:

How many kg are in 150 lbs?

$$\frac{150 \text{ lbs}}{2.2 \text{ lbs}} \times \frac{1.0 \text{ kg}}{2.2 \text{ lbs}} = 68 \text{ kg}$$

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

$$\frac{150 \text{ kg}}{1.0 \text{ kg}} \times \frac{2.2 \text{ lbs}}{2.2 \text{ lbs}} = 330 \text{ lbs}$$

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 LD₅₀ for acetaminophen (aka Tylenol) is 2,404 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 LD₅₀ for aspirin is 200 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?

Common name	Toxin	Lethal doses	Description	Toxic response
aspirin	acetyl- salicylic acid $C_9H_8O_4$	LD ₅₀ 200 mg/kg (rat, oral)	odorless white crystal	gastric distress, confusion, psychosis, stupor, ringing in ears, drowsiness, hyperventilation
table salt	sodium chloride NaCl	LD ₅₀ 3 g/kg (rat, oral) 12357 mg/kg (human, oral)	white cubic crystal	eye irritant, elevated blood pressure
bleach (fumes)	chlorine Cl_2	LD ₅₀ 850 mg/kg, (rat, inhaled)	greenish colored gas, amber liquid, pungent odor	corrosive to eyes, skin, respiratory tract, nausea, vomiting, pulmonary edema
helium	helium He	not established	odorless colorless gas	dizziness, nausea, simple asphyxiant
lorchel mushroom	gyromitrin $C_4H_8N_2O$	LD ₅₀ 200 mg/kg (rat, oral)		nausea, vomiting, severe liver damage, coma, convulsions
arsenic	arsenic, arsenic trioxide As, As_4O_6	LD ₅₀ 15 mg/kg (rat, oral)	grey, metallic crystals	acute - irritates eyes, skin, respiratory tract, nausea. Chronic - convulsions, tissue lesions, hemorrhage, kidney impairment,
sugar	glucose $C_6H_{12}O_6$	LD ₅₀ 30 g/kg (rat, oral)	sweet white powder	depressed activity, gastrointestinal disturbances. If diabetic – heart disease, blindness, nerve damage, kidney damage
iron tablets	iron sulfate $FeSO_4$	~ 5 adult tablets toxic for a 3 year old	greyish white powder	nausea, vomiting, diarrhea, black stool, liver damage, coma
lead	lead Pb	Lowest published dose 450 mg/kg (human, oral)	bluish or silvery solid	acute - headache, insomnia, joint pain. Chronic-anemia, kidney disease, reproductive and developmental toxin.
snake venom	α -bungarotoxin $C_{338}H_{529}N_{97}O_{105}S_{11}$	not available	large protein molecule	Paralysis, suffocation, loss of consciousness, seizures, hemorrhaging into tissues
Cola	caffeine $C_8H_{10}N_4O_2$	LD ₅₀ 140 mg/kg (dog, oral)	white odorless powder or crystals	acute renal failure, nausea, psychosis, hemorrhage, increased pulse, convulsions
alcohol	ethanol C_2H_6O	LD ₅₀ 7060 mg/kg (rat, oral)	colorless liquid, pleasant odor	nausea, headache, vomiting, dizziness, nervous system depression, confusion, loss of consciousness
vitamin A	retinol $C_{20}H_{30}O$	LD ₅₀ 2000 mg/kg (rat, oral)	yellow crystals, orange solid	convulsions, unconsciousness, reproductive toxin