CST – –

Chem 3b.c

Lethal Dose

ChemCatalyst:

Q: Which substance is most toxic- alcohol, aspirin or arsenic?

Q: How is toxicity determined?

Notes:

- What is meant by "lethal dose"?
  - concentration of a substance that kills 50% of the animals tested
  - represented by the symbol = LD_{50}
  - depends on body weight
  - expressed as the unit = mg/kg
    - $\frac{\text{mg (of substance)}}{\text{kg (of body weight)}}$

- How do I convert pounds to kg?
  - $\boxed{1\text{ kg} = 2.2\text{ lbs}}$ = conversion factor/ratio
  - use dimensional analysis bridges
    - ex: How many kg are in 150 lbs?

$$150\text{ lbs} \left| \frac{1\text{ kg}}{2.2\text{ lbs}} \right. = 68\text{ kg}$$

- ex: How many lbs are in 150 kg?

$$150\text{ kg} \left| \frac{2.2\text{ lbs}}{1\text{ kg}} \right. = 330\text{ lbs}$$

Lethal Dose

Name:_____

Date: _____Period _____

Purpose: In this activity you will compare the toxicity of various substances.

Part I: Determining lethal dose

Lethal dose (or **LD_{50}**) refers to the amount of substance that kills 50 percent of a test sample. LD_{50} is expressed in mg/kg, or milligrams of substance per kilogram of body weight. Assume LD_{50} is the same for rats and humans.

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

1. How many kg does a 132-lb human weigh?

   60 kg

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

   10 kg

The LD_{50} for acetaminophen is 2404 mg/kg (rat, oral).

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

   144,240 mg

4. How many 500 mg tablets of acetaminophen would be lethal for an adult?

   288

5. How many mg of acetaminophen would be lethal to a 22-lb child?

   24,040 mg

6. How many 500 mg tablets of acetaminophen would be lethal for a child?

   48

The LD_{50} for aspirin is 200 mg/kg (rat, oral).

7. How many mg of aspirin would be lethal to a 132-lb adult?

   12,000 mg

8. How many 500 mg tablets of aspirin would that be for an adult?

   24

9. How many mg of aspirin would be lethal to a 22-lb child?

2,000 mg

10. How many 500 mg tablets of aspirin would that be for a child?

4

Acetaminophen versus aspirin

11. Which is more toxic, acetaminophen or aspirin? How great is the difference in their toxicities? Explain.

Aspirin is 100x more toxic than acetomenophen (Tylenol)

Part II: Comparing lethal doses
Examine the table of lethal doses for various substances.

1. What substance in the table is the most toxic when ingested? Explain.

arsenic

2. Rank the substances as best you can based on their lethal doses for ingestion by putting a number next to each one, "1" being the most toxic.

arsenic → sugar

3. Are any substances in the table good for you? Explain.

Yes

4. Are there any substances in the world that are not toxic? Why or why not?

No

Making sense:
How is dosage related to toxicity?

If you finish early…
Explain how you would calculate the lethal dosage for vitamin A. Assume each tablet contains 3 mg of retinal.

Lethal Dose Table

Lethal dose (LD_{50}) is the amount of an ingested substance that kills 50 percent of a test sample. It is expressed in mg/kg, or milligrams of substance per kilogram of body weight.

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

Making Sense Notes:

- What determines the toxicity of a substance?
  - ALL substances are toxic if the dose (exposure) is great enough
  - Factors that determine toxcity:
    1. size (body weight)
    2. physiology (metabolism)
    3. health (illness)

  * the smaller the LD_{50}, the more toxic

- What is a solution?
  - solution: a mixture of 2 or more substances that is uniform throughout (aka homogenous mixture)
    - solvent: substance in greatest amount
      - does the dissolving
    - solute: substance in smaller amount
      - being dissolved

- What is concentration?
  - concentration: amount of solute per amount of solvent
    - symbolized as [ ]
    - in chemistry, it is usually measured in moles per liter (mol/L) referred to as molarity (M)

Check-in

Q: Methadone: LD_{50} = 95 mg/kg
Is it more toxic than Tylenol?

A: more

Q: Calculate the lethal dose for a 120 lb. human.

$$120 \text{ lbs} \left| \frac{1 \text{ kg}}{2.2 \text{ lbs}} \right. = 55 \text{ kg}$$

$$95 \frac{\text{mg}}{\text{kg}} \left| 55 \text{ kg} \right. = 5200 \text{ mg}$$